# FOREWORD

In the light of the noble goals assigned to faculty of science, as a prime cornerstone of the great Cairo University, and in the context of the need to cope and catch up with the miraculous scientific and technological advancements full of astonishing achievements, it has become a must to develop and modernize (enhance) the faculty protocol to meet the requirements of our modern society and to contribute in preparing the faculty graduates to occupy prospective leading professional positions in diverse fields. There is no doubt that the highly advancement in the well developed chemical industries, communication facilities, space sciences, genetic engineering and biotechnology, natural resources discoveries, environment fields and many others is merely a net result of basic science research.

Based on the amendments of Cairo University in 2000 and those of the supreme council of Universities (SCU) that call for establishing principles for the development and enhancement of faculty protocols and curricula to catch up with the world standards, faculty staff in all departments in a fruitful cooperation with the faculty administration made great efforts to establish such principles for the ultimate benefit from the semester system and the credit hours system. The development or enhancement strategy in new protocol is represented in four principal directions:

1. Application of the two-semester/year system.
2. Application of the credit hour system.
3. Creation and bringing about double specializations for the benefit of the modern society.
4. Establishment a system including compulsory and optional elective courses to keep a high level of faculty graduates.

The development strategy aims at:

1. Offering well-qualified and professional graduates.
2. Encouraging students for self-education.
3. Creating a positive atmosphere that allows students to have better opportunities for their academic, cultural and intellectual development.

As we are looking for a scientific revolution, we make commitment to God to work hard, do our best and ask him the Almighty to fulfill our hopes. Whatever we do is for the sake of God.

"And say (unto them): Act ! Allah will behold your deeds, and (so will) his messenger and the believers".

**Prof. H. M. Hassaneen**

**Dean of the Faculty**

# PREFACE

In the context of implemmenting Cairo University amendments calling for a shift towards the credit hours system in the educational systems of University colleges, Faculty of science has responded and adopted the credit hour system in its educational program.

The system requires the student to pass successfuly in at least 146 credit hour of compulsory and elective courses through four study levels. Each level covers two semesters including lectures, practical and applied periods submitted by all departments of the faculty.

A protocol consists of 19 articles in full agreement with the Universities Regulation Law and its excutive protocol has been established. This is followed by a comprehensive review of different programs in the diverse specializations, and what courses required by the concerned departments at the four levels. The information pertaining the educational programs is listed in tables including course level, semester, prerequisites and the course state, whether it is compulsory for specific specialization or elective (optional) for others. In addition, the credit hours for lectures, practical and applied periods are included with a resultant of Ca. 18 credit hour per semester for single specialization and Ca. 9 credit hour in each specialization in case of double major (specializations). Tables include imperative remarks to guide students in determining their pathways and specialization during their study period.

The tabulated programs include courses offered by the concerned department as well as courses from other departments that may be required for specific specialization. On the other hand, courses outlines submitted by the departments include courses offered by the concerned department only at all of the four levels, excluding courses from other departments. Each student is asked to make sure of what courses are required.

The tabulated programs are somewhat comprehensive, clear, simple and easy to follow all of its diverse segments.

We ask the Almighty God to guide us in implemmenting such ambitious project in cooperation with our colleagues, faculty staff, who constitute the team of the academic tutors and those working with the administration of Education and student's Affairs after digesting and acquiring the skills of the credit hour system.

I whish to express my gratitude for the many helpful efforts that have been received from colleagues, and coworkers in writing and presenting such material.

**Prof. Sherif A. Khairy**

**Vice Dean**
**For Education and Students Affairs**

# THE PROTOCOL

## Articles of the Protocol of the Credit Hour System in Faculty of Science, Cairo University

**Article (1)**

The Faculty of Science – University of Cairo – includes the following Departments:

1- Mathematics Department.
2- Physics Department.
3- Chemistry Department.
4- Botany Department.
5- Zoology Department.
6- Geology Department.
7- Entomology Department.
8- Astronomy and Meteorology Department.
9- Biophysics Department.
10- Geohpysics Department.

**Article (2)**

Based on recommendation of the Faculty Board, the University grants the following scientific degrees:

a- Special B. Sc. (single specialization).
b- General B. Sc. (double specialization).

**Article (3)**

The B. Sc. special degree (single specialization) is granted in the following specializations:

1. Chemistry.
2. Mathematics.
3. Statistics.
4. Computer Science.
5. Physics.
6. Communication Physics.
7. Biophysics.
8. Astronomy.
9. Space Science.
10. Geology.
11. Geophysics.

Other single specializations are established in accordance with the rules of the excutive protocol of the Universities Regulation Law.

**Article (4)**
The B. Sc. general degree (double specialization) is granted in the following specializations:

1. Chemistry/Physics.
2. Chemistry/Geology.
3. Chemistry/Zoology.
4. Chemistry/Botany.
5. Chemistry/Microbiology.
6. Chemistry/Biochemistry.
7. Chemistry/Entomology and Environmental Health.
8. Physics/Mathematics.
9. Physics/Astronomy.
10. Physics/Meteorology.
11. Mathematics/Astronomy.
12. Geology/Geophysics.

Other double specialization could be established according to the rules of the excutive protocol of the Universities Regulation Law.

**Article (5)**
The credit hour system (2 semesters) is the system of study adopted by the Faculty.

**Article (6)**
The period of study to obtain a B. Sc. degree is 4 academic years, according to the article 48 in the excutive protocol of the Universities Regulation Law. Through this period, 4 study levels are attained. Each level covers two semesters, intervened by the midyear vacation.

**Article (7)**
The academic semester extends for 17 weeks including:

a- One week for registration.
b- 14 weeks of study.
c- Two weeks for the exams.

The first semester starts every year by the 3rd Saturday of September.

**Article (8): Credit hour definition**

a- In case of lectures:
A credit hour equals a weekly hour lecture during the academic semester.

b- In case of practical and applied periods:
A credit hour equals an applied or practical period of 2 or 3 hours/week during the academic semester.

**Article (9)**

Requirements for B. Sc. graduation are:

1- 8 credit hours as University requirements including the following:

2 credit hours for computer study.

2 credit hours for studying English language.

2 credit hour course in human rights.

2 credit hours for humanities in one of the following:

Principles of Management and Accounting, Islamic culture, Arabic language, Introduction to law, Environmental culture, History and Philosophy of Science.

2- 30 credit hours as Faculty requirements, all falling in the first level and include:

18 credit hours equally divided among Chemistry, Physics and Mathematics.

12 credit hours equally divided for two of the following specializations:

Geology, Zoology, Botany, Entomology, Biology, Astronomy and Space Science, Mechanics, Algebra, Biophysics, Geophysics.

3- Specialization requirements:

a- For the award of the special B. Sc. degree (single specialization), 108 credit hours determined by the concerned department.

b- For the award of the General B. Sc. Degree (double specialization), 108 credit hours equally divided between the two major (specialization) subjects.

c- All students should perform a six weeks training period in one of the institutions related to his/her specialization during summer holidays in consultation with the academic adviser (No credit given).

**Article (10)**

Registration, academic load and courses:

1- Registration:

a. The Vice Dean for Education and Students' Affairs (VDESA) supervizes the execution of the rules and procedures of registration, of the subject groups, lists, study time-tables, and directing students to their academic tutors, issuing the student cards of the subject.

All academic data are to be introduced in special official records. Registration should be completed by the first week of the semester.

b. For those students who were unable to register in due time because of forcible reasons accepted by the Committee of Student Affairs, they can register through the 2nd week of the semester.

2- Academic tutoring:

An academic tutor is appointed to guide every student and help him/her in selecting subjects and determining the number of credit hours registered according to his/her conditions and abilities, as well as helping solve his/her

problems-all data are to be recorded in a student card. The tutor has to sense the subjects registered by the student in every semester until graduation.

3- Study (Academic) load:

The student is allowed to register for 18 credit hours in each semester, except in the following conditions:

a. Distinguished or highly performing students (with a cumulative average of 3.0 or higher) may add to those and register in additional elective (optional) courses, from the requirements of his/her specialization, offered by the different departments of the faculty. This is limited to a maximum of 8 credit hours throughout the study period and the grades are added to the general cumulative average.
b. The study load may be increased in the final semester in order to meet the graduation requirements, based on the approval of the Faculty Board.
c. A student with a cumulative average of 2 is not allowed to register in more than 12 credit hours per semester.

**Article (11)**

Additions, omission, withdrawal and major shifting (changing specialization)

a. Subject to the approval of the academic tutor, a student may add or omit one course or more, not after the end of the 4th week of the academic semester provided that the study load (article 10) is not affected.
b. A student may drop a course by the 6th week of the semester, as recommended by the academic tutor. The course will be included in the student's academic record with grade "withdraw" provided that the student does not exceed the allowed days of absence before withdrawal.
c. A student is allowed to modify (change) his specialization, on condition that he/she fulfills the requirements of the desired specialization. The credit hours he/she has passed before in inconsistent fields will be rejected. Such modification (change) should get the consent of the academic tutor and the Committee of Education and Students Affairs (CESA).

**Article (12)**

The student should submit to the rules of the University and Enrollment Faculty, regarding dissmissal, chances of rejoining (enrollment), accepted execuses for not taking the exams, freezing, and all rules pertaining to students' discipline, referred to in Article 123 in the excutive protocol of the Universities Regulation Law.

**Article (13): Attendance**

The course instructor reports student attendance, at the beginning of each lecture or practical period, in an attendance sheet prepared by Eduation and Student Affairs Administration (ESAA), considering the following:

a. Allowed absence for a student, with no excuse, is 10% of the total course hours. The course instructor will notify the (ESAA) when the student exceeds the percentage of absence, and the student will be given the first warning by the (ESAA).
   If the students absence reaches 20%, a second and last written warning should be directed to him/her.

b. If the students absence in the course exceeds 25% with an unaccepted excuse by the CESA and endorsed by the VDESA: the student will be given grade "unqualified" in this course. This will be considered "Fail" in the cumulative average of the student.

c. If the students absence exceeds 25% in more than half of the registered courses with no excuse or with an excuse not accepted by the CESA and endorsed by the VDESA, the student registration is frozen for an academic year (two semesters) and may be eligible for reenrollment within two academic years (four semesters) from the date of freeze. Otherwise if the excuse is accepted, the student will be considered absent. Forcible or obligatory commitments such as military service are not considered a period of absence.

**Article (14): Evaluation**

1. Each course is given 100 marks.
2. Lectures and practical periods are evaluated according to the following:
   a. Term (semester) assessments, which include periodic tests. The answer sheets are handed back to the students. these constitute 40% of the total course marks.
   b. The final examination is held within the last two weeks of the semester according to a time-table prepared by the ESAA and endorsed by CESA of the faculty. This is announced to students during registration. It constitutes 60% of the total course marks.
   c. If a course includes lectures and practical periods, the marks are divided in proportion to the credit hours given to each, and the evaluation goes according to (d) of this article.
   d. The final examination for a given course is given by a committee of instructors contributing in teaching the course and headed by a coordinator. The coordinator will take the responsibility of preparing a time-table for term tests and question sheets.
   e. An honors grade is conferred upon the student who gets a cumulative average of 3.0 or higher on graduation under the condition that he/she had nerver failed any course during his/her study in the faculty (or in the faculty he/she has transfered from).
   f. The final result of a course may be postponed for no more than one semester, as a result of not fulfilling the requirements because of forcible conditions (not attending the final examination of the course for an

accepted excuse). In that case, the student is given a grade of "Incomplete". If the student dose not finish the course requirements by the time of the final exam of the incompleted courses (the first week of the following semester), the student is given a grade (Fail) in that course.

**Article (15)**

Numerical and symbolic counterparts of the degrees and grades.

a. Degrees and grades are as follows:

| Grades | Symbols | No. of points | Degree |
|---|---|---|---|
| Excellent | A | 4 | 90% - 100% |
| Very Good | B | 3 | 80% - 89% |
| Good | C | 2 | 70% - 79% |
| Pass | D | 1 | 60% - 69% |
| Fail | F | 0 | 0 % - 59% |
| Absent | T | 0 | - |
| Incomplete | I | 0 | - |
| Withdrawal | W | 0 | - |
| Forbidden | F | 0 | - |

b. In case of recurring failure of a student in a course, it will be considered once in his/her cumulative average. However, all registration times for the course will remain on his/her academic record.

c. Semestral average; is the average points gained by a student in a single semester approximated to two decimals only. It is calculated as follows:

$$\text{Semestral average} = \left[ \frac{\text{Sum of semestral course points multiplied by its credit hours}}{\text{Sum of semestral credit hours of those courses}} \right]$$

d. General Point Average (GPA); is the average points gained by a student during his/her previous study period and approximated to two decimals only. It is calculated as follows:

$$(\text{GPA}) = \left[ \frac{\text{Sum of course points multiplied by its credit hours}}{\text{Sum of credit hours of those courses}} \right]$$

e. The minimal grade for cumulative average for graduation is D.

6- Grades are granted to a student upon graduation as follows:

| Degrees | Points | Symbol | Grade |
|---|---|---|---|
| 90% - 100% | 4 | A | Excellent |
| 80% - 89% | 3 | B | Very Good |
| 70% - 79% | 2 | C | Good |
| 60% - 69% | 1 | D | Pass |

**Article (16): Academic warnings**

a. If the student gets a cumulative average less than D, he/she will receive the first warning of unsatisfactory performance.
b. If this unsatisfactory performance (low cumulative average) recurs, the student is considered under academic follow up and is not permitted to register more than 12 credit hours per semester.
c. If this unsatisfactory performance in terms of grades continues for the first 3 semesters, the student will be warned that his/her registration may be terminated (dismissed) and will be given a last chance to register a number of credit hours less than the minimal limit to improve the cumulative average (22 cr.). In case of failure, his/her enrollment will be terminated.

**Article (17): Enrollment termination**

Enrollment of the student in the Faculty of Science – Cairo University is terminated in any of the following conditions:

a. If he/she has benefitted the maximum period of academic follow up as referred to in article (16) of this protocol.
b. If the student's absence exceeds 25% in more than half of the registered courses in any semester, without submitting an excuse accepted by the CESA (article 13 c).
c. If the student is involved in a misconduct or any activity not complying to the Faculty or University rules and regulations, or has been subjected to student discipline protocol in accordance with the University regulations.

**Article (18)**

The rules of this protocol will take effect at the beginning of the academic year following its official approval by the Ministry of Higher Education on:

a- Students who are enrolled for the first time in the faculty as freshmen.
b- Students failing their first year under the previous system.

**Article (19)**

The rules of the Universities Regulation Law and its executive protocol are to be applied in cases not reported in this protocol.

# STUDY PROGRAMS

**1- University Requirements (8 cr.):**

a- Compulsory Courses (6 cr.)

| | | |
|---|---|---|
| - U101 Introduction to Computer Science | (2 Cr.) | Faculty of Science |
| - U102 The English Language | (2 Cr.) | Faculty of Art |
| - U103 Human Rights | (2 cr.) | Faculty of Law |

b- Elective Courses (2 cr.)

| | | |
|---|---|---|
| - U104 Introduction to Legal Studies | (2 Cr.) | Faculty of Law |
| - U105 Principles of Management and Accounting | (2 Cr.) | Faculty of Commerce |
| - U106 Arabic Language | (2 Cr.) | Faculty of Art |
| - U107 Islamic Culture | (2 Cr.) | Faculty of Science, Faculty of Dar El- Elom |
| - U108 History and Philosophy of Science | (2 Cr.) | Faculty of Science, Faculty of Art |
| - U109 Environmental Culture | (2 Cr.) | Faculty of Science, Faculty of Art |

**2- Degrees Requirements (138 cr):**

| | |
|---|---|
| a- Faculty requirments | (30 cr.). |
| b- Specialization requirements | (108 cr.). |

# UNIVERSITY REQUIREMENTS COURSES OUTLINES

**U. 101 INTRODUCTION TO COMPUTER SCIENCE (2 cr.)**

Offered in fall and spring.

History of computers. Data types and data representation. Understanding the design and functioning of hardware and software computer systems. Computer networks and types. WWW (World Wide Web). Computer virus. Introduction to operating systems. Introduction to Office software. Programming languages.

**U. 102 THE ENGLISH LANGUAGE (2 cr.)**

Offered in fall and spring.

Coverage of selected scientific terminology, with the objective of familiarizing the students with the English terms and their Arabic counterparts, focusing on the spelling and pronunciation of these terms. Coverage of some areas in traditional English grammar, particularly those problematic for the students at this stage.

**U. 103 Human Rights(2 cr.)**

Offered in fall and spring.

Basic concepts of human rights: human rights definition, importance of studying human rights, human rights and people rights. Origin and sources of human rights: origin and development. Sources: national cource, international source. Categories of human rights and constrains. Rights: civilian and political rights, social and economical rights, human rights in Islamic religion and in other religions. Constrains: constrains under normal conditions, constrains under critical conditions. Tactics for human rights protection: constitutional tactics, national legislative tactics, international legislative tactics. Applied aspects of human rights: in the medical fiels, in the engineering fiels, in the agriculatural field, in scientific research field. Study cases of human rights at the national and international levels.

**U. 104 INTRODUCTION TO LEGAL STUDIES (2 cr.)**

Offered in fall and spring.

Theory of Law: Definition of law, Classification of laws, Sources of law, Application of law. Theory of Rights: Definition of Rights, Classification of rights, Elements of rights, Sources of rights.

**U. 105 PRINCIPLES OF MANAGEMENT AND ACCOUNTING (2 cr.)**

Offered in fall and spring.

Management and management careers, the history of management, organizational objectives, fundamentals of planning, fundamentals of organizing, fundamentals of influencing and communication, principles of controlling, accounting: the language of business, recording changes in financial position, measuring business income, completion of accounting cycle, accounting for merchandising activities, plant and equipment & depreciation.

**U. 106 ARABIC LANGUAGE (2 cr.)**

Offered in fall and spring.

Students will acquire the language skillssuch as writing, reading and conversation. Also, studing selected Arabic texts in accordance with the nature of study at the faculty of science, in addition to study of modern Arab intellectual trends.

**U. 107 Islamic Culture (2 cr.)**

Offered in fall and spring.

Basic concepts and fields of arabic and islamic culture and its relation with other cultures in the light of islamic religion teachings, in addition to the relation with basic, applied, teachnical, human and social sciences. Reveal all aspects of contributions of Islamic civilization.

**U. 108 HISTORY AND PHILOSOPHY OF SCIENCE (2 cr.)**

Offered in fall and spring.

knowledge theory and characters of scientific knowledge – mutual relationship between science, technology and society. Phases of science history. Theories of science history. Scientific concept (Mathematical – Experimental). Introducing the scientific achievements of Arabic and Islamic civilization scientists. Analysis of scientific development and current scientific theories through selected models from mathematics, physics, chemistry, astronomy, geology, biology .....etc. the importance of searching in the fields of history and philosophy of science.

**U. 109 ENVIRONMENTAL CULTURE (2 cr.)**

Offered in fall and spring.

Environmental culture definition, Environmental pollution problems. Sources of environmental pollution. Environment friendly technology. Relationship between man and environment. Problems of advanced science and technology and their impacts on the environment.

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# Fields of study

## MATHEMATICS

## First: Academic Programs Offered by Mathematics Department

The Department offers courses for all freshmen and for student of the following groups:

1- Special Mathematics (Math)
2- Special Computer Science (Comp)
3- Special Statistics (Stat)
4- Mathematics/Commputer Science (Math/Comp)
5- Mathmatics/Statistics (Math/stat)
6- Mathematics/Physics (Math/Phys)
7- Mathematics/Astronomy (Math/A)
8- Chemistry, Botany, Zoology, Entomology, Biophysics & Geophysics.(Chem, B, Z, Ent, Biophys, & Geophys)

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 1 | 1st | Math 130 | General Mathematics | - | - | All students | 2 | - | 3 | - | Comp 100, Univ. Prequirment U101 Math 130 Without cr. |
| | | Math 131 | Calculus and Analytical Geometry (1) | - | All students | - | 2 | - | 3 | 3 | |
| | | Comp 100 | Introduction to Computer Science | - | | - | - | 6 | - | 2 | |
| | | Math 110 | Algebra | - | Math, Comp, Stat | Other groups | 2 | - | 3 | 3 | |
| | | Stat 100 | Mathematical Statistics (1) | - | | | 2 | - | 3 | 3 | |
| | 2nd | Math 132 | Calculus and Analytical Geometry (2) | Math 131 | All students | - | 2 | - | 3 | 3 | |
| | | Comp 100 | Introduction to Computer Science | - | | - | - | 6 | - | 2 | |
| | | Math 170 | Newtonian Mechanics (1) | - | Math, Comp, Stat | Other groups | 2 | - | 3 | 3 | |
| | | Comp 101 | Fundamentals of Programming | - | | | 2 | - | 3 | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 2 | 3rd | Math 211 | Linear Algebra and Geometry (1) | Math 110 | Math, Comp, Stat | - | 3 | 1 | 2 | 4 | 17 cr. compuls |
| | | Math 231 | Calculus and Analytical Geometry (3) | Math 132 | | | | | | | |
| | | Math 271 | Newtonian Mechanics (2) | Math 170 | | - | 2 | 1 | 2 | 3 | |
| | | Stat 201 | Introduction to Probability Theory | Stat 100 | | - | 2 | 1 | 2 | 3 | |
| | | Stat 221 | Applied Statistic (1) | - | Chem | - | 1 | 2 | 1 | 2 | |
| | | Math 239 | Multiple Integrals and Ordinary Differential Equations | Math 132 | Biophys | - | 2 | 1 | 2 | 3 | |
| | | Math 241 | Ordinary Differential Equations | | Math, Comp, Stat, Phys, A, Met, Biophys, Geophys | - | 2 | 1 | 2 | 3 | |
| | 4th | Math 232 | Principles of Mathematical Analysis | Math 231 | Math, Comp, Stat | - | 2 | 1 | 2 | 3 | 19 cr. compuls. |
| | | Math 212 | Linear Algebra and Geometry (2) | Math 211 | | - | 3 | 1 | 2 | 4 | |
| | | Math 272 | Analytical Mechanics | Math 271 | | - | 2 | 1 | 2 | 3 | |
| | | Comp 201 | Object-Oriented Programming | Comp 101 | | - | 2 | 3 | - | 3 | |
| | | Math 213 | Discrete Mathematics | Math 110 | Comp | Math, Stat Comp | 2 | 1 | 2 | 3 | |
| | | Comp 202 | Data Structures & Algorithms | - | | | 2 | 1 | 2 | 3 | |
| | | Math 235 | Vector Analysis | Math132 | - | | 2 | - | 3 | 3 | |
| | | Stat 202 | Statistical Inferences (1) | Stat 201 | Stat | | 2 | 1 | 2 | 3 | |
| | | Stat 222 | Applied Statistic (2) | Stat 221 | Chem | - | 1 | 2 | 1 | 2 | 3 cr. compuls. |
| | | Math 216 | Linear Algebra and Analytic Geometry for Non-Mathematicians | - | BP | - | 2 | 1 | 2 | 3 | |
| | | Math 238 | Mathematical Analysis for Non-Mathematicians | Math 231 | Geophys, A | - | 2 | 1 | 2 | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 3 | 5th | Math 311 | Abstract Algebra (1) | Math 110 | Math | - | 2 | 1 | 2 | 3 | 15 cr. compuls. for Math<br>6 cr. elective. for Stat. |
| | | Math 371 | Continuum Mechanics (1) | Math 272 | | - | 2 | 1 | 2 | 3 | |
| | | Math 373 | Electromagnetism and Relativity (1) | | | - | 2 | 1 | 2 | 3 | |
| | | Math 331 | Real Analysis (1) | Math 232 | Math, Stat | - | 2 | 1 | 2 | 3 | |
| | | Math 351 | Numerical Analysis (1) | Math 132<br>Math241 | | Comp | 2 | 1 | 2 | 3 | |
| | | Math 305 | Mathematical Logic and Boolean Algebra (1) | - | - | | 2 | 1 | 2 | 3 | |
| | | Comp 305 | Algorithms Design and Analysis | Comp 202 | Comp | - | 2 | 1 | 2 | 3 | |
| | | Comp 302 | Computer Organization | Comp 201 | | - | 2 | 3 | - | 3 | |
| | | Comp 304 | Computer Graphics | Comp 201<br>Comp 202 | | - | 2 | 3 | - | 3 | |
| | | Comp 307 | Database Systems | Comp 202 | | - | 2 | 3 | - | 3 | |
| | | Comp 309 | System Analysis & Design | | | - | 2 | 3 | - | 3 | |
| | | Stat 301 | Stochastic Processes (1) | Stat 201 | Stat | - | 2 | 1 | 2 | 3 | |
| | | Stat 302 | Statistical Inferences (2) | Stat 202 | | - | 2 | 1 | 2 | 3 | |
| | | Math 344 | Special Functions | Math 132,<br>Math 241 | Phys/S | Math, Stat, Geophys | 2 | - | 1 | 2 | |
| | | Math 346 | Integral Transforms | | - | | 2 | - | 1 | 2 | 15 cr. compuls. for Math, 12 cr. for Stat. and 18 cr. for Comp. |
| | | Math 353 | Numerical Analysis and Computer (1) | - | Geophys | - | 2 | 2 | 1 | 3 | |
| | | Math 301 | Mathematical Logic (1) | - | - | Math | 2 | 1 | 2 | 3 | |
| | | Math 355 | Approximation Theory (1) | Math 232 | - | Math, Stat, Comp | 2 | - | 3 | 3 | |
| | | Math 361 | Mathematical Methods (1) | Math 231,<br>Math 241 | - | | 2 | - | 3 | 3 | |
| | | Comp 316 | File Organization and Processing | Comp 202 | - | | 2 | - | 3 | 3 | |
| | | Stat 321 | Introduction to Probability and Mathematical Statistics for Non-Mathematicians | Math 132 | Biophys | - | 2 | - | 3 | 3 | |
| | | Stat 326 | Theory of Correlation (1) | Stat 201 | - | Stat | 2 | - | 3 | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 3 | 6th | Math 332 | Real Analysis (2) | Math 331 | Math, Stat | - | 2 | 1 | 2 | 3 | 12 cr. compuls. for each of Math., Comp. and Stat. |
| | | Math 312 | Abstract Algebra (2) | Math 311 | Math | - | 2 | 1 | 2 | 3 | |
| | | Math 321 | Topology | Math 232 | | - | 2 | 1 | 2 | 3 | |
| | | Math 372 | Continuum Mechanics (2) | Math 371 | | - | 2 | 1 | 2 | 3 | |
| | | Comp 303 | Software Development | Comp 201 | Comp | - | 2 | 3 | - | 3 | |
| | | Comp 306 | Operating Systems | Comp 305 | | Math, Stat | 2 | 2 | 1 | 3 | |
| | | Comp 308 | Database Design | Comp 307 | | - | 2 | 3 | - | 3 | |
| | | Math 302 | Mathematical Logic (2) | Math 301 | - | Math | 2 | 1 | 2 | 3 | |
| | | Math 306 | Mathematical Logic and Boolean Algebra (2) | Math 305 | - | Comp | 2 | 1 | 2 | 3 | |
| | | Math 352 | Numerical Analysis (2) | Math 351 | - | | 2 | 1 | 2 | 3 | |
| | | Math 335 | Functional Analysis | Math 232 | Math, Stat | - | 2 | 1 | 2 | 3 | |
| | | Stat 303 | Regression Analysis | Stat 201, Stat 202 | Stat | - | 2 | 1 | 2 | 3 | |
| | | Stat 304 | Statistical Packages | Stat 302 | | - | 2 | 1 | 2 | 3 | |
| | | Math 354 | Numerical Analysis and Computer (2) | Math 353 | - | Geophys | 2 | - | 3 | 3 | 6 cr. electives for each of Math., Comp. and Stat |
| | | Math 356 | Approximation Theory (2) | Math 355 | - | Math Stat Comp | 2 | - | 3 | 3 | |
| | | Math 362 | Mathematical Methods (2) | Math 361 | - | | 2 | - | 3 | 3 | |
| | | Math 374 | Electromagnetism and Relativity (2) | Math 373 | - | | 2 | - | 3 | 3 | |
| | | Comp 317 | Distributed Systems | Comp 306 | - | | 2 | - | 3 | 3 | |
| | | Stat 322 | Biostatistics and Difference Equations | Math 132 | - | Biophys | 2 | - | 3 | 3 | |
| | | Stat 324 | Biostatistics | | - | B, Z, Ent | 2 | - | 3 | 3 | |
| | | Stat 325 | Elements of Sampling Theory | Stat 201 | - | Stat | 2 | - | 3 | 3 | |
| | | Stat 327 | Theory of Correlation (2) | Stat 326 | - | | 2 | - | 3 | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 7th | Math 421 | Differential Geometry (1) | Math 332, Math 312 | Math | - | 2 | 1 | 2 | 3 | 9 cr. compuls. for each of Math and comp. 6 cr. compuls. for Stat |
| | | Math 431 | Complex Analysis (1) | Math 332 | | - | 2 | 1 | 2 | 3 | |
| | | Math 471 | Quantum Mechanics (1) | Math 272 | | - | 2 | 1 | 2 | 3 | |
| | | Comp 401 | Computer Networks | Comp 306 | Comp | - | 2 | 1 | 2 | 3 | |
| | | Comp 403 | Formal Languages and Automata | Comp 305 | | - | 2 | - | 3 | 3 | |
| | | Comp 408 | Artificial Intelligence | | | - | 2 | 3 | - | 3 | |
| | | Stat 401 | Experiment Design | Stat 302 | Stat | - | 2 | 1 | 2 | 3 | |
| | | Stat 402 | Non-Parametric Statistics | Stat 202 | | - | 2 | 1 | 2 | 3 | |
| | | Math 433 | Complex Analysis for Non-Mathematicians | Math 132 | Phys/S | Other groups | 2 | - | 3 | 3 | |
| | | Math 451 | Numerical Solution of Partial Differential Equations | Math 351 | - | Math , Comp , Stat | 2 | - | 3 | 3 | 9 cr. elective. for each of Math and Comp. 12 cr. electiv. for Stat. |
| | | Math 473 | Hydrodynamics (1) | Math 231 | - | | 2 | - | 3 | 3 | |
| | | Math 475 | Computational Fluid Dynamics (1) | | - | | 2 | - | 3 | 3 | |
| | | Math 477 | Theory of Elasticity (1) | Math 231, Math 241 | - | | 2 | - | 3 | 3 | |
| | | Math 481 | Theory of Optimal Control (1) | | - | | 2 | - | 3 | 3 | |
| | | Math 493 | Selected Topics in Mathematics (1) | Consent of Instructor | - | | 2 | - | 3 | 3 | |
| | | Comp 406 | Simulation and Modeling | Stat 201, Comp 305 | - | | 2 | - | 3 | 3 | |
| | | Comp 415 | Management Information Systems | Comp 308 | - | | 2 | - | 3 | 3 | |
| | | Comp 416 | Programming of Biological Systems | Comp 100 | - | | 2 | - | 3 | 3 | |
| | | Comp 417 | Neural Networks | Comp 305 | - | | 2 | - | 3 | 3 | |
| | | Comp 418 | Advanced Distributed Systems | Comp 317 | - | | 2 | - | 3 | 3 | |
| | | Comp 421 | Advanced Computer Graphics | Comp 304 | - | | 2 | - | 3 | 3 | |
| | | Comp 426 | Selected Topics in Computer Science (1) | Consent of Instructor | - | | 2 | - | 3 | 3 | |
| | | Stat 405 | Selected Topics in Statistics(1) | | - | | 2 | - | 3 | 3 | |
| | | Stat 428 | Statistical Quality Control | - | - | | 2 | - | 3 | 3 | |
| | | Stat 429 | Statistical Demography | Stat 202 | - | | 2 | - | 3 | 3 | |

| LEVEL | SEMESTER | SUBGECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURES | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 8th | Math 432 | Complex Analysis (2) | Math 431 | Math | - | 2 | 1 | 2 | 3 | 12 cr. compuls. for each of Math., 9 cr. compuls. for Stat. |
| | | Math 441 | Partial Differential Equations (1) | Math 241, Math 332 | | - | 2 | 1 | 2 | 3 | |
| | | Math 472 | Quantum Mechanics (2) | Math 471 | | - | 2 | 1 | 2 | 3 | |
| | | Math 490 | Project | - | | - | - | - | - | 3 | |
| | | Math 411 | Theory of Numbers | - | Comp | - | 2 | 1 | 2 | 3 | |
| | | Comp 402 | Cryptology | Comp 305, Stat 201, Math 213 | | - | 2 | 1 | 2 | 3 | |
| | | Comp 407 | Programming Languages Design | Comp 403 | | - | 2 | 1 | 2 | 3 | |
| | | Comp 490 | Project | - | | - | - | - | - | 3 | |
| | | Stat 403 | Reliability Theory | Stat 201 | Stat | - | 2 | 1 | 2 | 3 | |
| | | Stat 404 | Multivariate Statistics | Stat 302 | | - | 2 | 1 | 2 | 3 | |
| | | Stat 490 | Project | - | | - | - | - | - | 3 | |
| | | Math 422 | Differential Geometry (2) | Math 312, Math 421 | - | Math , Comp , Stat | 2 | - | 3 | 3 | 6 cr. elective for each of Math. & Comp. 9 cr. Elective for Stat. |
| | | Math 442 | Partial Differential Equations (2) | Math 441 | - | | 2 | - | 3 | 3 | |
| | | Math 452 | Numerical Solution of Integral Equations | Math 351 | - | | 2 | - | 3 | 3 | |
| | | Math 474 | Hydrodynamics (2) | Math 473 | - | | 2 | - | 3 | 3 | |
| | | Math 476 | Computational Fluid Dynamics (2) | Math 475 | - | | 2 | - | 3 | 3 | |
| | | Math 478 | Theory of Elasticity (2) | Math 477 | - | | 2 | - | 3 | 3 | |
| | | Math 479 | Nonlinear Mechanics | Math 241, Math 272 | - | | 2 | - | 3 | 3 | |
| | | Math 482 | Theory of Optimal Control (2) | Math 481 | - | | 2 | - | 3 | 3 | |
| | | Math 494 | Selected Topics in Mathematics (2) | consent of instructor | - | | 2 | - | 3 | 3 | |
| | | Comp 422 | Advanced Computer Networks | Comp 401 | - | | 2 | - | 3 | 3 | |
| | | Comp 423 | Pattern Recognition | Comp 402 | - | | 2 | - | 3 | 3 | |
| | | Comp 424 | Advanced Operating Systems | Comp 306 | - | | 2 | - | 3 | 3 | |
| | | Comp 425 | Expert Systems | Comp 402 | - | | 2 | - | 3 | 3 | |
| | | Comp 428 | Selected Topics in Computer Science (2) | consent of instructor | - | | 2 | - | 3 | 3 | |
| | | Comp 427 | Selected Programming Languages | | - | | 2 | - | 3 | 3 | |
| | | Stat 406 | Selected Topics in Statistics (2) | | - | | 2 | - | 3 | 3 | |
| | | Stat 430 | Theory of Estimation | Stat 302 | - | | 2 | - | 3 | 3 | |
| | | Stat 431 | Applied Statistics | | - | | 2 | - | 3 | 3 | |
| | | Stat 432 | Life Testing and Reliability | | - | | 2 | - | 3 | 3 | |
| | | Stat 433 | Time Series Analysis | Stat 303 | - | | 2 | - | 3 | 3 | |
| | | Stat 422 | Biostatistics for biologists | - | B, Z, Ent | - | 1 | 2 | 1 | 2 | |
| | | Stat 423 | Computer-aided Biostatistics for non-mathematicians | - | Ent | - | 2 | - | 3 | 3 | |

# Second: Courses Offered by Mathematics Department

## MATHEMATICS

**Math 110 ALGEBRA (3 cr.).**

Offered in fall

Elements of mathematical logic, sets, relations, equivalence relations, functions, mathematical induction, binary operations, groups (basic properties and main results), symmetric groups, rings and fields (basic properties and main results).

**Math 130 GENERAL MATHEMATICS.**

Offered in fall

Functions and graphs: problems and their representations, functions, linear functions and their graphs, lines of best fit for data, using graphs to study characteristics of functions.

Solving equations and more on functions: solving equations graphically, solving equations algebraically, solving absolute value and radical equations and inequalities, operations on functions and composition of functions, relations and parametric equations, describing graphs using transformations, inverse relations and inverse functions.

Polynomial functions: quadratic functions, polynomial functions of higher degree, polynomial division and factor theorem, zeros of polynomial functions, complex numbers, fundamental theorem of Algebra. Exponential and logarithmic functions: exponential functions, comparisons with the power function, logarithmic functions, inverses of exponential functions, properties of logarithmic functions, equation solving, applications, interest and annuities. Rational functions: rational functions and asymptotes, graphing rational functions, rational functions and inequalities, partial fractions. Trigonometry: angles and their measures, trigonometric functions of acute angles, extending trigonometric functions, graphs of sine and cosine functions, graphs of other trigonometric functions, advanced trigonometric graphs, inverse trigonometric functions, applications of trigonometric functions. Analytic trigonometry: applications of fundamental identities, solving trigonometric equations, sum and difference identities, multiple angle identities, law of sines, law of cosines, vectors, trigonometric form of complex numbers, de moivre theorem and n-th roots. Analytical Geometry: Parametric equations, conics and polar equations. parametric equation and motion, conic sections, conic sections and transformations, polar coordinates, graphs of polar equations, polar equations of conics. Systems of equations and inequalities: Solving systems of equations, solving systems of linear equations using gaussian elimination, solving systems of linear equations with matrices, solving systems of linear equations with inverse matrices, solving systems of inequalities.

**Math 131 CALCULUS AND ANALYTICAL GEOMETRY (1) (3 cr.).**

Offered in fall

The real line, rational and irrational numbers, distances on the line, bounded and unbounded intervals, maximal and minimal elements, the plane and the coordinates, functions and their graphs: linear and quadratic functions, polynomials, the modulus functions, trigonometric functions, radians, even and odd functions, periodic functions, monotonicity, operations on functions, the inverse function and conditions for its existence.

Limits: limit of a function defined on an interval at an interior point or at an end point (definition and examples), limits of polynomials and of trigonometric functions, calculating limits.

Applications in approximation, continuous functions: examples, algebra and properties of continuous functions, with stress on the Mean-value theorem and its applications in finding approximate solutions to some equations, existence of the inverse for monotonic, continuous functions, inverses of some well-known algebraic functions, inverse trigonometric functions, limits at infinity, limits of sequences (definition and examples). The derivative: derivatives of functions, relation of differentiability to continuity, examples, derivative of a function on an interval, algebra of derivatives, chain rule. Derivative of the inverse function, applications. Properties of differentiable functions: the

Mean-value theorems and their applications, l'Hôpital's rule, higher-order derivatives, leibnitz rule, Taylor's theorem, maxima and minima, properties of graphs of functions, applications.

**Math 132 CALCULUS AND ANALYTICAL GEOMETRY (2) (3 cr.).**

Prerequisite: Math 131. Offered in spring.

Integrals and areas: summation notation, approximation of areas by rectangles, examples, the definite integral of a continuous function, examples, Newton-Leibnitz theorem, logarithmic functions and their properties, exponential and logarithmic functions, hyperbolic functions and their properties, inverse hyperbolic functions and their properties, indefinite integral. Primitive function, examples, methods of integration (substitution, by parts), integration by reduction, L'Hôpital's rule revisited. Introduction to improper integrals. Analytic geometry: systems of coordinates, plane polar coordinates, parametric equations, examples, cartesian equations of 2-nd order in the plane and their classification, conic sections and their properties. Applications of integration: calculation of curve lengths, volumes and surfaces of revolution, abelian and elliptic integrals. Approximation methods for integrals, applications.

**Math 170 NEWTONIAN MECHANICS (1) (3 cr.).**

Offered in spring.

Vectors, vector algebra, forces as vectors, moments, couples, systems of forces, equivalence of two systems of forces, wrench, kinematics of a material point in 2-D, relative velocity, 1-D motion under variable force, Newton's laws of motion, projectiles in the plane, simple harmonic motion, plane polar coordinates, motion on a circle, impulse and impact.

**Math 211 LINEAR ALGEBRA AND GEOMETRY (1) (3 cr. + 1 cr. Lab.).**

Prerequisite: Math 110. Offered in fall.

Vector spaces: definition and basic properties, subspaces, linear combinations and span, linear independence, basis and dimension, sum and direct sum.

Linear transformations: definition and examples, properties of linear transformations (range and kernel), non-singular transformations, algebra of linear transformations, dual spaces.

Matrices: definition and properties of matrices, transpose of a matrix, square matrices, algebra of square matrices, echelon matrices, invertible matrices and rank of a matrix, matrices and systems of linear equations, change of basis and equivalent matrices.

**Math 212 LINEAR ALGEBRA AND GEOMETRY (2) (3 cr. + 1 cr. Lab.).**

Prerequisite: Math 211. Offered in spring.

Eigenvalues and eigenvectors, similar matrices and diagonalization, symmetric matrices and orthogonal diagonalization, characteristic polynomial, Cayley-Hamilton theorem.

Bilinear, quadratic and hermitian forms. Inner product spaces, Cauchy-Schwartz inequality, Gram-Schmidt orthogonalization process, orthogonal and unitary matrices, change of orthonormal basis.

Vectors in space, cross-product of two vectors, lines and planes in space, classification of second degree surfaces in space.

**Math 213 DISCRETE MATHEMATICS (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 110. Offered in spring.

Logic. Sets. Counting: basics, permutations and combinations, relations and equivalence relations. ordering, and partial ordering. Algorithms and complexity of algorithms. Tree traversal, sorting, and spanning, graphs: connectivity, euler path, shortest path problems. Boolean algebra: boolean functions, logic gates and circuits.

**Math 216 LINEAR ALGEBRA AND ANALYTIC GEOMETRY FOR NON-MATHEMATICIANS (2 cr. + 1 cr. Lab.).**

Offered in spring.

Systems of linear equations and matrices, determinants, vectors in two- and three- dimensional spaces, linear spaces, linear transformations, eigenvalues and eigenvectors, applications, geometry of conical sections, numerical methods of linear algebra.

**Math 231 CALCULUS AND ANALYTICAL GEOMETRY (3) (3 cr. + 1 cr. Lab.).**

Prerequisite: Math 132. Offered in fall.

3-D space, vectors, addition of vectors, scalar product of vectors, length of a vector, cartesian and vector equations in 3-D, equation of plane, equation of straight line, spherical polar coordinates and cylindrical coordinates, examples of surfaces, functions of two variables, limit of functions defined on a region, functions of three variables and their limits, partial derivatives, calculation of partial derivatives, continuity of functions in more than one variable, higher-order partial derivatives, Taylor's theorem for functions of two variables, maxima and minima, saddle points, integrals depending on a parameter, multiple integrals, improper integrals and methods for their evaluation, line integrals, double and triple integrals, integration by substitution, applications.

**Math 232 PRINCIPLES OF MATHEMATICAL ANALYSIS (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 231. Offered in spring.

Improper integrals, convergence and uniform convergence, tests of uniform convergence and conditions for improper integrals, sequences of numbers, convergence and Cauchy's condition, limit points and subsequences, Bolzano-Weierstrass theorem, continuity and sequences, uniform convergence, series of numbers and convergence tests, sequences and series of functions, pointwise convergence and uniform convergence, Weierstrass theorem, power series, relation between convergence and differentiation and integration, Taylor's and Maclaurin's series, Fourier series.

**Math 235 VECTOR ANALYSIS (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 132. Offered in spring.

Vector functions in one variable, the derivative and the integral of vector fields, examples, Vector functions in several vaviables, partial derivatives, Jacobi's matrix, the chain rule, Most popular differential operators and their expressions in the different systems of coordinates, theorem on implicit functions, theorem on the inverse function, Integrals of vector functions in several variables, line integrals, Green's theorem and its applications, surface integrals, Stoke's theorem and its applications, Stoke's theorem in higher dimensions and its geometric content.

**Math 238 MATHEMATICAL ANALYSIS FOR NON-MATHEMATICIANS (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 231. Offered in spring.

Improper integrals, sequences of numbers, convergence, limit points and subsequences, continuity and sequences, uniform convergence, series of numbers and convergence tests, sequences and series of functions, pointwise convergence and uniform convergence, power series, relation between convergence and differentiation and integration, Taylor's and Maclaurin's series, Fourier series, differential operators: gradient, divergence and curl, line integrals, surface integrals, volume integrals, Gauss's theorem for integrals, Stoke's theorem for integrals.

**Math 239 MULTIPLE INTEGRAL AND ORDINARY DIFFERENTIAL EQUATIONS (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 132. Offered in spring.

Multiple Integrals: Orthogonal Cartesian coordinates: Elements of area and volume in orthogonal Cartesian coordinates, plane polar coordinates: Definition, relation to orthogonal Cartesian coordinates, elements of area and volume in plane polar coordinates, Multiple Integrals: Definition of a multiple integral, properties, Applications: Calculation of plane areas, calculation of volumes of revolution by disks, washers and cylindrical shells, calculation of volumes by cross-sections, calculation of surfaces of revolution, miscellaneous applications.

Ordinary Differential Equations: First order and first degree ODE's: Introduction, definitions, forming ODE's. Methods of solution of first order and first degree ODE's: separation of variables, homogeneous ODE's, ODE's with linear coefficients, 1st order linear ODE's, ODE's reducible to linear ODE's, exact ODE's, the integrating factor, nth order ODE's with constant coefficients: Definition and general properties, nth order non-homogeneous ODE's with constant coefficients, ODE's with variable coefficients reducible to ODE's with constant coefficients, method of variation of parameters, method of undetermined coefficients, simultaneous ODE's, series solution of ODE's: First order ODE's, 2nd order ODE's, Frobenius method.

**Math 241 ORDINARY DIFFERENTIAL EQUATIONS (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 132. Offered in fall.

First order and first degree ODE's: Introduction, definitions, forming ODE's, methods of solution of first order and first degree ODE's: separation of variables, homogeneous ODE's, ODE's with linear coefficients, 1st order linear ODE's, ODE's reducible to linear ODE's, exact ODE's, the integrating factor, nth order ODE's with constant coefficients: Definition and general properties, 2nd order homogeneous ODE's with constant coefficients, nth order ODE's with constant coefficients, nth order non-homogeneous ODE's with constant coefficients, ODE's with variable coefficients reducible to ODE's with constant coefficients, other methods for finding the particular solution of non-homogeneous ODE's, order reduction for ODE's, method of variation of parameters, method of undetermined coefficients, simultaneous ODE's, series solution of ODE's: First order ODE's, 2nd order ODE's, Frobenius method, numerical methods for solving ODE's, Picard's method, Taylor series method.

**Math 271 NEWTONIAN MECHANICS (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 170. Offered in fall.

Central orbits, stability of circular orbit, planetary motion, Kepler's laws, scattering problem (Rutherford scattering), construction of orbit from initial conditions, qualitative analysis of orbit properties in phase space, constrained motion on plane curve, kinematics in 3-D, spherical polar coordinates, rotating axes, applications, motion of a projectile taking into account the earth's rotation, motion of a particle on a surface, motion of a rigid body with a fixed point, momet of inertia, general motion of a rigid body.

**Math 272 ANALYTICAL MECHANICS (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 271. Offered in spring.

Motion of a sysyem of particles, constraints and their types, the general equation of dynamics, applications, Lagrange's equations of the 1st kind, calculus of variations, generalized coordinates, Lagrange's equations of the 2nd kind, cyclic coordinates, constants of the motion, applications, the symmetrical top with a fixed end, Hamilton's equations, law of energy conservation, conservative systems, Poisson's brackets, small vibrations.

**Math 301 MATHEMATICAL LOGIC (1) (2 cr. + 1 cr. Lab.).**

Offered in fall.

The Propositional Calculus: Truth-functional operations, propositional connectives, statement forms, parentheses, truth tables, tautologies and contradictions, logical implication and equivalence, some general facts about tautologies (substitution, replacement, duality,...), adequate systems of connectives, normal form (disjunctive and conjunctive normal forms), switching circuits and simplification of circuits, an axiom system for the Propositional Calculus, the Deduction Theorem, some provabler formulas (theorems) and derived rules, completeness theorems.

First order Logic: Quantifiers, formulas, free and bound occurences of variables, interpretations, satisfiability and truth-models, some consequences of the notions of truth and satisfiability.

**Math 302 MATHEMATICAL LOGIC (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 301. Offered in spring.

First order theories: Properties of first order theories, the Deduction Theorem, completeness theorems, some additional metatheorems, rule C (arbitrary act of Choice), Prenex Normal Form, Formal Number Theory: An axiom system, induction, equality, replacement, addition, multiplication, order, formal calculation, Gödel's theorem.

**Math 305 MATHEMATICAL LOGIC AND BOOLEAN ALGEBRA (1) (2 cr. + 1 cr. Lab.).**

Offered in fall.

Orders (partial, linear), well orders and induction, recursion and induction, some examples of recursive definitions in Computer Science, lattices, distributive lattices and examples, abstract Boolean algebras, Boolean rings, equivalence of Boolean rings and Boolean algebras, informal remarks and formal languages, propositional logic and Boolean algebras, truth assignments, switching circuits, adequate set of connectives, disjunctive normal forms.

**Math 306 MATHEMATICAL LOGIC AND BOOLEAN ALGEBRA (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 305. Offered in spring.

Algebraic concepts like homomorphisms, subalgebras, isomorphism theorems in Boolean algebras, ideals and filters, Zorn's Lemma and ultrafilters, some topological concepts like open sets, closed sets, completions of Boolean algebras, Stone's representation theorem, equivalence of Stone's representation theorem and completeness (and compactness) of Propositional Logic, applications in Computer Science, combinatorial networks, networks and Boolean expressions, simplifying Boolean expressions using Karnaugh maps, simplifying Boolean expressions using the Quine-McCluskey method.

**Math 311 ABSTRACT ALGEBRA (1) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 110. Offered in fall.

Normal subgroups, cosets and Lagrange's theorem, factor (quotient) groups, cyclic groups, isomorphism theorems, Sylow theorems and applications, direct product of groups, the fundamental theorem of finite abelian groups.

**Math 312 ABSTRACT ALGEBRA (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 311. Offered in spring.

Characteristic of a ring, integral domain, factor (quotient) rings, quotient fields, prime and maximal ideals, polynomial rings, irreducible polynomials, principal ideal domain, unique factorization domain, fields.

**Math 321 TOPOLOGY (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 232. Offered in spring.

Topology of the real line and plane, topological spaces: Topology, open set, closed set, neighbourhood, accumulation point, derived set, interior, exterior, boundary, subspaces, comparison of topologies, sequences and convergence, bases, sub-bases, local bases, continuity and homeomorphisms: Continuous maps, local continuity, sequential continuity, open maps, closed maps, bicontinuous maps, homeomorphisms, topological properties, countability axioms: First countable spaces, second countable spaces, separable spaces, separation axioms: T1- spaces, T2 - spaces (Hausdorff spaces), T3- spaces, T4- spaces, Compactness: Compact sets and spaces, compactness and separation, sequential compactness, Bolzano-Weierstrass compactness, compactness in metric spaces, Connectedness: Connected sets and spaces, connectedness of the real line, connected components, local connectedness, arcwise connectedness.

**Math 331 REAL ANALYSIS (1) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 232. Offered in fall.

Equivalence of sets, denumerable and countable sets, the Cantor-Bernstein theorem, basic concepts of topological spaces, bases, convergence in topological spaces, metric spaces, Minkowski inequality, continuous mappings and homeomorphisms, isometric spaces, convergence in metric spaces, separable spaces, complete metric spaces, the nested sphere theorem, everywhere and nowhere dense subsets, first and second category sets, completion of metric spaces, contraction mappings.

**Math 332 REAL ANALYSIS (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 331. Offered in spring.

Algebras and semi-algebras, Borel sets, measurable spaces, Lebesgue-measurable sets, Cantor set, measurable functions, convergence almost everywhere, convergence in measure, Egorov theorem, structure of measurable functions, Lebesgue integral, the space Lp , comparison of Riemann and Lebesgue integrals, summable functions, absolute continuity, functions of bounded variation.

**Math 335 FUNCTIONAL ANALYSIS (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 232. Offered in spring.

Normed spaces, Banach spaces, inner-product spaces, orthogonality and bases, orthogonalization theorem, Bessel inequality, Riesz-Fischer theorem, Hilbert spaces, isomorphism theorem, orthogonal complement and direct sum, compact sets, Ascoli-Arzela theorem, topological vector spaces, dual spaces, Hahn-Banach theorem, strong and weak topologies, reflexive spaces.

**Math 344 SPECIAL FUNCTIONS (2) (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 132, Math 241. Offered in fall.

Hypergeometric functions, Delta, Gamma and Beta functions, Cylindrical functions: Bessel functions, Hankel functions, Neumann functions, modified Bessel functions, Spherical functions: Legendre functions, associated Legendre functions, Laguerre functions, Hermite functions.

**Math 346 INTEGRAL TRANSFORMS (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 132, Math 241. Offered in fall.

Sine and cosine Fourier transforms. Complex form, Finite Fourier transform, Laplace transform, Hankel transform, Mellin transform, Applications.

**Math 351 NUMERICAL ANALYSIS (1) (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 132, Math 241. Offered in fall.

Errors, norms of vectors and matrices, Solving linear systems of equations by Gauss-elimination, Solving nonlinear equations by iteration: Solving a linear system of equations by iterative methods such as Jacobi, Gauss-Seidal, over-relaxation method giving attention to convergence and error analysis for Gauss-Seidal method, Approximation using Lagrange's interpolation, Interpolation for numerical integration: Trapezodial and Simpson's rules, Gauss's quadrature rules and Newton-Cotes rules for numerical integration.

**Math 352 NUMERICAL ANALYSIS (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 351. Offered in spring.

Numerical solution of 1-st order ODE's: Initial-value problems, Taylor's method with error analysis, Euler's method, Runge-Kutta method, Adams-Basforth method, Adams-Moulton method with error analysis, numerical stability, Numerical solution of PDE's using finite-difference method: Explicit scheme, implicit scheme, convergence, stability. Weierstrass approximation theory, Approximation with L2 and $L\infty$ norms.

**Math 353 NUMERICAL ANALYSIS AND COMPUTER (1) (2 cr. + 1 cr. Lab.).**

Offered in fall.

Mathematical preliminaries and error analysis: Sources of error, computer application, Solutions of equations in one variable: Newton's method, error analysis, acceleration of convergence, computer application, Interpolation and polynomial approximation: Lagrange's polynomials, Hermite interpolation, computer application, Numerical integration and differentiation: trapezoidal rule, error estimate, Simpson's rule, error estimate, numerical differentiation, computer application, Numerical solution of initial value problems: Taylor's method, Runge-Kutta's method, computer application, Direct methods for solving linear systems: Gaussian elimination, pivoting strategies, computer application.

**Math 354 NUMERICAL ANALYSIS AND COMPUTER (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 353. Offered in spring.

Iterative methods for solving linear systems: The Jacobi and Gauss-Seidel methods, the successive over-relaxation method, survey of software methods, computer application, Approximation theory: Discrete and continuous least squares approximation, Chebyshev polynomials, survey of software methods, computer application, Approximating eigenvalues: The power method, Householder method, computer application, Solutions of system of nonlinear equations: Newton's method, the stepest descent method, survey of software methods, computer application, Boundary-value problems for ordinary differential equations: Linear finite difference method, variational techniques, survey of software methods, computer application, Numerical methods for partial differential equations: Finite difference method for elliptic and for parabolic problems, introduction to the finite element method, survey of software methods, computer application.

**Math 355 APPROXIMATION THEORY (1) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 232. Offered in fall.

Fundamentals: The approximation problem, general approach, the Lp norms, the Tchebysheff norm and the Polya algorithm, existence theorems, Least squares and orthogonal functions: least squares approximation, orthogonal functions, functions orthogonal on finite point sets, approximation on an interval as the limit of approximation on a finite point set, orthogonalization, Tchebysheff

approximation, the characterization of best approximations, uniqueness, continuous dependence, approximation on finite subsets, the de la Vallée Poussin algorithm, unisolvent functions, rational functions, the limits of a Tchebysheff-type theory, existence, characterization, uniqueness.

**Math 356 APPROXIMATION THEORY (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 355. Offered in spring.

Approximation in the L1 norm, the convex set K, the tangent planes of K, characterization of best L1 approximation, uniqueness and Tchebycheff sets, polynomials and trigonometric sums, finite point sets, The Weierstrass theorem and degree of convergence: The Weierstrass theorem, Fourier series, kernels, the degree of convergence, Computational methods: Expansions from Analysis, transformations of known expansions, telescoping procedures, the method of descent, the method of descent for polytopes, descent mappings, the method of ascent for Tchebycheff approximation, Approximation theory and programming.

**Math 361 MATHEMATICAL METHODS (1) (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 231, Math 241. Offered in fall.

The Laplace transform and its properties, convolution theorem, solution of ODE's by series around regular or singular points, Hypergeometric functions, Delta, Gamma and Beta functions, Orthogonal functions, uniform convergence, Fourier series, Fourier transforms. Parseval's formula and other properties, Applications.

**Math 362 MATHEMATICAL METHODS (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 361. Offered in spring.

Bessel functions, Legendre functions, Boundary-value problems in bounded domains. Sturm-Liouville problem, Applications: The problem of wave propagation, the problem of heat diffusion, Laplace's equation.

**Math 371 CONTINUUM MECHANICS (1) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 272. Offered in fall.

Vector and tensor theory: Vector algebra, tensor algebra, the tensor product, proper vectors and proper numbers of tensors, symmetric tensors, skew-symmetric tensors, orthogonal tensors, polar decomposition, geometrical considerations and coordinates, scalar, vector and tensor fields, Basic kinematics: Bodies, configurations and motions, the referential and spatial descriptions, the deformation and velocity gradients, stretch and rotation, streching and spin, circulation and vorticity.

**Math 372 CONTINUUM MECHANICS (2) (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 371. Offered in spring.

Balance laws, field equations and jump conditions: Mass, momentum, force and torque, the theory of stress, equations of motion, energy, jump conditions, Constitutive equations: Basic constitutive statement, examples of constitutive equations, observer transformations, reduced constitutive equations, material symmetry, internal constraints. Examples of constitutive equations.

**Math 373 ELECTROMAGNETISM AND RELATIVITY (1) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 272. Offered in fall.

Vector analysis: Parametric equations of a curve, scalar line integral, vector line integral, parametric equations of a surface, scalar surface integral, gradient vector, Green's theorem, divergence of a vector, Stokes's theorem, curl of a vector, conservative vector fields, lamellar and solenoidal vector fields, second Green's theorem, curvilinear coordinates, Electrostatic field, boundary-value problems in Electrostatics, images, solutions of Laplace's and Poisson's equations, Dielectrics: Multipole expansion, microscopic and macroscopic Electrostatics, boundary conditions, polarization, energy of a dielectric, Magnetostatics, Steady currents.

**Math 374 ELECTROMAGNETISM AND RELATIVITY (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 373. Offered in spring.

Time-varying E.M. fields, Maxwell's equations, conservation laws, plane electromagnetic waves, radiation, motion of electric charges, Special theory of Relativity: Postulates, Lorentz transformations, relativistic kinematics, 4-D formulation of Electrodynamics, tensor of the electromagnetic field.

**Math 411 THEORY OF NUMBERS (2 cr. + 1 cr. Lab.).**

Offered in spring.

Linear congruences, chinese remainder theorem, Fermat, Euler and Wilson theorems, Phythagorian equation, congruences modulo (pm), Arithmetic functions: Perfect numbers, Möbius inversion formula, the Dirichlet product. The group of units: um basic units, primitive units, Quadratic congruences: Legendre symbol, Gauss' law of quadratic reciprocity. Sums of squares: Computational Number Theory, Introduction to Cryptology.

**Math 421 DIFFERENTIAL GEOMETRY (1) (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 212, Math 331. Offered in fall.

Local theory of curves, Global theory of curves, Local theory of surfaces, Global theory of surfaces.

**Math 422 DIFFERENTIAL GEOMETRY (2) (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 312, Math 421. Offered in spring.

Some topological notions, Differentiable manifolds, Tangent bundle, Linear connecticns, Some Riemannian geometry.

**Math 431 COMPLEX ANALYSIS (1) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 332. Offered in fall.

Complex numbers: Definition, complex field (C,+,.) representations, n-th roots, Complex functions: Complex differentiation, Cauchy-Riemann equations, analytic and harmonic functions, Complex sequences and series: Convergence, power series, Abel's lemma, radius and disc of convergence, tests of absolute convergence, term by term differentiation, identity theorems, trigonometric and logarithmic functions, principal values, change of centre of a power series, natural boundary, uniform convergence, Weierstrass M-test, The Riemann surface, Stereographic projection: The point, the extended complex plane C, Inversion in a circle: Symmetric points, orthogonal circles, symmetric points to two non-intersecting circles, Bilinear transformations: Non-singular transformations, group of non-singular bilinear transformations, elementary bilinear transformations, properties, fixed points of a bilinear transformation, standard forms, Cross-ratio: Ptolemy's theorem, Complex integration: Rectifiable curves, existence theorem of complex integration, properties, Goursat's theorem.

**Math 432 COMPLEX ANALYSIS (2) (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 431. Offered in spring.

The winding number: Existence of the winding number w.r. to some geometric figures, Bounded isolated singularity: Removable singularity, Exact differentials: Existence of a primitive function, Morera theorem, Cauchy integral theorem, integral forms and integral estimates in a disc, Taylor expansion: Zeros of an analytic function, identity theorems, entire functions, Liouville's theorem, maximum principle, minimum principle, Isolated Singularities: Poles, essential singularities, non isolated singularities, Weierstrass, Casorati theorem, behaviour at infinity, quotient of two analytic functions.

**Math 433 COMPLEX ANALYSIS FOR NON MATHEMATICIANS (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 132. Offered in fall.

Complex numbers: properties, geometric representation, complex conjugates, absolute values, polar form, products, powers, quotients, n-th roots, regions in the complex plane, Analytic functions: Functions of a complex variable, mapping, limits, theorems on limits, continuity, the derivative, differentiation formulas, the Cauchy-Riemann conditions, sufficient conditions, analytic functions, harmonic functions, Elementary functions: The exponential function, trigonometric functions, hyperbolic functions, the logarithmic function, complex exponents, inverse trigonometric functions, Mapping by elementary functions: linear functions, functions zn , the function 1/z, the function z1/2, linear fractional transformations, Integrals: Definite integrals, contours, line integrals, Cauchy-Goursat theorem, simply and multiply connected domains, indefinite integrals, the Cauchy integral formula, derivatives of analytic functions, Morera's theorem, maximum moduli of functions, the Fundamental Theorem of Algebra, Power series: Taylor's series, Laurent's series, properties of series, uniform convergence, integration and differentiation of power series, uniqueness of representations by power series, multiplication and division, zeros of analytic functions, Residues

and poles: Residues, the Residue Theorem, poles, quotients of analytic functions, evaluation of improper real integrals, integration around a branch point.

**Math 441 PARTIAL DIFFERENTIAL EQUATIONS (1) (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 241, Math 332. Offered in spring.

Mathematical background, Partial differential equations of the 1st order: Origins, Cauchy's problem, linear equations, integral surfaces, nonlinear equations, compatible systems of equations, Charpit's method, special types of equations, solutions satisfying given conditions, Partial differential equations of the 2nd order: origins, equations of the 2nd and higher orders in physics, linear equations with constant coefficients, classification of 2nd order equations, characteristics, equations with variable coefficients, separation of variables, Diffusion (parabolic) equations: Boundary conditions, separation of variables, transformation of nonhomogeneous boundary conditions into homogeneous ones, transformation of equations into simpler forms, solution of nonhomogeneous equations, integral transforms, Fourier sine and cosine transforms, Fourier series and Fourier transforms and their applications to PDE's, Wave (hyperbolic) equations: 1-D wave equation, boundary conditions, D'Alembert's solution for the infinite vibrating string, existence, uniqueness and stability of the solution, finite vibrating string (standing waves), vibrating rods (4th order equations), finite Fourier transform, vibrations of the circular drum (wave equation in polar coordinates), Elliptic equations: Dirichlet, Neumann and Robin (radiation boundary condition) problems, internal Dirichlet's problem for Laplace's and Poisson's equations, solutions of Laplace's equation in polar cylindrical and spherical polar coordinates, Green's function for Dirichlet's and Neumann's problems for Poisson's equation, solution in terms of Green's function.

**Math 442 PARTIAL DIFFERENTIAL EQUATIONS (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 441. Offered in spring.

Formulation of problems of PDE's: Dirichlet, Neumann and mixed boundary value problems, well-posed problems, Hadamard problem as example of an ill-posed problem, Introduction to the Theory of Distributions, fundamental solution for a linear differential operator, Laplace's and Poisson's equations, Newton's potential, harmonic functions and their properties, Green's function for Dirichlet and Neumann problems for Laplace's equation, 3-D wave equation (Kirchoff's solution), 2-D case (Poisson's formula), physical meaning of the solutions, Theorems of existence and uniqueness for the solutions of PDE's.

**Math 451 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 351. Offered in fall.

Introduction to finite difference formulae: descriptive treatment of elliptic, parabolic and hyperbolic equations, Parabolic equations: Explicit scheme, Crank-Nicholson implicit scheme, finite differences in cylindrical and in spherical polar coordinates, Convergence, stability and consistency: stability, descriptive treatment, stability of Crank-Nicholson method, stability of three or more time-level difference equations, Hyperbolic equations and characteristics: rectangular mesh for 1st order equations, discontinuities and finite differences, method of characteristics, Elliptic equations and symmetric iterative methods: Finite differences in polar coordinates, convergence of iterative methods. Solution of partial differential equations using software packages.

**Math 452 NUMERICAL SOLUTION OF INTEGRAL EQUATIONS (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 351. Offered in spring.

Numerical solution of Fredholm integral equations: Collection method, Young's method, expansion methods (Elliot, Scraton, Elgendi, Galerkin), Numerical solution of Fredholm integral equations with singular kernels: Contour method, fast Galerkin method, Error analysis, Solution of integral equations using software packages.

**Math 471 QUANTUM MECHANICS (1) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 272. Offered in fall.

Postulates of Quantum Mechanics, Probabilistic interpretation of Quantum Mechanics, simple 1-D quantum mechanical system, the free particle, particle in a potential well potential barrier, potential, step, simple harmonic oscillator in Q.M., linear vector spaces in Q.M., Heisenberg's uncertainity

principle, the angular momentum in Q.M., 3-D motion in spherical polar coordinates, the hydrogen atom, pictures of Q.M.

**Math 472 QUANTUM MECHANICS (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 471. Offered in spring.

Quantum dynamics, The evolution operator, Time dependent perturbation theory, Adiabatic perturbation, Instantaneous perturbation, Transition probabilities, Time independent perturbation theory,The secular equation, Scattering in Q.M., Born approximation, The meaning of force in Q.M. as exchanged particles, The phase shift, Partial wave scattering amplitude, The optical theorem .

**Math 473 HYDRODYNAMICS (1) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 371. Offered in fall.

Note in Vector Analysis, Eulerian and Lagrangian methods for describing the fluid motion, analysis of motion of a fluid element, vorticity vector, vortex tube and vortex layer, connectivity of regions, irrotational flow, velocity potential, Laplace's equation, boundary conditions. uniqueness theorem, kinetic energy, Kelvin's minimum theorem, momentum equation, Bernoulli's equation, constancy of circulation, some 3-D flows, moving sphere, impulsive motion, applications, compressible flow, waves, general wave equation, spherical waves, sound waves, vibration in a tube, software packages.

**Math 474 HYDRODYNAMICS (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 473. Offered in spring.

Two-dimensional flow, the stream function $\Psi$, use of complex variables in 2-D irrotational motion, complex potential for standard 2-D flow, uniform stream, line sources and line doublets, line vortices, 2-D image systems, applications, Milne-Thomson circle theorem and some applications, vortex rows, Kármán vortex street, Blasius theorem, applications, Kutta-Joukowski theorem, conformal mapping, Joukowski transformation, applications.

**Math 475 COMPUTATIONAL FLUID DYNAMICS (1) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 231. Offered in fall.

Basic thoughts and equations: Philosophy of Computational Fluid Dynamics, governing equations, Basics of numerics: Discretization, grids and transformations, finite-difference methods (FDM), Applications: Applications of FDM to wave equation, heat equation, Laplace's equation, Numerical methods for boundary layer-type equations, grid generation, Computer applications. Use of software packages.

**Math 476 COMPUTATIONAL FLUID DYNAMICS (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 475. Offered in spring.

The Finite Element Method (FEM), Variational formulation of boundary-value problems, Variational methods of approximation: Ritz's method, method of weighted residuals, time-dependent problems, Finite element analysis of 1-D problems: 2nd and 4th order equations, Finite element analysis of 2-D problems, Computer applications.

**Math 477 THEORY OF ELASTICITY (1) (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 231, Math 241. Offered in fall.

Introduction: Overview of the Mechanics of Continuous media, Theory of stress: types of forces acting on the medium, analysis of internal surface forces (stress forces), stress tensor, equations of equilibrium, principal axes of stress, maxima of the tangential stress component, Mohr's circles, simple stress states, Theory of strain: The displacement vector, angle variation between two perpendicular elemntary displacements, the strain tensor, transformation under rotation, quadratic deformation surface, principal axes of strain, relative volume variation, Helmholtz theorem for the motion of a particle, determination of the displacement components in terms of strain, Theory of state: Generalized Hooke's law, Approximate solutions to some problems of equilibrium of elastic bodies, Saint Venant's principle, Basic equations of linear Elasticity: Hooke's law for small deformations, internal energy of an elastic body, isotropic media, Basic boundary-value problems of the Theory of Elasticity and solution methods, Lamé's equations, basic equations in stresses, stress compatibility equations, Beltrami-Mitchell equations, uniqueness of solutions.

**Math 478 THEORY OF ELASTICITY (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 477. Offered in spring.

Plane problems of Elasticity in Cartesian coordinates: Plane strain and plane stress states, generalized plane stress state, Solution of plane problems in stress, Airy's function, solutions for some simply connected domains (rectangular), Plane problems of Elasticity in polar coordinates: Basic equations in polar coordinates, axisymmetric stress, plane bending of a body in the form of a circular ring, pure radial stress and foundations, stress distribution around holes in plates, plane problems under volume forces, Torsion of thin rods: Torsion of cylindrical and prismatic rods, torsion potential function and its properties, Bredt theorem on the rotation of the shear stress vector, torsion of a rod with elliptic cross-section, solutions of some simple torsion problems for prismatic cross-sections (equilateral triangle or rectangle).

**Math 479 NONLINEAR MECHANICS (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 241, Math 272. Offered in spring.

Stability of linear systems, classification of singular points, applications using software Mathematica or Maple, stability of nonlinear systems, determination of the spatial fields of singular points, applications using software Mathematica or Maple, lenard's theorem, Poincaré theorem, Calculus of Variations (free or constrained), applications, nonlinear waves, progressive waves.

**Math 481 THEORY OF OPTIMAL CONTROL (1) (2 cr. + 1 cr. Lab.).**

Prerequisites: Math 231, Math 241. Offered in fall.

Introduction and problem formulation, variational approach to optimization, optimal open-loop solution, computational considerations, 2-point boundary-value problems, constrained optimization, time-optimal problem, optimization of continuous systems, optimal closed-loop control.

**Math 482 THEORY OF OPTIMAL CONTROL (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Math 481. Offered in spring.

Linear programming, dynamic programming, computational algorithms, the most common methods for numerical solution of optimal control problems, applications including feedback control, time optimal control and others, nonlinear control.

**Math 490 PROGECT (3 cr.).**

Offered in spring.

Partcipating students continue the wok on the project topic selected by groups of students according to their area of interest and the advistor approval. Participants give an oval presentation of the main results achieved. After criticism and suggestions, they submit a written report.

**Math 493 SELECTED TOPICS IN MATHEMATICS (2 cr. + 1 cr. Lab.).**

Offered in spring.

Determined by instructor.

## COMPUTER SCIENCE

**Comp 100 INTRODUCTION TO COMPUTER SCIENCE (2 cr.).**

Offered in fall and spring.

History of computers. Data types and data representation. Understanding the design and functioning of hardware and software computer systems. Computer networks and types. WWW (World Wide Web). Computer virus. Introduction to operating systems. Introduction to Office software. Programming languages.

**Comp 101 FUNDAMENTALS OF PROGRAMMING (2 cr. + 1 cr. Lab.).**

Offered in spring.

Number systems. Algorithms and flowcharts. Expressions and statements. Control structures: if statement (logical connectives, logical expressions, and formulas), loops. Functions and library functions. Recursions. Arrays. Pointers and strings. Structures.

**Comp 201 OBJECT-ORIENTED PROGRAMMING (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 101. Offered in fall.

Structured programming. Introduction to data abstraction and object-oriented program design. Object Oriented Design Techniques. Object class construction with varying levels of encapsulation. Object relationships with single and multiple inheritances. Code re-use through class libraries and generic templates. Code readability through function overloading. Basic I/O with streams, Application design. Intermediate problem solving techniques. Algorithmic topics including recursion, dynamic storage, lists, pointers and binary trees. User interface design.

**Comp 202 DATA STRUCTURES & ALGORITHMS (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 100. Offered in spring.

Data types. Stacks, Queues. One-dimensional arrays and two-dimensional arrays. Linear lists: sequential array-based list, linked list, circular linked list, and doubly linked list. Binary Search Trees. Writing algorithms. Analyzing algorithms. Sorting: merge/sort, and quick-sort. Selection. Hashing. Divide-and-conquer. Backtracking.

**Comp 302 COMPUTER ORGANIZATION (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 201. Offered in fall.

Digital logical concepts and principles of digital design. Number systems. Boolean algebra. Logic design: Flip-Flop, transfer circuits, shift register and counters. ALU: half adder, full adder, parallel adder, multiplexers and decoders. Simple design for memory.

**Comp 303 SOFTWARE DEVELOPMENT (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 201. Offered in spring.

Step-wise refinement. Problem decomposition. Algorithm correctness and cost. Programming language concepts include iteration, selection, input-output protocols, arrays, structures and subprograms. Introduction to user interface design. Programming language used is C++.

**Comp 304 COMPUTER GRAPHICS (2 cr. + 1 cr. Lab.).**

Prerequisites: comp 201, comp 202. Offered in fall.

A survey of computer graphics. Output primitives: lines, colors, fill areas, character generation, circles, ellipses, and other curves. Two-dimensional transformations: basic transformations, homogenous coordinates, and composite transformations. Windows and clipping. Segments. Interactive input methods.

**Comp 305 ALGORITHMS DESIGN AND ANALYSIS (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 202. Offered in fall.

Basic algorithmic analysis: Asymptotic analysis of upper average complexity, bounds; best, average, and worst case behaviors. Fundamental algorithmic strategies: Brute-force; greedy; divide and conquer; backtracking; branch and bound; numerical approximation. Fundamental data structures: trees and graphs. Introduction to language translation. P and NP algorithms classes.

**Comp 306 OPERATING SYSTEMS (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 305. Offered in spring.

Study of design and implementation of traditional and distributed operating systems. History of operating system development. Processes. System calls and interprocess communication. Memory management. File system implementations. I/O management. Distributed systems, synchronization, distributed file systems. Examples of operating systems such as Windows, Unix, and OS2.

**Comp 307 DATABASE SYSTEMS (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 202. Offered in fall.

Data description. Data manipulation. Database architecture. Details of the three logical data base models: hierarchical, network (CODASYL-DBTG) and relational.

**Comp 308 DATABASE DESIGN (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 307. Offered in spring.

Relational database: basic concepts, relations, relational algebra, relational calculus, Database design: functional dependencies, normalization (1st, 2nd , 3rd, 4th, 5th normal forms).

**Comp 309 SYSTEM ANALYSIS & DESIGN (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 202. Offered in fall.

Systems development life cycle. Classical and structured tools/techniques for describing process flows, data flows, file designs, input and output designs, and program specifications. Data gathering and analysis methods.

**Comp 316 FILE ORGANIZATION AND PROCESSING (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 202. Offered in fall.

Fundamental file processing operations. Secondary storage. Data compression. Sequential and random storage. Blocking and buffering. Indexed Files. B+ tree. Hashing. File structures on CD-ROM.

**Comp 317 DISTRIBUTED SYSTEMS (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 306. Offered in spring.

Distributed System Architecture: motivation, system structures, architecture, ODP Reference model and distribution transparencies, design issues. Interaction Primitives: message passing, remote procedure call, remote object invocation.

**Comp 401 COMPUTER NETWORKS (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 306. Offered in fall.

Theoretical concepts necessary to understand the complex problem of computer networking. Computer network architectures and models, Bandwidth limitations of physical media. Analog and digital signaling methods. Data link protocols. Error detection and correction Medium access control in broadcast networks. Routing algorithms, internetworking. The Internet Protocol, connection management, transport services including TCP/UDP. Network applications, local-area and wide-area networks.

**Comp 402 CRYPTOLOGY (2 cr. + 1 cr. Lab.).**

Prerequisites: comp 305, stat 201, Math 213. Offered in spring.

Elementary Number Theory. Elementary Discrete Probability Theory. Defining Security: Shannon's Theory. Symmetric Key Cryptosystems. Public Key Cryptosystems. Identification, Authentication and Non-Repudiation Protocols. Economic / Political / Ethical Considerations. Zero-Knowledge Protocols and Oblivious Transfer Quantum Cryptography.

**Comp 403 FORMAL LANGUAGES AND AUTOMATA (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 305. Offered in fall.

Introduction to abstract notions encountered in machine computation. Finite automata, regular expressions and formal languages with emphasis on regular and context-free grammars. Introduction to models of computation including Turing machines, recursive functions and universal machines.

**Comp 406 SIMULATION AND MODELING (2 cr. + 1 cr. Lab.).**

Prerequisites: comp 305, stat 201. Offered in fall.

Introduction to Simulation. Hand Simulation. Review of basic Probability Theory. Random Number Generation, Generation of Random Varieties. Analysis of Output. Elementary Queuing Models.

**Comp 407 PROGRAMMING LANGUAGES DESIGN (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 403. Offered in spring.

Systems development life cycle. Classical and structured tools/techniques for describing process flows, data flows, file designs, input and output designs, and program specifications. Data gathering and analysis methods. The Structure of a Compiler. Lexical Analyzer: Top down Parsing, LL(1) parsers, Bottom up Parsing, LR parsers. Syntax Directed Translation.

**Comp 408 ARTIFICIAL INTELLIGENCE (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 305. Offered in spring.

Heuristic and algorithmic techniques in problem solving. Knowledge representation, Selected topics from natural language processing, automatic theorem proving, game playing, pattern recognition, and other current topics in artificial intelligence. Introduction to PROLOG (or LISP).

**Comp 415 MANAGEMENT INFORMATION SYSTEMS (3 cr.).**

Prerequisite: comp 308. Offered in fall.

The facilitation of managerial functions through transaction processing. Integration of IT to facilitate operations and decision making. The alignment of MIS with organizational needs and resources

**Comp 416 PROGRAMMING OF BIOLOGICAL SYSTEMS (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 100. Offered in fall.

Number systems. Algorithms and flowcharts. Expressions and statements. Control structures: if statement (logical connectives, logical expressions, and formulas), loops. Functions and library functions. Recursions. Arrays. Pointers and strings. Structures. Structured programming, Introduction to object-oriented program design. Object Oriented Design Techniques, Object relationships with single and multiple inheritances. Basic I/O with streams, User interface design, Applications in biological systems (selected by instructor).

**Comp 417 NEURAL NETWORKS (3 cr.).**

Prerequisite: comp 305. Offered in fall.

Introduction to the theory, architecture, and application of artificial neural systems. Supervised, unsupervised, and reinforcement learning in single and multiple layer neural networks. Associative neural memory recording, and retrieval dynamics. Self-organizing maps. Learning capacity and generalization. Hardware implementations.

**Comp 418 ADVANCED DISTRIBUTED SYSTEMS (3 cr.).**

Prerequisite: comp 317. Offered in fall.

Distributed Systems Security: threat analysis, security policies, military (Bell Lapadula) vs commercial models; access control concepts, identification, authentication, authorization and delegation; authorization policy: web security; security management. Distributed Systems Management: SNMP and OSI Management Models, monitoring and event generation, domains & policy. Fault Tolerance in Distributed Systems.

**Comp 421 ADVANCED COMPUTER GRAPHICS (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 304. Offered in fall.

Principles of image synthesis, construction of application models, current models for the interaction of light and materials, rendering techniques based on these models. Applications of interactive computer graphics for scientific visualization, design, simulation and entertainment, techniques for obtaining real-time performance of computer graphics algorithms, some areas of current computer graphics research.

**Comp 422 ADVANCED COMPUTER NETWORKS (3 cr.).**

Prerequisite: comp 401. Offered in spring.

Advanced network management, security, and server issues. Topics include server types (file, database, fax, communication, FTP, e-mail, CD-ROM), authentication, remote monitoring, viruses, and disaster recovery. (Upon completion, students should be able to perform advanced monitoring and management of various types of servers and networks).

**Comp 423 PATTERN RECOGNITION (3 cr.).**

Prerequisite: comp 402. Offered in spring.

Pattern recognition algorithms, maximum likelihood estimation, Bayesian parameter estimation, Parzen windows, hidden Markov models, linear discriminates, multilayer neural networks, radial-basis functions, support vector machines, decision trees, k-nearest neighbor classifiers, and k-means clustering.

**Comp 424 ADVANCED OPERATING SYSTEMS (3 cr.).**

Prerequisite: comp 306. Offered in spring.

File systems, security in operating systems, case study: Unix variants, Windows 2000, communication paradigms, naming, synchronization and security in distributed systems, Distributed file systems.

**Comp 425 EXPERT SYSTEMS (2 cr. + 1 cr. Lab.).**

Prerequisite: comp 402. Offered in spring.

Theoretical foundations: representation and control, automated reasoning, representing uncertainty. Production systems. Associative nets. Procedural deduction. Practical problem solving. Software tools and architecture.

**Comp 426 SELECTED TOPICS IN COMPUTER SCIENCE (2 cr. + 1 cr. Lab.).**

Prerequisite: consent of instructor. Offered in spring.

Topics chosen according to special interests of faculty and students.

**Comp 427 SELECTED PROGRAMMING LANGUAGES (2 cr. + 1 cr. Lab.).**

Prerequisite: consent of instructor. Offered in spring.

Topics chosen according to special interests of faculty and students.

**Comp 490 PROGECT (3 cr.)**

Offered in spring.

Partcipating students continue the wok on the project topic selected by groups of students according to their area of interest and the advistor approval. Participants give an oval presentation of the main results achieved. After criticism and suggestions, they submit a written report.

## STATISTICS

**Stat 100 MATHEMATICAL STATISTICS (1) (3 cr.).**

Offered in fall.

Collection, preparation and tabulation of data, frequency distributions, central tendency measures: mean, median and mode, dispersion measures: range, semi-quartile difference, standard deviation, comparison between distributions, linear regression, correlation (Pearson and Spearman) time series analysis, introduction to probability: sample space, event, calculus of events, conditional probability and independence, random variables, probability distribution, some important distributions (binomial, Poisson, normal), sampling and sampling distribution, ratio distribution (small sample, large sample), confidence interval, tests of statistical hypothesis, index number.

**Stat 201 INTRODUCTION TO PROBABILITY THEORY (2 cr. + 1 cr. Lab).**

Prerequisite: stat 100. Offered in spring.

Random experiment, sample space, event, compound event, probability of event, axioms of probability, calculus of events, conditional probability and independence, total probability and Bayes's theorem, random variables: definition, types, cumulative distribution function, expectation, moments, types of moments, moment generating function, probability generating function and its properties, probability distributions: continuous (normal, exponential, gamma, beta, uniform), discrete (binimial, geometric, negative binomial, Poisson).

**Stat 202 STATISTICAL INFERENCES (1) (2 cr. + 1 cr. Lab).**

Prerequisite: stat 201. Offered in spring.

Definitions of: Population, sample, statistics, estimator, type of samples, properties of good estimator (unbiased, sufficiency, efficiency, consistency), some methods of estimation: point estimation, interval estimation, Bayes and minimax estimators, asymptotic properties of estimators.

**Stat 221 APPLIED STATISTIC (1) (2 cr. + 1 cr. Lab).**

Offered in fall.

Collection, preparation and tabulation of data, frequency distributions, central tendency measures: mean, median and mode, dispersion measures: range, semi-quartile difference, standard deviation, comparison between distributions, linear regression, correlation (Pearson and Speaman).

**Stat 222 APPLIED STATISTIC (2) (2 cr. + 1 cr. Lab).**

Prerequisite: stat 221.Offered in spring.

Introduction to probability: sample space, event, calculus of events, conditional probability and independence, random variables, probability distribution, some important distribution, some important distributions (binomial, Poisson, normal), sampling and sampling distributions, ratio distribution (small sample, large sample), confidence interval.

**Stat 301 STOCHASTIC PROCESSES (1) (2 cr. + 1 cr. Lab).**

Prerequisite: stat 201. Offered in fall.

Concepts, types of stochastic processes, Markov property, Markov chain, transition probability matrices, one, and multi-step transition, classification of state spaces, Kolmogorov-Chapman equation, stationary distribution of Markov chains, pure jump processes, applications.

**Stat 302 STATISTICAL INFERENCES (2) (2 cr. + 1 cr. Lab).**

Prerequisite: stat 202. Offered in fall.

Types of hypotheses, types of errors, critical regrion, certain best tests, Neyman-Pearson theorem, uniformly most powerful tests, likelihood ratio test, conditional tests and confidence interval.

**Stat 303 REGRESSION ANALYSIS (2 cr. + 1 cr. Lab).**

Prerequisite: stat 201, 202. Offered in spring.

Simple linear regression model, multiple linear regression, analysis of residuals and predictions, stepwise methods, some nonlinear regression models and data transformations (use of statistical computer packages), multiple linear regression models using matrices, variance and covariant matrices.

**Stat 304 STATISTICAL PACKAGES (2 cr. + 1 cr. Lab).**

Prerequisite: stat 302. Offered in spring.

Introduction to computer programming, some statistical applications, survey of major computer packages available for statistical analysis (including SPSS and MINITAB), uses of these packages in statistical analysis in various fields.

**Stat 321 INTRODUCTION TO PROBABILITY AND MATHEMATICAL STATISTICS FOR NON MATHEMATICIANS (2 cr. + 1 cr. Lab).**

Prerequisite: Math 132. Offered in fall.

Random experiments, sample spaces, events, probability of an event, some rules of probability, conditional probability, independent events, Bayes theorem, random variables, discrete and continuous probability distributions, mathematical expectation (mean, variance, moment generating functions), some special discrete distributions (binomial, Poisson, geometric, hypergeometric), some special continuous distributions (uniform, gamma, exponential, normal), Populations and samples, descriptive and inferential statistics, statistical variables, data collection, data preparation, data presentation using tables and charts, measures of location, measures of dispersion, regression and correlation.

**Stat. 322 BIOSTATISTICS AND DIFFERENCE EQUATIONS (2 cr. + 1 cr. Lab).**

Prerequisite: Math 132. Offered in fall.

Sampling distribution of mean, variance, difference between means and proportion and other statistics, central limit theorem, interval estimation, confidence intervals for mean, proportion, difference between means, difference between proportions, variance, ratio between variances, tests of hypotheses.

**Miscellaneous applications (determined by the instructor).**

The difference calculus,difference equations, linear difference equations with constant coefficients, stability, asymptotic methods.

**Stat. 324 BIOSTATISTICS (2 cr. + 1 cr. Lab).**

Prerequisite: Math 132. Offered in spring.

Sampling distribution of mean, variance, difference between means and proportion and other statistics, central limit theorem, interval estimation, confidence intervals for mean, proportion, difference between means, difference between proportions, variance, ratio between variances, analysis of variance, tests of hypotheses, interpretation of laboratory tests. Miscellaneous applications (determined by the instructor).

**Stat. 325 ELEMENTS OF SAMPLING THEORY (2 cr. + 1 cr. Lab).**

Prerequisite: stat 201. Offered in spring.

Population and its characteristics, concept of a sample, applications of sampling theory, statistics from sample, probability and non-probability sampling. Random sample, stratified samples, small and large samples, uniform samples, Relation between different types of samples, applications.

**Stat. 326 THEORY OF CORRELATION (1) (2 cr. + 1 cr. Lab).**

Prerequisite: stat 201. Offered in fall.

Correlation and regression, linear correlation, measures of correlation, the least squares regression lines, standard error of estimates, explained and unexplained variation, coefficient of correlation, remarks concerning the coefficient of correlation, product-moment formula for the linear correlation coefficient, short computational formulae, regression lines and the linear correlation coefficient, rank correlation, correlation of time series, correlation of attributes. Sampling theory of correlation, sampling theory of regression.

**Stat. 327 THEORY OF CORRELATION (2) (2 cr. + 1 cr. Lab).**

Prerequisite: stat 326. Offered in spring.

Multiple correlation, subscript notation, regression equation, regression plane, normal equations for the least square regression plane, regression planes and correlation coefficients, standard error of estimate, the coefficient of multiple regression, change of dependent variable, generalization to more than three variables, partial correlation, relationship between multiple and partial correlation coefficients, nonlinear multiple regression.

**Stat.401 EXPERIMENT DESIGN (2 cr. + 1 cr. Lab).**

Prerequisite: stat 302. Offered in fall.

Simple comparative experiments: sampling and sampling distributions, inferences about the differences in means, randomized design, inferences about the difference in means, paired comparison designs, inference about variances, experiments to compare several treatments, analysis of variance: fixed effects completely randomized, randomized blocks for 1-way, 2-way and 3-way classification, orthogonal contrasts: comparing pairs of treatment means, comparing treaments with a control, non-parametric methods in ANOVA - Kruskal-Wallis test, rank transformation.

**Stat.402 NON-PARAMETRIC STATISTICS (2 cr. + 1 cr. Lab).**

Prerequisite: stat 202. Offered in fall.

Distribution free statistics, Linear rank statistics and their applications to the location, scale, location scale problems, one, two and multi-sample cases, estimation of location and scale parameter, efficiency of tests and estimates, goodness of fit tests, non parametric design and regression problems.

**Stat.403 RELIABILITY THEORY (2 cr. + 1 cr. Lab).**

Prerequisite: stat 301. Offered in spring.

Order statistics, reliability concepts, parallel and series systems, complete sample, type I censored sampling, type-II censored sampling, estimation of parameters, applications on the use of exponential and Weibull distributions in reliability.

**Stat.404 MULTIVARIATE STATISTICS (2 cr. + 1 cr. Lab).**

Prerequisites: stat 302, Math 212. Offered in spring.

Matrix algebra, multivariate normal distribution, samples from multivariate normal, multiple and partial correlation, Testing in the multivariate normal case, Hotelling's T-statistics, Discrimination and classification, Principal components, Applications.

**Stat 405 SELECTED TOPICS IN STATISTICS (1)(2 cr. + 1 cr. Lab).**

Prerequisite: consent of instructor. Offered in fall.

**Stat 406 SELECTED TOPICS IN STATISTICS (2)(2 cr. + 1 cr. Lab).**

Prerequisite: consent of instructor. Offered in spring.

**Stat 422 BIOSTATISTICS FOR BIOLOGISTS (2 cr. + 1 cr. Lab).**

Offered in spring.

Sampling distribution of mean, variance, difference between means and proportion and other statistics, central limit theorem, interval estimation, confidence intervals for mean, proportion,

difference between means, difference between proportion, variance, ratio between variances, analysis of variance, tests of hypotheses, interpretation of laboratory tests. Miscellaneous applications (determined by the instructor).

**Stat 423 COMPUTER-AIDED BIOSTATISTICS FOR NON-MATHEMATICIANS (1 cr. Lab).**

Offered in spring.

Use of statistical computer packages in biological domains.

**Stat 428 STATISTICAL QUALITY CONTROL (2 cr. + 1 cr. Lab).**

Offered in fall

Quality control, Shewart control charts for mean, median, variance and range, Cumulative sum control charts for mean, range and variance, Use of masks, Acceptance sampling, tolerance limit, simple series system.

**Stat 429 STATISTICAL DEMOGRAPHY (2 cr. + 1 cr. Lab).**

Prerequisite: stat 202. Offered in fall.

Demography and population concepts, vitual statistics, population census, distribution of population according to age and sex, rates and structures of birth, mortality, fertility and internal and external immigration, Life tables, constituents and formation. Demographic forecasting, Mathematical models of statistical demography.

**Stat 430 THEORY OF ESTIMATION (2 cr. + 1 cr. Lab).**

Prerequisite: stat 302. Offered in spring.

Point estimation, Methods of point estimation: Moment method, maximum likelihood method, Properties of good estimators: Unbiased, sufficiency, efficiency, completeness, Bayes method of estimation, Pitman estimation and interval estimation.

**Stat 431 APPLIED STATISTICS (2 cr. + 1 cr. Lab).**

Prerequisite: stat 302. Offered in spring.

Introduction to time series, forecasting, linear processes models, moving average processes, Applications on goodness of fit test, practical applications using statistical packages SPSS and MINITAB.

**Stat 432 LIFE TESTING AND RELIABILITY (2 cr. + 1 cr. Lab).**

Prerequisite: stat 302. Offered in spring.

Order statistics, reliability concepts, life testing distributions (Waybill, gamma, normal), Series and parallel systems. Censored and uncensorted samples.

**Stat 433 TIME SERIES ANALYSIS (2 cr. + 1 cr. Lab).**

Prerequisite: stat 303. Offered in spring.

Time series, graphs of time series, characteristic movements of time series, classification of time series movements, moving averages, smoothing of time series, estimation of trend, estimation of seasonal variations, seasonal index, deseasonalization of data, estimation of cyclical variations, estimation of irtregular or random variations, comparability of data, forecasting, summary of fundamental steps in time series analysis.

**Stat 490 PROGECT (3cr.)**

Offered in spring.

Partcipating students continue the wok on the project topic selected by groups of students according to their area of interest and the advistor approval. Participants give an oval presentation of the main results achieved. After criticism and suggestions, they submit a written report..

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# PHYSICS

## First: Academic Programs Offered by Physics Department

The Department offers courses for all freshmen and for students of the following groups:

1- Physics (Phys.)
2- Communication Physics (Com.)
3- Chemistry , Chemistry/Physics (Chem), (Chem/Phys)
4- Physics/Space Science (Phys/S.)
5- Physics/Meteorology (Phys/Met)
6- Physics/Astronomy (Phys/A)

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 1 | 1st | Phys101 | General Physics ( 1) | - | All students | - | 2 | 2 | 1 | 3 | 6 cr. compuls |
| | 2nd | Phys 102 | General Physics (2) | Phys101 | | - | 2 | 2 | 1 | 3 | |
| 2 | 3rd | Phys 201 | Practical Physics | Phys102 | All students | - | - | 4 | - | 2 | 9cr. compuls. for all dual<br>18 cr. compuls. for each of Phys. & Com |
| | | Phys 221 | Classical Mechanics (1) | Phys102 | | - | 2 | - | 1 | 2 | |
| | | Phys 231 | Electromagnetism (1) | Phys102 | | - | 2 | - | 1 | 2 | |
| | | Phys 241 | Mathematical Physics (1) | Phys102 | | - | 2 | - | 2 | 3 | |
| | | Phys 235 | Physical Optics | Phys231 | Phys., Com. | - | 2 | - | 2 | 3 | |
| | | Phys 245 | Computer Science | Phys102 | | - | 2 | 2 | 1 | 3 | |
| | | Phys251 | Therrmodynamics | Phys102 | | - | 2 | - | 2 | 3 | |
| | | Phys 249 | Crystallography and X-ray diffractions | - | Chem. | - | 2 | - | 3 | 3 | |
| | 4th | Phys 202 | Practical physics | Phys201 | All students | - | - | 4 | - | 2 | 9 cr. compuls. for all dual<br>18 cr. compuls. for each of phys. & com. |
| | | Phys 222 | Classical mechanics (2) | Phys221<br>Phys241 | | - | 2 | - | - | 2 | |
| | | Phys 232 | Electiomagnetism (2) | Phys231<br>Phys241 | | - | 2 | - | - | 2 | |
| | | Phys 224 | Physics of wave | Phys231 | Phys., Com. | - | 2 | - | 2 | 3 | |
| | | Phys 235 | Physical Optics | Phys231 | | - | 2 | - | - | 2 | |
| | | Phys 261 | Modern Physics | Phys221 | | - | 2 | - | - | 2 | |
| | | Phys 242 | Mathematical Physics (2) | Phys241 | Phys. | - | 2 | - | 2 | 3 | |
| | | Phys 234 | Relativity mechanics | Phys221 | Com. | Phys. | 2 | - | 1 | 2 | |
| | | Phys 247 | Computer and communications | Phys | | | 2 | 2 | 1 | 3 | |
| | | Phys 251 | Therrmodynamics | Phys102 | Dual | - | 2 | - | 2 | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 3 | 5th | Phys 301 | Practical Physics | Ph202 | All students | - | - | 4/6 | - | 2/3 | 18 cr. compuls. for Phys., com. & 8 cr. compuls. for all dual<br>Phys. 301: 3 cr for phys & com only |
| | | Phys 351 | Statistical physics (1) | Phys251 | Phys., Com | - | 2 | - | 2 | 3 | |
| | | Phys 362 | Quantum mechanics (1) | Phys241 | | - | 2 | - | 2 | 3 | |
| | | Phys 366 | Laser physics and Applications | Phys362 | | - | 2 | - | 1 | 2 | |
| | | Phys 390 | Introduction to Electronic Circuit Analysis | Phys261 | | - | 2 | - | - | 2 | |
| | | Phys 235 | Physical Optics | Phys231 | Dual | - | 2 | - | 1 | 2 | |
| | | Phys 245 | Computer Science | Phys102 | | - | 2 | 2 | 1 | 3 | |
| | | Phys 261 | Modern Physics | Phys221 | | - | 2 | - | - | 2 | |
| | | Phys 424 | Fluid Mechanics | Phys222 | Phys, Geophys | - | 3 | - | - | 3 | |
| | | Phys 434 | Non-Linear Optics | Phys235 | Com. | - | 2 | - | - | 2 | |
| | | Phys 394 | Vacuum Tech. & Instrumentation | Phys102 | | - | 2 | - | 1 | 2 | |
| | | Phys 345 | Computational Physics | Phys102 | - | Phys., Com. | 2 | - | - | 2 | |
| | | Phys 354 | Physics of energy | Phys102 | - | | 2 | - | - | 2 | |
| | | Phys 392 | Environmental physics (1) | Phys102 | - | | 2 | - | - | 2 | |
| | 6th | Phys 302 | Practical Physics | Phys301 | All student | - | - | 4/6 | - | 2/3 | 18 cr. compuls. for phys., 19 for com., 8 cr. compuls for all dual<br>Phys. 302: 3 cr for phys & com only |
| | | Phys 351 | Statistical physics (1) | Phys251 | Dual | - | 2 | - | 2 | 3 | |
| | | Phys 362 | Quantum mechanics (1) | Phys241 | | - | 2 | - | 2 | 3 | |
| | | Phys 363 | Quantum mechanics (2) | Phys362 | Phys. + Com. | - | 2 | - | 2 | 3 | |
| | | Phys 371 | Solid state physics (1) | Phys362 | | - | 2 | - | 2 | 3 | |
| | | Phys 381 | Nuclear Physics (1) | | | - | 2 | - | 2 | 3 | |
| | | Phys 366 | Laser physics and Applications | Phys362 | - | Dual | 2 | - | - | 2 | |
| | | Phys 391 | Instrumentation & Electronics | Phys390 | Com. | | 2 | - | 2 | 3 | |
| | | Phys 435 | Microwaves & Applications | Phys232 | | - | 2 | - | - | 2 | |
| | | Phys 352 | Statistical physics (2) | Phys351 | Phys. | - | 2 | - | 2 | 3 | |
| | | Phys 393 | Environmental physics (2) | Phys392 | - | Phys., Com | 2 | - | 2 | 3 | |
| | | Phys 394 | Vacuum tech. and Intrumentation | Phys102 | - | | 2 | - | 1 | 2 | |
| | | Phys 398 | Device physics | Phys 372 | - | | 2 | 2 | 1 | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 7th | Phys 401 | Practical physics | Phys 302 | All students | - | - | 4/6 | - | 2/3 | 18 cr. compuls. for Phys., com., & 8 cr. compuls. for all dual Phys. 401: 3 cr for phys & com only |
| | | Phys 372 | Solid State (2) | Phys371 | Phys., Com. | - | 2 | - | 2 | 3 | |
| | | Phys 371 | Solid State (1) | Phys362 | Dual | - | 2 | - | 2 | 3 | |
| | | Phys 381 | Nuclear Physics (1) | Phys362 | | - | 2 | - | 2 | 3 | |
| | | Phys 382 | Nuclear Physics (2) | Phys381 | Phys. | - | 2 | - | 2 | 3 | |
| | | Phys 499 | Project | - | Phys., Com. | - | 2 | - | - | 2 | |
| | | Phys 395 | Digital Electronics | Phys 390 | | - | 2 | - | - | 2 | |
| | | Phys 475 | Thin Film Principles & Tecnology | Phys 371 | Com. | - | 2 | - | - | 2 | |
| | | Phys 496 | Optical Communication Systems | Phys235 | | - | 2 | - | - | 2 | |
| | | Phys 435 | Microwaves & Applications | Phys232 | | Phys. | 2 | - | - | 2 | |
| | | Phys 443 | Micro processors | Phys261 | - | Phys., Com. | 2 | - | - | 2 | |
| | | Phys 445 | Field theory | Phys232 | - | | 3 | - | - | 3 | |
| | | Phys 461 | Relativistic quantum mechanics | Phys362 | - | | 2 | - | 2 | 3 | |
| | | Phys 495 | Low Temperature Physics | Phys371 | - | | 2 | - | - | 2 | |
| | 8th | Phys 402 | Practical physics | Phys401 | All students | - | - | 4/6 | - | 2/3 | 18 cr. compuls. for Phys., com. & 10 cr. compuls for all dual. Phys. 402: 3 cr for phys & com only |
| | | S.422 | Space Communications | - | Com. | - | 2 | - | - | 2 | |
| | | Phys 444 | Group Theory | Phys363 | Phys. | - | 3 | - | - | 3 | |
| | | Phys 372 | Solid State (2) | Phys371 | - | All students | 2 | - | 2 | 3 | |
| | | Phys 382 | Nuclear Physics (2) | Phys381 | - | | 2 | - | 2 | 3 | |
| | | Phys 395 | Digital Electronics | Phys 390 | - | | 2 | - | - | 2 | |
| | | Phys 473 | Introduction to condensed matter physics | Phys 372 | - | | 2 | - | - | 2 | |
| | | Phys 475 | Thin film principles and technology | Phys371 | - | | 2 | - | - | 2 | |
| | | Phys 483 | physics of Elementary particles | Phys 381 | - | | 2 | - | - | 2 | |
| | | Phys 494 | Plasma Physics | Phys381 | - | | 2 | - | - | 2 | |
| | | Phys 496 | Optical communication systems | Phys235 | - | | 2 | - | - | 2 | |
| | | Phys 497 | Fundamentals of antenna | Phys371 | - | | 2 | - | - | 2 | |
| | | Phys 498 | Digital electronic designation | Phys390 | - | | 2 | - | - | 2 | |

## Second: Courses Offered by Physics Department

**phys 101 GENERAL PHYSICS (1) (2cr. + 1cr. Lab.)**

Offered in fall

Units and dimensions, vectors, particle dynamics, statics and dynamics of rigid bodies, conservation laws, oscillatory motion, fluids, temperature and heat, equation of state, kinetic theory of gases, entropy and the second law of thermodynamics, introduction to the special theory of relativity.

**Phys 102 GENERAL PHYSICS (2) (2.cr. +1cr.Lab.)**

Prerequisite: Phys 101. Offered in spring.

Electric charges and fields, Gauss's law and electric Potential, capacitors and dielectrics, current and resistance, E.M.F. and circuits, magnetic field, Ampere's law, Faraday's law and inductance magetic properties of matter, E.M. oscillations and waves nature of light, reflection, interference, diffraction and polarization, wave-particle duality; modern physics.

**Phys 201 PHYSICS LAB. (2.cr.)**

Offered in fall.

Basic experiments in electricity and magnetism.

**Phys 202 PHYSICS LAB. (2.cr.)**

Offered in spring.

Experiments in properties of matter and geometrical optics.

**Phys 221 CLASSICAL MECHANICS (1) (2.cr.)**

Prerequisite: Phys 201, 202. Offered in fall.

Vector analysis, Newtonian mechanics, motion of a particle in three dimensions, gravitation and central forces, dynamics of a system of particles, planar motion of a rigid body.

**Phys 222 CLASSICAL MECHANICS (2) (3cr.)**

Prerequisites: Phys 221, Phys 241. Offered in spring.

Motion of a rigid body in three dimensions, Lagrangian mechanics, dynamics of oscillating systems, Hamilton, Jacobi theorem , special relativity and relativistic mechanics.

**Phys 224 PHYSICS OF WAVES (2cr.)**

Prerequisites: Phys 221, Phys 232. Offered in spring.

Forced oscillation and resonance, coupled oscillators and normal modes, Fourier series, the equation of wave motion, waves in strings, waves in membranes, electromagnetic waves, radiation, longitudinal oscillations, sound waves, waves in liquids, travelling waves, signals, wave packets and group velocity, two and three dimensional waves, polarization, interference and diffraction, holography. X-ray crystallography.

## Phys 231 ELECTROMAGNETISM (1) (2. cr.)

Prerequisite: Phys 102. Offered in fall.
Differential and integral vector calculus, curvilinear coordinates, electrostatics, electrostatic Field and its properties, electric potential, work and energy in electrostatics, Laplace's equation and uniqueness theorems, the method of images, separation of variables, multipole expansion, electrostatic field in matter, magnetostatics, the Lorentz force law, the Biot-Savart law, properties of the magnetic field, magnetic vector potential, magnetostatic fields in matter.

## Phys 232 ELECTROMAGNETISM (2) (.2.cr. + 1cr.2Lab.)

Prerequisite: Phys 231. Offered in spring.
Electrodynamics, electromotive force, Faraday's law, Maxwell's equations, potential formulation of electrodynamics, energy and momentum in electrodynamics, electromagnetic waves, the wave equation, electromagnetic waves in nonconducting media, electromagnetic waves in conductors, dispersion, electromagnetic radiation, dipole radiation from a point charge, radiation reaction, relativistic electrodynamics .

## Phys 249 Crystallography and X-ray diffractions (2 cr. + 1cr. Lab.)

Offered in fall.
Lattice Geometry, unit cell, symmetry elements, crystal systems, Bravais lattics, stereographic projection and point groups X- rays and their interaction with matter, sources of X-rays, diffraction by perfect crystals, photoelectric absorption.

**Phys 234 RELATIVITY (2.cr. + 1cr. Lab.)**

Prerequisite: Phys 221. Offered in spring.

Postulates of special and general relativity including acceleration, four vectors, energy and momentum, Lorentz group and Poincare group, relativictic connection between electric and magnetic fields, curved space, gravitation and black holes.

**Phys 235 OPTICS (2.cr.)**

Prerequisite: Phys 241. Offered in fall.

Gaussian optics, optical instruments, matrix analysis of lens systems, aberrations, sources of light and their spectra, the speed of light, Physical Optics: double and multiple–beam interference, Fraünhoffer diffraction by a single opening, the double- slit, the diffraction grating, Fresnel's diffraction, absorption and scattering, dispesion, polarization of light, reflection from dielectrics and metals, double refraction, interference of polarized light, optical activity, magneto-and electro-optics.

**Phys 241 MATHEMATICAL PHYSICS (1) (2 cr. + 1 cr. Lab.)**

Prerequisite: Phys 102. Offered in fall.

Determinants and matrices, coordinate systems, orthogonal curvilinear coordinates, coordinate transformation and Jacobi determinant, differential and integral vector operations, Partial differentiation and perfect differentials, Ordinary differential equations, Sturm–Liouville theorem, the Gamma fun-ction and related functions, partial differential equations (homogeneous and non-homogeneous).

**Phys 242 MATHEMATICAL PHYSICS (2) (2.cr. + 3cr.-Lab.)**

Prerequisite: Phys 241. Offered in spring.

Functions of complex variables, calculus of residues, Bessel functions, Legendre functions, spherical functions, Fourier series, integral equations, calculus of variations.

**Phys 245 COMPUTERS COMMUNICATION (1) (2 cr1. + 1 cr. Lab.)**

Prerequisite: Phys 101. Offered in fall.

Introduction to computer communication parallel ports, serial ports, USB and data acquisition cards.

**Phys 247 COMPUTER SCIENCE (2 cr. + 1cr. Lab.)**

Prerequisite: Phys 245. Offered in spring.

Application of computers, data and programming, hardware features,computer arithmetic,logic control, system architecture,software programming (languages,databases,operating systems, application, (interactive processing, batch processing).

**Phys 249 Crystallography and X-ray diffractions (2 cr. + 1cr. Lab.)**

Offered in fall.

Lattice Geometry, unit cell, symmetry elements, crystal systems, Bravais lattics, stereographic projection and point groups X- rays and their interaction with matter, sources of X-rays, diffraction by perfect crystals, photoelectric absorption.

**Phys 251 THERMODYNAMICS (2 cr.)**

Prerequisite: Phys 102. Offered in fall.

Historical; thermodynamics and statistical mechanics, equilibrium states, heat, temperature and pressure, state variables and equations of state, the first law of thermodynamics, the second law of thermodynamics, entropy, the Joule- Thomson experiment, black- body radiation, paramagnetic gas, the thermodynamic potentials, change of phase, chemical reactions, kinetic theory: probability and distribution functions, velocity distributions, the Maxwell-Boltzmann's distribution, transport phenomena, fluctuations.

**Phys 261 MODERN PHYSICS (3 cr.)**

Prerequisites: Phys 221, Phys 231. Offered in spring.

Thermal radiation and the origin of quantum mechanics, electrons and quanta, the discovery of the atomic nucleus, Bohr's theory of atomic structure, particles and waves, Shrodinger's theory of quantum mechanics, quantum mechanics of the hydrogen atom, quantum numbers, eigen values and degeneracies, angular momentum of one electron atom, eigen functions.

**Phys 301 Physics Lab. (2.cr.)**

Offered in fall.

Basic experiments in physical optics.

**Phys 302 Physics Lab. (2.cr.)**

Offered in spring.

Experiments in semiconductor devices and electronics.

**Phys 345 COMPUTATIONAL PHYSICS (2 cr. + 1 cr. Lab.)**

Prerequisite: Phys 102. Offered in fall.

Introduction: review of computer programming and accessibility, numerical methods. Monte Carlo techniques, statistics for physicists, special topics: computer algebra, (Mathematica, Maple), chaotic dynamics.

**Phys 351 STATISTICAL PHYSICS (1) (2 cr.)**

Prerequisite: Phys 251. Offered in fall.

Ensembles and distribution functions, entropy and ensembles, the microcanonical ensemble, the canonical ensemble, statistical mechanics of a crystal, statistical mechanics of a gas, a gas of diatomic molecules, the grand canonical ensemble, quantum statistics, Bose – Einstein statisatics, Fermi-Dirac statistics, quantum statistics for complex systems, electrons in a metal, ortho – and para- hydrogen.

**Phys 352 STATISTICAL PHYSICS (2) (2 cr. + 1 cr. Lab.)**

Prerequisite: Phys 351. Offered in spring.

Interacting systems: cluster expansions, Van der Waal's gas, and mean-field theory, the hydrodynamic limit and classical field theories, phase transitions and broken symmetries, universality, correlation functions, scaling theory, the renormalization approach to collective phenomena, dynamic critical behavior, random systems.

**Phys 354 PHYSICS OF ENERGY (2 cr.)**

Prerequisite: Phys 102. Offered in fall.

Energy in its various forms. conservation of energy, nuclear reactors and their safety, nuclear fission, heat engines, refrigerators and their efficiencies, exponential growth and resource depletion curves, stored energy sources, renewable energy sources, space heating.

**Phys 362 QUANTUM MECHANICS (1) (2 cr.)**

Prerequisite: Phys 261. Offered in fall.

Historical review, experiments and theories, the postulates of quantum mechanics: operators, eigen functions and eigenvalues, Function spaces and Hermitian operators, superposition and compatible observables, time development, conservation theorems and parity, the harmonic oscillator: eigenfuuctions of the harmonic oscillator Hamiltonian, the harmonic oscillator in momentum space, unbound states, one dimensional barrier problems, the rectangular barrier tunneling, the ramsauer effect, scattering of a wave–packet from a barrier, the W.K.B approximation, perturbation theory: time independent perturbations, the treatment of degeneracies.

**Physics 363 QUANTUM MECHANICS (2) (2 cr. + 1 cr. Lab.)**

Prerequisite: Phys 361. Offered in spring.

Quantum mechanics in three dimensions, central potentials and the radial equation, bound and scattering states. angular momentum: operators, commutator algebra, eigenvalues and eigenstates, spherical harmonics, spin: Stern–Gerlach devices and measurements, nuclear magnetic resonance, spin and statistics, addition of angular momentum: Clebsch–Gordan series and coefficients. elements of Matrix mechanics. Spin wave functions. Time dependent perturbation theory, Harmonic perturbation, scattering in three dimensions: partial waves, S-wave scattering, center of mass frame, the Born approximation.

**Phys 366 LASER PHYSICS AND APPLICATIONS (2.cr. + 1 cr. Lab.)**

Prerequisite: Phys 362. Offered in fall.

Fundamentals of lasers, operation of practical lasers, properties of laser radiation, nonlinear techniques, metrological and scientific applications, industrial, medical and military applications, holography, optical information transmission and storage .

**Phys 371 SOLID STATE PHYSICS (1) (2.cr.)**

Prerequisite: Phys 362. Offered in fall.

Introduction to the basic concepts of the quantum theory of solids. Topics: periodic structure and symmetry of crystals, diffraction, reciprocal lattice, chemical bonding, lattice dynamics, phonons, thermal properties, free electron gas model of metals, bloch theorem and band structure, nearly free electron approximation, tight binding method, fermi surface, semiconductors, electrons, holes, impurities, optical properties, excitons, and magnetic properties.

**Phys 372 SOLID STATE PHYSICS (2) (2 cr. + 1 cr. Lab.)**

Prerequisite: Phys 371. Offered in spring.

Second term of a theoretical treatment of the physics of solids. Interacting electron gas: many-body formulation, feynman diagrams, random phase approximation. General theory of linear response: dielectric function, sum rules, plasmons, optical properties, applications to semiconductors, metals, and insulators. Transport properties, non-interacting electron gas with impurities, diffusions. Quantum Hall-effect: integral and fractional. Electron phonon interaction: general theory, applications to semiconductors, metals and insulators, polarons, and field-theory description. Superconductivity: experimental observations, phenomenological theories, and B.C.S. theory .

**Phys 381 NUCLEAR PHYSICS (1) (2 cr.)**

Prerequisite: Phys 362. Offered in fall.

Basic nuclear properties, binding and separation energies, systematics of stable nuclides, semi-empirical mass formula, radioactive decay, production of radioisotopes by nuclear bombardment, widths of decaying states, gamma decay, classification of gamma decays, internal conversion, alpha decay, hinderance factors, beta decay, neutrino hypothesis, the theory of beta decay, classification of beta decays, electron capture, inverse beta decays, parity nonconservation in beta decay, interaction of nuclear radiation with matter, nuclear detectors , accelerators.

**Phys 382 NUCLEAR PHYSICS (2) (2 cr. + 1 cr. Lab.)**

Prerequisite: Phys 382. Offered in spring.

Nuclear reactions: conservation laws, Q-value equations, classification of nuclear reactions, cross section. Energy and angular dependence of cross sections, compound nuclear reactions, resonance reactions, direct nuclear reactions: projectile stripping and target stripping reactions, knock-out and pick-up reactions, heavy ion reactions, energy spectrum, excitation function, angular distribution. Nuclear structure information from nuclear reaction studies, nuclear forces: information from the two– nucleon system, scattering, theory, scattering amplitude, partial wave analysis, s-wave phase shift, scattering length, n-p and p-p scattering. Parameters of two– nucleon forces, nuclear models: nuclear shell model, liquid drop model, statistical model of excited levels, collective nuclear model.

**Phys 390 INTRODUCTION TO ELECTRONIC CIRCUIT ANALYSIS (3 cr.)**

Prerequisite: Phys 261. Offered in fall.

Basic circuit elements, Ohm's law, Kirchoff's laws, simple resistive circuits, dependent sources, Ideal operational amplifier, nodal voltage analysis, mesh- current analysis, source transformation, thevenin and norton equivalent, maximum power transfer, superposition, first order systems, natural and forced responses, step response, second order systems, sinusoidal steady state analysis, phasors, complex and reactive power, three-phase circuits, frequency responses, two-port networks, analogue electronics: p-n junctions, bipolar junction transistor, field effect transistor, metal oxide semiconductor, field effect transistor. Single stage amplifiers, biasing, computer aided design of analog circuits, differential amplifiers, models of transistors, standard amplifiers, differential and

multistage transistor amplifiers, operational amplifiers, feedback amplifiers, integrated circuits, current mode amplifiers, power amplifiers, multiplier structures, oscillators, switched capacitor circuits, modeling and analysis of noise in amplifiers.

**Phys 392 ENVIRONMENTAL PHYSICS (1) (2 cr.)**

Prerequisite: Phys 102. Offered in fall.

Heat transfer, thermal radiation, solar energy and its technology, molecular absorption of electromagnetic waves, the earth's thermal environment and the Greenhouse effect, fluctuations in the earths climate and orbital parameters, effects of nuclear explosions, water, water vapour, and humiditity, density, pressure and temperature profile of the atmosphere, wet and dry adiabatic lapse rates, dispersal of air pollutants, pollutants detection and control.

**Phys 393 ENVIRONMENTAL PHYSICS (2) (2 cr.)**

Prerequisite: Phys 392. Offered in spring.

Stratospheric pollution, the ozone layer, noise and light pollution, air pollutants and their interaction with the respiratory system, indoor air pollution, ventillation of buildings, environmental consequences of electric power generation and automobile use, ionizing radiations and its effects on humans, the radon problem, radiation protection, risk assessment .

**Phys 394 VACUUM TECHNOLOGY AND INSTRUMENTATION (2 cr. + 1 cr. Lab.)**

Prerequisite: Phys 102. Offered in spring.

Vacuum pumps, vacuum materials, vacuum systems assembly techniques, design and performance of Vacuum systems, measurements in vacuum: leak detection, pressure measurements, residual gas analysis.

**Phys 395 DIGITAL ELECTRONICS (2 cr.)**

Prerequisite: Phys 390. Offered in spring.

What is digital electronics? numbers we use in digital electronics, binary logic gates. IC specifications and simple interfacing, encoding, decoding and seven-segment displays, flip-flops, counters, shift registers, arithmetic circuits, memories, digital systems, connecting with analog devices.

**Phys 398 DEVICE PHYSICS (2 cr. + 1 cr. Lab.)**

Prerequisite: Phys 390. Offered in spring.

The physical princples which underline the operation of technologically important electronic and optical devices. The course deals with semi-conductor devices: function, field effect and charge coupled devices, as well as devices based upon electro - optical effects.

**Phys 401 PHYSICS LAB. (2.cr.)**

Offered in fall.

Experiments in solid state physics.

**Phys 402 Physics Lab. (2.cr.)**

Offered in spring.

Experiments in nuclear physics.

**Phys 424 FLUID MECHANICS (2 cr.)**

Prerequisite: Phys 222. Offered in fall.

A physics-based introduction to the properties of fluids and fluid systems with examples drawn from a broad range of sciences, including atmospheric physics and astrophysics, definitions of fluids and the notion of continuum, equations of state and continuity, hydrostatics and conservation of momentum, ideal fluids and Euler's equation, viscosity and the Navier-Stokes equation, energy considerations, fluid thermodynamics, and isotropic flow, Bernoulli's theorem, steady flow, streamlines and potential flow, circulation and vorticity, kelvin's theorem, boundary layers, fluid wave and instabilities, quantum fluids.

**Phys 425 PHYSICAL PRINCIPLES OF ELECTRON MICROSCOPY (1.cr.)**

Prerequisite: Phys 394. Offered in fall.

Review of optics, wave motion and motion of electrons in electric and magnetic fields, magnetic and electrostatic electron lenses, resolution and contrast in conventional electron microscopy for biological and crystalline specimens, elements of electron diffraction, scanning electron microscopy, transmission electron microscopy, scanning-transmission electron microscopy, high resolution electron microscopy, electron energy loss spectroscopy, specimen preparation and interpretation of micrographs.

**Phys 434 NON-LINEAR OPTICS (2 cr.)**

Prerequisite: Phys 222. Offered in fall.

Techniques of nonlinear optics with emphasis on fundamentals for optics research and engineering, topics include: electro-optic modulators, harmonic generation, and frequency conversion devices, nonlinear effects in optical fibers including self phase modulation, non linear wave propagation, and solitons, interaction of light with matter, density matrix techniques, and nonlinear laser spectroscopies including femtosecond optics.

**Phys 435 MICROWAVES AND APPLICATIONS (2 cr.)**

Prerequisite: Phys 232. Offered in fall.

Transmission system environment, statistical methods in digital transmission system analysis, digital modulation methods, microwave amplifiers, system gain: the concept and its applications, M-ary, PSK and QAM systems, correlative (Partial response) techniques and applications to digital radio systems, digital and hybrid systems, digital microwave systems design, diversity and protection switching techniques, measurement techniques, flight.)

**Phys 443 MICROPROCESSORS ( 3 cr.)**

Prerequisite: Phys 261. Offered in fall.

In depth study of current microprocessor issues, interfacing and data communications, buses and memory, peripheral connections, parallel interfaces, serial interfaces, analog interfaces, applications by means of the case study method.

**Phys 444 GROUP THEORY (2 cr. + 1 cr. Lab.)**

Prerequisite: Phys 362. Offered in fall.

Introduction: abstract groups and mathematical tools, representations of discrete groups: representations, similarity transformations and coordinate transformations, reducible and irreducible representations, unitary representations, schurs lemmas and the great orthogonality theorem, characters and their orthogonality relations, character tables, regular representation. physical applications of discrete groups, groups constructed from other groups, physical applications.

**Phys 445 FIELD THEORY (2 cr.)**

Prerequisite: Phys 232. Offered in fall.

Lagrangian and Hamiltonian formulations for continuous systems and fields, field equations, schrödinger field, scalar field, conservation laws, quantum field theory, canonical quantization, spinor fields, noether's theory, Yang–Mills' theory. Feynman diagrams, renormalization introduction, to the standard model (Electro weak theory).

**Phys 461 RELATIVISTIC QUANTUM MECHANICS (2 cr.)**

Prerequisite: Phys 362. Offered in fall.

Klein Gordan equation for integral spin-particles, probability density and interpretation for negative probability. Dirac equation for half-integral spin-particles, Dirac matrices: derivation of spin, covariant form, matrices, solutions for free particles, hole theory, Lorentz transformation of Dirac wave functions, transformation properties of charge, complete set of Dirac matrices, bilinear covariants, relativistic theory of e-e- scattering. e+ - e- interactions. pair production process in the presence of a nucleus .

**Phys465 QUANTUM ELECTRONICS AND LASER SPECTROSCOPY (2.cr.)**

Prerequisite: Phys 395. Offered in fall.

Fundamental processes in lasers and their applications to studying physical properties of atoms and molecules, Interaction of classical and quantum systems with electromagnetic radiation, The physics of two-level atoms, laser oscillations, techniques in nonlinear, spectroscopy, stimulated Raman effect , free induction decay , optical nutation , photon echoes and CARS .

**Phys 473 INTRODDUCTION TO CONDENSED MATTER PHYSICS (2.cr.)**

Prerequisite: Phys 372. Offered in spring.

Introduction: emergent properties in macroscopic systems, broken symmetries, order parameters, and generalized rigidities. Interatomic forces in solids: metallic bond, ion bond, covalent bond, hydrogen bond, electrons in solids: Drude model, Sommerfeld model: elementary band theory, classification of metals, insulators, and semiconductors, magnetism: dia, para, ferro, ferri magnetism, magnetic anisotropy and domains, superconductivity: BCS theory, phonon mediated electron pairing, spontaneously broken gauge symmetry, vortex matter, quantum Hall effects: integer and fractional, double layer QHE, topological spin textures, localization: Mott transition, anderson transitions, weak localization, soft matter: polymers, membranes, emulsions, foams,-- etc. generalized rigidity and topological defects. applications.

**Phys 474 INSTRUMENTATION AND ELECTRONICS (2 cr.)**

Prerequisite: Phys 395. Offered in spring.

Passive circuits, design with discrete transistors, integrated operational amplifiers and applications in the design of circuits like: integrators, oscillators, regulatros, and filters, overview of wireless communication, signal averaging, construction techniques, computer aided design.

**Phys 475 THIN FILM PRINCIPLES AND TECHNOLOY (2 cr.)**

Prerequisite: Phys 371. Offered in spring.

Thin-film technology, film formation and structure, evaporation, deposition, epitaxy, chemical vapor deposition, physical vapor deposition, mechanical properties of thin films, electrical and magnetic properties of thin films, optical properties of thin films, analysis of thin films.

**Phys 483 ELEMENTARY PARTICALES PHYSICS (2 cr.)**

Prerequisite: Phys 381. Offered in spring.

Quarks and leptons, interactions and fields, invariance principles and conservation laws, quark interactions and QCD. Models for high-energy interactions, neutrino physics.

**Phys 494 PLASMA PHYSICS (3 cr.)**

Prerequisite: Phys 381. Offered in spring.

Introduction: occurrence of plasmas in nature, definition of plasma, concept of temperature, debye's shielding, the plasma parameter, applications of plasma in physics, single-particle motions in electric, magnetic or electromagnetic fields (both static and time–varying), summary of guiding center drifts and adiabatic invariants, plasmas as fluids, waves in plasma, diffusion and resistivity

**Phys 495 LOW – TEMPERATURE PHYSICS (2 cr.)**

Prerequisites: Phys 371, Phys 372. Offered in spring.

Production of low temperatures. Liquifiers. Cryostat design and cryogenics. Superconductivity. Superfluidity

**Phys 496 OPTICAL COMMUNICATION SYSTEMS (2 cr.)**

Prerequisite: Phys 235. Offered in spring.

Overview of optical communication systems, review of optics, characteristics of optical fibers, optical wave guides, review of digital communications, optical sources and transmitters, optical detectors and receivers, optical amplifiers, noise and detection, dispersion in optical communication systems, optical link design.

**Phys 497 FUNDAMENTALS OF ANTENNA (2 cr.)**

Prerequisite: Phys 371. Offered in spring.

Introduction to wireless line access networks (LANS), antennas, antenna setup, 2.4GHz omni-directional antennas, 2.4GHz directional antennas, 5GHz antennas, antenna installation, antenna cables.

**Phys 498 DIGITAL SYSTEM DESIGN (2 cr.)**

Prerequisite: Phys 390. Offered in spring.

Digital design methodology and techniques; control and timing; machine organization, instruction sequencing and data for flow control; control unit implementation by means of hardware and microprogramming; synchronization of I/O operations with interface design.

**Phys 499 PHYSICS PROJECT (2 cr.)**

Prerequisite: consent of instructor. Offered in fall and spring.

Participating students continue the work on the project topic selected by groups of students according to their area of interest and the advisor's approval. Participants give an oral presentation of the main results achieved. After criticism and suggestions, they submit a written report.

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# CHEMISTRY

## First: Academic Programs Offered by Chemistry Department

**The Department offers courses for all freshmen and for students of the following groups:**

1- Special Chemistry (Chem)
2- Chemistry/Physics (Chem/Phys)
3- Chemistry/Botany (Chem/B)
4- Chemistry/Zoology (Chem/Z)
5- Chemistry/Entomology (Chem/Ent)
6- Chemistry/Microbiology (Chem/MB)
7- Chemistry/Geology (Chem/G)
8- Chemistry/Biochemistry (Chem/Biochem)
9- Special Biophysics (Biophys)

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 1 | 1st | Chem.101 | General Chemistry (1) | - | All Students | - | 2 | 3 | - | 3 | 6 cr. compuls. |
| | 2nd | Chem.102 | General Chemistry (2) | Chem.101 | | - | 2 | 3 | - | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 2 | 3rd | Chem.211 | Chemical Thermodynamics | Chem.101, Math.102 | All Groups | - | 2 | 3 | - | 3 | 18 cr. compuls for special and 9 cr. for other groups |
| | | Chem.221 | Principles of Qualitative and Quantitative Analysis | Chem.101 | | - | 2 | 3 | - | 3 | |
| | | Chem.241 | Basic Organic Chemistry (1) | Chem.102 | | - | 2 | 3 | - | 3 | |
| | | Chem.242 | Basic Organic Chemistry (2) | Chem.102 | Chem, Chem/Biochem | - | 2 | - | - | 2 | |
| | | Chem.214 | Phase Equililria | Chem.101, Phys.101 | Chem | - | 2 | - | - | 2 | |
| | | Phys. 249 | Crystallography and X-ray diffractions | Phys.101 | | - | 2 | 3 | - | 3 | |
| | | Stat.221 | Applied Statistic (1) | Math.101 | | - | 2 | - | - | 2 | |
| | | B.210 | General Microbiology | B.101, B.102 | Chem/Biochem | - | 2 | - | - | 2 | |
| | | Z. 211 | Cell Biology (1) | Z.102 | | - | 2 | 3 | - | 3 | |
| | | Z. 212 | Cell Biology (1) | Z.102 | | - | 2 | - | - | 2 | |
| | 4th | Chem.212 | Equilibrium Electrochemistry (1) | Chem.102, Phys.101 | Chem | - | 2 | 3 | - | 3 | 18 cr. compuls. for Chem., Chem/Biochem. And 9 cr. for other groups. |
| | | Chem.213 | Quantum Chemistry | Chem.102, Math.101 | | - | 2 | - | 1 | 2 | |
| | | Chem.231 | Chemistry Of Representative Elements | Chem.101 | Chem Chem/Biochem | - | 2 | 3 | - | 3 | |
| | | Chem.243 | Stereochemistry | Chem.241, Chem.242 | Chem | - | 2 | - | - | 2 | |
| | | Chem.244 | Basic Organic Chemistry (3) | Chem.241 | All groups | - | 2 | 3 | - | 3 | |
| | | Chem.251 | Biochemistry (1) | Chem.241 | Chem/Biochem | - | 2 | - | - | 2 | |
| | | Chem.252 | Biochemistry (2) | | | - | 2 | 3 | - | 3 | |
| | | Chem.215 | Equilibrium Electrochemistry (2) | Chem.102, Phys.101 | All groups Except special | - | 2 | - | - | 2 | |
| | | Chem.232 | Chemistry of Representative Elements | Chem.101 | Chem/Phys. Chem/B. Chem/Z. Chem/Ent. Chem/G. | - | 2 | - | - | 2 | |
| | | Chem.242 | Basic Organic Chemistry (2) | Chem.102 | | - | 2 | 3 | - | 3 | |
| | | Biochem. 253 | Basic Biochemistry | Chem.241 | Biophys. | - | 2 | - | - | 2 | |
| | | Stat.222 | Applied Statistic (2) | Math.101 | Chem/Biochem | - | 2 | - | - | 2 | |
| | | Biophys.211 | General Biophysics | - | | - | 2 | 3 | - | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 3 | 5th | Chem. 311 | Quantum Chemistry | Chem.213 | Chem | - | 2 | - | - | 2 | 18 cr. compuls for each of chem. and Chem/Biochem. 9 cr. compuls. for other groups. |
| | | Chem.312 | Dynamic Electrochemistry | Chem.212 | | - | 2 | - | 1 | 2 | |
| | | Chem.313 | Reaction Kinetics | Chem.211 | | - | 2 | - | - | 2 | |
| | | Chem.321 | Instrumental Methods of Analysis (1) | Chem.221 | | - | 2 | 6 | - | 4 | |
| | | Chem.331 | Transition Metal Chemistry(1) | Chem.231 | | - | 2 | - | 1 | 2 | |
| | | Chem.341 | Physical Organic Chemistry | Chem.241, Chem.242 | All Groups | - | 2 | 3 | - | 3 | |
| | | Chem.342 | Heterocyclic Chemistry | | Chem | - | 2 | 3 | - | 3 | |
| | | Chem.316 | Molecular Structure & Spectroscopy | Chem.211 | Chem/Phys Chem/B Chem/Z Chem/Ent Chem/G | - | 2 | - | - | 2 | |
| | | Chem.317 | Chemicl Kinetics and Dynamic Electrochemistry | Chem.215 | | - | 2 | - | - | 2 | |
| | | Chem.332 | Transition Metal Chemistry(2) | Chem.232 | | - | 2 | - | - | 2 | |
| | | Biochem.351 | Metabolism of Carbohydrates and lipids | Chem.251, Z.211 | Chem/Biochem Ent | - | 2 | - | - | 2 | |
| | | Biochem.352 | Metabolism of Amino Acids and Proteins | Chem.252 | | - | 2 | 3 | - | 3 | |
| | | Biochem.353 | Metabolism of Nucleotides and Nucleic Acids | | | - | 2 | - | - | 2 | |
| | | Biochem.354 | Vitamins and Inorganic Metabolism | - | | - | 2 | - | - | 2 | |
| | | Biochem. 359 | Metabolism of Macromolecules | Biochem. 253 | Biophys. | - | 2 | - | - | 2 | |
| | 6th | Chem.314 | Molecular Spectroscopy | Chem.311 | Chem | - | 2 | - | 1 | 2 | 18 cr. compuls for each of chem. and Chem/Biochem. 9 cr. compuls. for other groups. |
| | | Chem.315 | Physical Chemistry of Polymers | Chem.211 | | - | 2 | - | 1 | 2 | |
| | | Chem.322 | Instrumental Methods of Analysis (2) | Chem.321 | | - | 2 | - | 1 | 2 | |
| | | Chem.333 | Transition Metal Chemistry (3) | Chem.232 | | - | 2 | 6 | - | 4 | |
| | | Chem.343 | Natural Products | Chem244 | | - | 2 | 3 | - | 3 | |
| | | Chem.344 | Photochemistry and Pericyclic | | | - | 2 | 3 | - | 3 | |
| | | Chem.345 | Applied Spectroscopy | | | - | 2 | - | 1 | 2 | |
| | | Chem.318 | Physical Chemistry of Polymers | Chem.215 | Chem/Phys Chem/B Chem/Z Chem/Ent Chem/G | - | 2 | - | 1 | 2 | |
| | | Chem.321 | Instrumental Methods of Analysis (1) | Chem.221 | | - | 2 | 6 | - | 4 | |
| | | Chem.342 | Heterocyclic Chemistry | Chem.241, Chem.242 | | - | 2 | 3 | - | 3 | |
| | | Biochem.355 | Enzymology (1) | Chem.252 | Chem/Biochem Ent | - | 2 | 3 | - | 3 | |
| | | Biochem.356 | Biological Function and Body Fluids | Biochem.351, Biochem.352 | | - | 2 | - | - | 2 | |
| | | Biochem.357 | Endocrinology | | | - | 2 | - | - | 2 | |
| | | Biochem.358 | Chemistry of Immune System | | | - | 2 | - | - | 2 | |
| | | Biochem. 360 | Body Fluids | Biochem. 359 | Biophys | - | 2 | - | - | 2 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 7th | Chem.481 | Practical Chemistry (1) | - | Chem | - | - | 6 | - | 2 | 4 cr. compuls. + 14 cr. elective for Chem., 6 cr. compuls. + 12 elective for Chem/Biochem. 4 cr. compuls. + 14 cr. elective for other group. |
| | | Chem. 482 | Practical Organic Chemistry (1) | - | | - | - | 6 | - | 2 | |
| | | Chem.485 | Practical Organic Chemistry | -- | Chem/Phys Chem/B Chem/Z Chem/Ent Chem/G | - | - | 6 | - | 2 | |
| | | Chem.345 | Applied Spectroscopy | Chem.244 | | - | 2 | - | 1 | 2 | |
| | | Biochem.491 | Estimation of some Enzymes & Electrolytes in Blood | - | Chem/Biochem Ent | - | - | 6 | - | 2 | |
| | | Chem.411 | Corrosion and Corrosion Control | Chem. 312 | - | Chem Chem/Phys Chem/B Chem/Z Chem/Ent Chem/G | 2 | - | - | 2 | |
| | | Chem.412 | Energy Conversion | | - | | 2 | - | - | 2 | |
| | | Chem.413 | Chemistry of The Solid State | Chem.211 | - | | 2 | - | - | 2 | |
| | | Chem.414 | Applied Physical Chemistry | Chem.313 | - | | 2 | - | - | 2 | |
| | | Chem.421 | Instrumental Methods of Analysis (3) | Chem. 321 | - | | 2 | - | - | 2 | |
| | | Chem.422 | Instrumental Methods of Analysis (4) | Chem. 322 | - | | 2 | - | - | 2 | |
| | | Chem.423 | Instrumental Methods of Analysis (5) | Chem. 322 | - | | 2 | - | - | 2 | |
| | | Chem.424 | Kinetic Methods of Analysis | Chem. 322 | - | | 2 | - | - | 2 | |
| | | Chem.431 | Organometallic Compounds | - | - | | 2 | - | - | 2 | |
| | | Chem.432 | Bioinorganic Chemistry | - | - | | 2 | - | - | 2 | |
| | | Chem.441 | Petroleum and Petrochemicals | - | - | | 2 | - | - | 2 | |
| | | Chem.442 | Environmental Organic Chemistry | - | - | | 2 | - | - | 2 | |
| | | Chem.443 | Polymer Chemistry | - | - | | 2 | - | - | 2 | |
| | | Biochem.451 | DNA Technology | Biochem.352, Biochem.353 | - | Chem/ Biochem Ent | 2 | - | - | 2 | |
| | | Biochem.452 | Photochemistry & Photobiology | | - | | 2 | - | - | 2 | |
| | | Biochem.453 | Novel Drug Discovery | Biochem.355 | - | | 2 | - | - | 2 | |
| | | Biochem.454 | Enzymology Part (2) | | - | | 2 | - | - | 2 | |
| | | Biochem.460 | Applied Clinical biochemistry | Biochem. 360 | Biophys | | 2 | - | - | 2 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 8th | Chem.483 | Practical Chemistry (2) | - | Chem | - | - | 6 | - | 2 | 4 cr. compuls. + 14 cr. elective for Chem. , 2 cr. compuls. + 16 cr. elective for other group. |
| | | Chem.484 | Practical Organic Chemistry (2) | - | | - | - | 6 | - | 2 | |
| | | Chem.486 | Practical Chemistry | - | Chem/Phys Chem/B Chem/Z Chem/Ent Chem/G | - | - | 6 | - | 2 | |
| | | Biochem.492 | Estimation of some Metabolites in Blood-2 | - | Chem/Biochem | - | - | 6 | - | 2 | |
| | | Chem.415 | Electorganic and Environmental Electrochemistry | Chem.312 | -- | Chem Chem/Phys Chem/B Chem/Z Chem/Ent Chem/G | 2 | - | - | 2 | |
| | | Chem.416 | Symmetry in Chemistry | Chem.314 | - | | 2 | - | - | 2 | |
| | | Chem.417 | Advanced Course in Polymer Chemistry | Chem.315 | - | | 2 | - | - | 2 | |
| | | Chem.418 | Special Topics in Polymer Science | | - | | 2 | - | - | 2 | |
| | | Chem.425 | Environmental Chemistry | CHem. 322 | - | | 2 | - | - | 2 | |
| | | Chem.426 | Advanced Analytical Chemistry | | - | | 2 | - | - | 2 | |
| | | Chem.427 | Clinical Chemistry and Drug Analysis | | - | | 2 | - | - | 2 | |
| | | Chem.433 | Inorganic Reaction Mechanisms | Chem.332 | - | | 2 | - | - | 2 | |
| | | Chem.434 | Role of organometallic compounds in catalysis | Chem.431 | - | | 2 | - | - | 2 | |
| | | Chem.444 | Chemistry of Nucleic Acids | - | - | | 2 | - | - | 2 | |
| | | Chem.445 | Special Topics in Organic Chemistry | - | - | | 2 | - | - | 2 | |
| | | Chem.446 | The Chemistry of Drugs | - | - | | 2 | - | - | 2 | |
| | | Chem.447 | Colour Chemistry (Dyes and Pigments) | - | - | | 2 | - | - | 2 | |
| | | Biochem.455 | Cancer Biology | Biochem.352, Biochem.353 | - | | 2 | - | - | 2 | |
| | | Biochem.456 | Clinical Biochemistry | Biochem.351, Biochem.356 | - | Chem/ Biochem | 2 | - | - | 2 | |
| | | Biochem.457 | Biotechnology | Biochem.451 | - | | 2 | - | - | 2 | |
| | | Biochem.458 | Genetic Engineering and Gene Therapy | Biochem.451 | - | | 2 | - | - | 2 | |
| | | Biochem.459 | Proteomics & Bioinformatics | Biochem.451 | - | | 2 | - | - | 2 | |

# Second: Courses Offered by Chemistry Department

## PHYSICAL CHEMISTRY

**Chem. 101 GENERAL CHEMISTRY (1) (2 cr. + 1 cr. Lab.).**

Offered in fall.

**Physical chemistry: i**ntroduction (measurements and units), stoichiometry and chemical reactions, states of matter: gaseous state, thermochemistry, liquid, solids and changes of state of matter, solutions, chemical equilibria (homogeneous and heterogeneous system).

**Inorganic Chemistry:** wave mechanics, electron orbital and quantum numbers, electron configuration of the elements. Atomic properties and the periodic law, periodicity of atomic radius ionization, energy, electron affinity and electronegativity. Basic concepts of chemical bonding: Lewis symbols, the octet rule, energetics of ionic bond formation, Lewis structures, resonance forms, exception to the octet rule, strength of covalent bonds (bond energies and chemical reactions), bond polarity and electronegativities, geometries of molecules, molecular orbitals: molecules geometries (valence shell electron-pair repulsion model), hybridization in molecules containing multiple bonds, orbital configuration for diatomic molecules, rules.

**Practical**: Identification of simple inorganic unknowns.

**Chem. 102 GENERAL CHEMISTRY (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Chem 101. Offered in spring.

**Physical Chemistry:** chemical equilibria (Homogeneous and heterogeneous systems), ionic equilibria (reactions in aqueous solutions, acids and bases), chemical thermodynamics (enthalpy, free energy, entropy and equilibrium), chemical kinetics (reaction rates and activation energy concept), electrochemistry (electrochemical equilibrium and dynamic electrochemistry-the concept of overpontetial).

**Organic Chemistry:** introduction and classification, nomenclature, alkanes, alkenes and alkynes (structures, syntheses and reactions), isomerism: structural, valence, tautomerism and stereoisomerism. Conjugation and aromaticity (structure of bezene).

**Practical**: Purification of organic compounds, elements test.

**Chem. 211 CHEMICAL THERMODYNAMICS (2 cr. + 1 cr. Lab.).**

Prerequisites: Chem 102, Math 101. Offered in fall.

**Introduction & Ideal gases. The First Law of Thermodynamics:** work & heat, the first law, enthalpy & internal energy, heat capacities, the Joule and Joule-Thomson experiments, state functions, molecular nature of internal energy, the second law of thermodynamics. Heat engines, entropy. **The third law of thermodynamics:** calculation of entropy changes, reversible & irreversible processes, energy, entropy & free energy, fundamental equations of thermodynamics.

**Chem. 212 EQUILIBRIUM ELECTROCHEMISTRY (2 cr. + 1 cr. Lab.).**

Prerequisites: Chem 102, Phys 101. Offered in spring.

Electrostatics, electrochemical systems, thermodynamics of electrochemical systems, galvanic cells, ypes of reversible electrodes, thermodynamics of galvanic cells, standard electrode, potential, nernst equation, classsification of electrochemical cells, liquid–junction potential, the electrical double layer.

**Chem. 213 QUANTUM CHEMISTRY (2 cr.).**

Prerequisites: Chem 102, Math101. Offered in spring.

The origin of quantum theory: line spectra, black-body radiation, photoelectric effect-wave-like properties of particles, postulates of quantum theory: the particle in a one–dimensional box two and three dimensions, the rigid rotator, the classical harmonic oscillator, operators and angular momenta, the tunneling phenomena.

**Chem. 214 PHASE EQUILILRIA (2 cr.).**

Prerequisites: Chem 101, Phys 101. Offered in fall.

The phase rule, one–component system, the clapeyron equation, phase transitions, multicomponent phase equilibria, thermodynamics of physical changes.

**Chem. 215 EQUILIBRIUM ELECTROCHEMISTRY (2) (2 cr.).**

Prerequisites: Chem 102. Offered in spring.

**Electrochemistry:** ionics, electrochemical systems, thermodynamics of electrochemical systems, galvanic cells and electrolytic cells, types of reversible electrodes, thermodynamics of galvanic cells, standard electrode potentials, nernst equation, classsification of electrochemical cells, the electrical double layer.

**Chem. 311 QUANTUM CHEMISTRY (2 cr.).**

Prerequisite: Chem 213. Offered in fall.

The schrödinger equation for the hydrogen–like atoms. the quantum, numbers & spin. The energy and one-electron orbital, helium atom: pauli exclusion principle and asymmetric wave functions, the lithium atom, and general many electron atom, the periodic properties, term symbols, atomic spectra and selection rules. The born – oppenheimer approximation: the hydrogen – molecule ion MO description of $H_2$, electron configuration of homonuclear diatomic molecules the MO & VB theories, the FEM and the Hückel MO theoy for conjugated dienes.

**Chem. 312 DYNAMIC ELECTROCHEMISTRY (2 cr.).**

Prerequisite: Chem 212. Offered in fall.

Irreversible electrode processes, the concept of overpotential, types of overpotential, measurements of overpotential, electrolysis of aqueous solutions and decomposition potential, change transfer processes and the Butler–Volmer equation, the hydrogen overpotential, anodic processes and oxygen overpotential, passivity of metals, concentration polarization, polarography & Ilkovic equation, cathodic processes, deposition of metals and alloys, corrosion phenomena, applications of dynamic, electrochemistry, batteries and fuel cells, bioelectrochemical systems.

**Chem. 313 REACTION KINETICS (2 cr.).**

Prerequisite: Chem 211. Offered in fall.

Reaction rates (order and molecularity of reactions), rate laws, determination of rate laws, ionic reactions, theories of reaction rates, rate constants and equilibrium constants, temperature dependence of rate constants, the rate law in non-ideal systems, Uni-, Bi-, and Tri-molecular reactions, chain reactions, catalysis & rates of reactions.

**Chem. 314 MOLECULAR SPECTROSCOPY (2 cr.).**

Prerequisite: Chem 311. Offered in spring.

The basic ideas of spectroscopy, the dipole moment, overlapping transitions, signal to noise ratio. Reasons for broadening of spectral lines, transition probabilities and selection rules, rotational spectra of diatomic molecules, the combined rotational, vibrational spectra, normal modes for poly atomic molecules, Raman spectra, electronic energy levels & selection rules, the Franck-Condon principle, determination of dissociation energies-oscillator strength & electronic spectra of polyatomics, fluorescence and phosphorescence, fate of electronic transitions, lasers- photoelectron spectroscopy ESR and NMR.

**Chem. 315 PHYSICAL CHEMISTRY OF POLYMER (2 cr.).**

Prerequisite: Chem 211. Offered in spring.

Introduction: definition, different types of polymers; and nomenclature, kinetics of polymerization, condensation and step-growth type polymerization, linear step polymerization, the reactivity of large molecules, rates of polycondensation reactions, kinetics of polyesterification, molecular weight distributions of linear condensation polymers, effect of nonstoichiometric reactant ratios on condensation polymers, branched and cross-linked condensation polymers. Thermodynamics and physical characterization of polymers, thermodynamics of polymer solutions: thermodynamics of ideal solutions, flory-Huggins theory, chain dimensions, determination of polymers molecular weights, colligative properties and molecular weight, osmotic-pressure measurements of absolute

molecular weight, Light scattering for measurements of molecular weight, ultracentrifugation for measurements of molecular weight, solution viscosity, gel permeation chromatography, detection and measurements of crystallinity.

**Chem. 316 MOLECULAR STRUCTURE & SPECTROSCOPY (2 cr.).**

Prerequisite: Chem 211. Offered in fall.

Quantum chemistry: origin and wave–nature of particles, postulates of quantum mechanics, particle in a box, the H-atom- the heluim and many electron atoms born, oppenheimer approximation - energy levels of hormo and hetero–diatomic molecules, spectroscopy: origin and principles - overlapping transition and broadening of spectral lines– rotational and vibrational spectroscopy. term symbol - lasers - ESR and NMR.

**Chem. 317 CHEMICL KINETICS ND DYNAMIC ELECTROCHEMISTRY (2 cr.).**

Prerequisite: Chem 215. Offered in fall.

Reaction kinetics: reaction rates (order and molecularity), rate laws, theoreis of reactio rates, temperature depednce of rate constants, catalysis, enzyme catalyzed reactions. Dynamic electrochemistry: irreversible electrode processes, overpotential (concept, types and measurement), electrolysis and deomposition potential, passivity of metals, polarography, deposition of metals and alloys, bioelectrochemical systems, battaries.

**Chem. 318 PHYSICAL CHEMISTRY OF POLYMERS (2 cr.).**

Prerequisite: Chem 215. Offered in spring.

Introduction: definition, different types of polymers; and nomenclature, kinetics of polymerization, thermodynamics and physical characterization of polymers, determination of polymers molecular weights.

**Chem. 411 CORROSION AND CORROSION CONTROL (2 cr.).**

Prerequisite: Chem 312. Offered in fall.

Introduction: corrosion phenomena and environment, economic aspects, corrosion and electrochemistry potential-pH diagrams, concept of passivity, environmental effects on passivity, metallurgical aspects, electro-motive series and galvanic series, orrosion testing: different tests, testing procedures, lab, pilot plant tests, field tests, modern theory: theory of mixed potential, evans diagrams, mixed effects, corrosion control, immunity regions, inhibitors, catholics protection, anodic protection, methods of corrosion rate measurements and electrode kinetics: mass loss, polarization techniques (linear and tafel-polarization), impedance techniques.

**Chem. 412 ENERGY CONVERSION (2 cr.).**

Prerequisite: Chem 312. Offered in fall.

Introduction: sources of energy, electrochemical energy conversion, solar energy, metals, semiconductors and insulators. Photovaltaric effect and principles of solar energy conversion, mechanisms of energy conversion, electrochemical cells, solar cells, fuel cells, electronic models of the different energy converters, economics of energy conversion, environmental aspects.

**Chem. 413 CHEMISTRY OF THE SOLID STATE (2 cr.).**

Prerequisite: Chem 211. Offered in fall.

The growth and forms of crytals, X-ray crystallography, semiconductors, liquid crystals, nonstoichiometric compounds, crystallinity in polymes, point defects, linear defects, dislocations, band theory of solids, cohesive energy in solids, selective reaction for solids, point defect model, super conductivity.

**Chem. 414 APPLIED PHYSICAL CHEMISTRY (2 cr.).**

Prerequisite: Chem 313. Offered in fall.

**Catalysis:** Introduction to catalysis, classification of catalysis (homogeneous and heterogeneous catalysis), acid-base catalysis, mechanism of acid-base catalysis, effect of solvents on rate constant of noncatalytic and catalytic reactions, ionic reactions: primary and secondary salt effects, heterogeneous catalysis: theories of heterogeneous catalysis, (intermediate compounds theory, bodenstein and fink theory, langmuir theory, taylor theory, active site theory, multiple theory, burk

and balandin theory. Electronic theory of catalysis and of holes/metal theory, resonance bond theory and (polyni) theory of semiconductors.

**Metallurgy:** different types of phase diagrams, eutectic mixtures, chemical compounds, solid solutions, methods for studying metallic structures, iron-carbon phase diagrams and phase transformations occurring in the iron-carbon system, heat treatment of steels, chemical heat treatment of steels, minor constituents and alloying elements in steels.

**Chem. 415 ELECTORGANIC AND ENVIRONMENTAL ELECTROCHEMISTRY (2 cr.).**

Prerequisite: Chem 312. Offered in spring.

Introduction and overiew of electrode processes, kinetics of electrode reactions, electro-organic chemistry and applicantions, environmental electrochemistry, dynamic electrodes, micro electrodes, electropolymerization, techniques based on impedance, coupled spectroscopic and electrochemistry techniques, instrumentation.

**Chem. 416 SYMMETRY IN CHEMISTRY (2 cr.).**

Prerequisite: Chem 314. Offered in spring.

Symmetry operations & symmetry elements, point groups & character tables, applications of symmetry, matrix representation.

**Chem. 417 ADVANCED COURSE IN POLYMER CHEMISTRY (2 cr.).**

Prerequisite: Chem 315. Offered in spring.

Kinetics of free radical polymerization, introduction, steady-state approximation (assumption), rate of polymerization, average degree of polymerization and molecular weight, distribution of molecular weight chain transfer, dependence of the degree of polymerization on temperature, absolute propagation and termination rate constants, copolymerization. Kinetics of ionic polymerization, difference between ionic and free radical polymerizations, cationic polymerization, anionic polymerization, living polymerization and block copolymers. Ziegler-Natta coordination polymerization, Ziegler-Natta catalysts, stereochemistry of polymerization. Morphology, glass transitions, and polymer crystallinity, morphological changes in polymers, characteristics of the viscoelastic state, the glass transition temperature, detection of glass transitions, crystallinity of polymers, influence of crystallinity on physical properties.

**Chem. 418 SPECIAL TOPICS IN POLYMER SCIENCE (2 cr.).**

Prerequisite: Chem 315. Offered in spring.

X-ray diffraction of polymers, electroactive polymers, biomedical applications of synthetic polymers, polymer liquid crystals, polymer degradation and stabilization.

## ANALYTICAL CHEMISTRY

**Chem. 221 PRINCIPLES OF QUALITATIVE AND QUANTITATIVE ANALYSIS (2 cr. + 1 cr. Lab).**

Prerequisite: Chem 101. Offered in fall.

**Basis of qualitative analysis,** separation of cations, separation of anions, **Basis of quantitative analysis, a**pplications of statistics to, data treatment and evaluation, titrimetric methods, theory of neutralization titration, theory of oxidation-reduction titration, theory of precipitation titration, theory of complex titration. Gravimetric methods of analysis, (theory and basis), separation techniques, non-chromatographic methods of separation, chromatographic methods of separation, column methods, thin layer methods, Ion-exchange methods, gas chromatography, applications of chromatographic techniques.

**Practical: t**itrimetric methods of analysis, neutralization titrations, oxidation-reduction titrations, precipitation titrations, complex formation titrations.

**Chem. 321 INSTRUMENTAL METHODS OF ANALYSIS (1) (2 cr. + 2 cr. Lab).**

Prerequisite: Chem 221. Offered in fall.

Optical methods of anlysis: introduction to spectrochemical methods, instruments for optical methods, molecular absorption spectroscopy, molecular fluorescence and phosphorescence,

turbidimtric methods, atomic spectrometry based on flame and electrothermal atomization, introduction to advanced optical methods of analysis.

**Practical:** gravimetric analysis, Optical methods of analysis.

**Chem. 322 INSTRUMENTAL METHODS OF ANALYSIS (2) (2 cr. + 1 cr. Lab).**

Prerequisite: Chem 321. Offered in spring.

Principles of electronalytical methods of analysis, introdution of electroanalytical chemistry, potentiometric methods, voltammetric methods, coulometric and electrogravimetric methods, conductometric methods. Chromatographic methods of analysis: high performance liquid chromatography, ion chromatography, electrophoresis and electrochromatography. Thermogravimetric methods of analysis: thermogravimetry, differential thermal analysis, differential scanning calorimetry, thermometric titrations.

**Chem. 421 INSTRUMENTAL METHODS OF ANALYSIS (3) (2 cr.).**

Prerequisite: Chem 321. Offered in fall.

Atomic spectrometry based on flame and electrothermal atomization, Atomic emission spectrometry based on plasma arc and spark atomization, Chemiluminscence spectrometry, polarimetry, optical rotatory dispersion and circular dichrosim.

**Chem. 422 INSTRUMENTAL METHODS OF ANALYSIS (4) (2 cr.).**

Prerequisite: Chem 322. Offered in fall.

**Automatic and combined methods of analysis:** Principles of automation, automatic instruments (process control), automatic analysis of large number of samples, on line analysis, combined methods of analysis.

**Chem. 423 INSTRUMENTAL METHODS OF ANALYSIS (5) (2 cr.).**

Prerequisite: Chem 322. Offered in fall.

**Thermal methods of analysis:** Thermogravimetry, differential thermal analysis, differential scanning calorimetry, thermometric titrations, enthalpimetric methods.

**Chem. 424 KINETIC METHODS OF ANALYSIS (2 cr.).**

Prerequisite: Chem 322. Offered in fall.

Rate of Chemical reactions, determination of reaction rate, application of kinetic methods, catalysis of chemical reactions and their use in analysis, enzyme catalysis in analysis.

**Chem. 425 ENVIRONMENTAL CHEMISTRY (2 cr.).**

Prerequisite: Chem 322. Offered in spring.

Air chemistry and pollution, water chemistry and pollution, water treatment, soil and plant chemistry and pollution.

**Chem. 426 ADVANCED ANALYTICAL CHEMISTRY (2 cr.).**

Prerequisite: Chem 322. Offered in spring.

Analysis of real samples, preparation of samples for analysis, decomposition and dissolution of samples, elimination of interferences, analysis in non-aqueous media.

**Chem. 427 CLINICAL CHEMISTRY AND DRUG ANALYSIS (2 cr.).**

Prerequisite: Chem 322. Offered in spring.

**Clinical Chemistry:** the composition of blood, collection and reservation of samples, clinical analysis, radio immunoassay, the Van Slyke manometric apparatus, the blood gas analyzer, trace elements in the body. **Drug analysis:** classification of drugs, gas chromatography screening, thin layer chromatographic screening, spectrophotometric methods of drug analysis. Electrometric methods of drug analysis.

# INORGANIC CHEMISTRY

**Chem. 231 CHEMISTRY OF REPRESENTATIVE ELEMENTS (s,p-Block) (2 cr. + 1 cr. Lab).**

Prerequisite: Chem 101. Offered in spring.

Some Aspects of Structure and Bonding in Main Group Chemisrty, The chemistry of hydrogen, The group 1 (alkali metals) elements: Lithium, Sodium, Potassium Rubidium, caesium and francium, the group 2 elements: beryllium, magnesium, calcium, strontium, barium and radium, the group 13 elements: boron, aluminum, gallium, indium and thallium, the group 14 elements: carbon, silicon, germanium, tin and lead, the group 15 elements: nitrogen, phosphorus, arsenic, antimony and bismuth, the group 16 elements: oxygen, sulfur, selenium, tellurium and polonium, the group 17 elements: fluorine, chlorine, bromine, iodine and astatine, the group 18 elements: helium, neon, argon, krypton, xenon, and radon.

**Chem. 232 CHEMISTRY OF REPRESENTATIVE ELEMENTS (2 cr.).**

Prerequisite: Chem 231. Offered in spring.

The chemistry of Hydrogen. The group 1 (alkali metals) elements: Lithium, Sodium, Potassium Rubidium, Caesium and Francium. The group 2 elements: Beryllium, Magnesium, Calcium, Strontium, Barium and Radium. The group 13 elements: Boron, Aluminum, Gallium, Indium and Thallium. The group 14 elements: Carbon, Silicon, Germanium, Tin and Lead. The group 15 elements: Nitrogen, Phosphorus, Arsenic, Antimony, and Bismuth. The group 16 elements: Oxygen, Sulfur, Selenium, Tellurium and Polonium. The group 17 elements: Fluorine, Chlorine, Bromine, Iodine and Astatine. The group 18 elements: Helium, Neon, Argon, Krypton, Xenon and Radon.

**Chem. 331 TRANSITION METAL CHEMISTRY (1) (2 cr.).**

Prerequisite: Chem 231. Offered in fall.

Transition metals and d-block characteristics, theories of complex formation- stereochemistry, general characteristics of transition metals: electronic configuration, general physical and chemical properties, atomic and Ionic Radii, chemical bonding, variable oxidation state.

Mangnetic properties of transition metals and their compounds. Spectral properties: theories of complex formation coordination chemistry, double salts and coordination compounds werner, coordination theory, stereochemistry and classification of complexes, theories of ligand-metal bonding: valence bond theory (VBT), crystal field theory (CFT), molecular orbital approach, ligand field theory, recent methods for investigating the structure of complexes (spectral and other tools), methods for preparing complexs, stability of coordination compounds, chelates and factors affecting their stability.

**Chem. 332 TRANSITION METAL CHEMISTRY (2) (2 cr. + 2 cr. Lab.).**

Prerequisite: Chem 331. Offered in spring.

The elements, abundance and distribution, preparation and uses of the metals, properties of the elements, chemical reactivity and trends. Compounds: simple compounds, complexes, chemistry of various oxidation states of transition metal, Ions spectral and magnetic characteristics, application, organometallic compounds.

The f- block metals: introduction, f-orbitals and oxidation states, sources of the lanthanides and actinides; occurrence and separation of the lanthandies and the actinides, atom and ion sizes the lanthanide contraction; coordination numbers, spectroscopic and magnetic properties, inorganic compounds and coordination complexes of the lanthanides and actinides, organometallic complexes of the lanthanides and actinides, the actinide metals.

**Chem. 333 TRANSITION METAL CHEMISTRY (3) (2 cr. + 2 cr. Lab).**

Prerequisite: Chem 231, Chem 232. Offered in fall.

General characteristics of transition metals d and f block elements, atomic and Ionic Radii, chemical bonding, magnetic properties of transition metals and their compounds, spectral properties, recent methods for investigating the structures of complexes, chemistry of various oxidation states of d and f transition metals (representative groups as examples).

**Chem. 431 ORGANOMETALLIC COMPOUNDS (2 cr.).**

Offered in fall.

Classification of organometallic compounds, the metal- carbon bond: Ionic bond-sigma covalent bond-electron deficient bond. Delocalized bond- dative bond (sigma donor-pi acceptor), organometallic compounds of non-transition elements and transition elements with ligand having different functional groups. Preparation, structure characterization and reactivity. Organometallic compounds in catalysis: the homogeneous hydrogenation of alkene, polymerization of alkene.

**Chem. 432 BIOINORGANIC CHEMISTRY (2 cr.).**

Offered in fall.

Bio coordination chemistry & complex equilibrium, mixed ligands, stability of bioinorganic mixed ligands complexes and methods of their detection, therapeutic uses of coordination compounds (metal nucleic acid interactions), metalloporphyrin, chlorophyl, heme protein (hemoglobins, myglobins, cytochromes & enzymes), metals in medicine and their management, some important applications.

**Chem. 433 INORGANIC REACTION MECHANISMS (2 cr.).**

Offered in spring.

Reaction mechanisms of substitution reactions, the general mechanism of squar planar substitution complexes of Pt (II) and other d metal lons, substitution of octahedral complexes, replacement of coordinated water solvolysis or hydrolysis, electron transfer reactions, key ideas concerning electron transfer, outer sphere electron transfer reactions, inner sphere electron transfer, two- electron transfers, synthesis of coordination compounds using electron transfer reactions, enantiomer synthesis, linkage isomer synthesis, molecular rearrangements and reactions of coordinated ligands, molecular rearrangements, four-coordinated complexes, six-coordinated complexes, reactions at coordinated ligands, trans effect and lablization.

**Chem. 434 ROLE OF ORGANOMETALLIC COMPOUNDS IN CATALYSIS (2 cr.).**

Offered in spring.

The role of organametalic chemistry in catalysis, general principles, properties of catalysts, homogeneous catalysis, heterogeneous catalysis.

## ORGANIC CHEMISTRY

**Chem. 241 BASIC ORGANIC CHEMISTRY (1) (2 cr. + 1 cr. Lab).**

Prerequisite: Chem 102. Offered in fall.

Electronic effects (resonance, inductive, steric and Hyper-conjugation), substitution and elimination reactions ($S_N2$, $S_N1$, Sni, E2, E1 and E1cB), the chemistry of alcohols, phenols and ethers and related sulfur compounds (nomenclature, structure, acid and base properties of alcohol, synthesis), reactions of alcohols: formation of esters, halides, alkoxides-oxidation reactions of ethers: cleavage by strong acids-protecting groups for alcohols, reactions of thiols and sulfides: displacement reactions, reduction, oxidation, carbonyl chemistry: nomenclature, synthesis. reactions:(addition reactions, addition-elimination reaction, reactions at the $\alpha$-position, condensation reactions, carboxylic acids (nomenclature, structure, acidity and basicity, synthesis), reactions, formation of acid derivatives, decarboxylation, formation of alkyl bromides (hunsdiecker reaction) reactivity of $\alpha$-position, reactions of aromatic nucleus of phenols, derivatives of carboxylic acids: acid halides, acid anhydrides, acid amides, nitriles and esters (nomenclature, synthesis and reactions), amines (structure, acid and base properties of amines, synthesis), reactions: alkylation, addition to carbonyl groups, elimination reaction, formation and reactivity of diazonium, compounds, reactivity of aromatic nucleus.

**Practical:** identification of organic compounds part I.

**Chem. 242 BASIC ORGANIC CHEMISTRY (2) (2 cr.)**

Prerequisite: Chem 102. Offered in fall.

Substitution reactions of aromatic compounds: electrophilic aromatic substitution: the friedel-crafts (alkylation & acylation), nitrosation, nitration, halogenation, sulfonation, disubstituted benzenes: Ortho, Meta and Para substitution, inductive effects in aromatic substitution, orientation and reactivity. poly-substitution of aromatic compounds and synthesis of multiply substituted benzenes, nucleophilic aromatic substitution reactions. Chemistry of polynuclear aromatic hydrocarbons (naphthalene, anthracene, phenanthrene).

**Chem. 243 STEREOCHEMISTRY (2 cr.).**

Prerequisites: Chem 241, Chem 242. Offered in spring.

**Introduction: Stereochemistry of Carbon acyclic compounds:** Optical isomerism, Optical isomerism due to asymmetric carbon atom, Optical isomerism in compounds containing no asymmetric carbon atom, Racemic modification, Properties of racemic modification, Resolution or separation of racemic modification, Asymmetrical synthesis, Stereochemistry and reaction mechanism, Configurational isomerism, Synthesis of optically active compounds. **Stereochemistry of Nitrogen compounds:** Optical isomerism in nitrogen compounds, Geometrical isomerism in nitrogen compounds, Stereochemistry of each of Sulfur, Phosphorus and arsenic compounds.

**Chem. 244 BASIC ORGANIC CHEMISTRY (3) (2 cr. + 1 cr. Lab).**

Prerequisite: Chem 241. Offered in spring.

**Chemistry of bifunctional compounds:** Halogenated, acids, hydroxy acids, amino acids, keto Acids, dialdehydes, hydoxy aldehydes, dihydroxy, β-keto esters, malonic esters, β-diketones, etc.). **Aliphatic cyclic compounds:** Nomenclature of cycloalkanes (mono- and bicyclic), Sigma bonds and bond rotation, Conformational analysis of butane, The relative stabilities of cycloalkanes, Origin of the ring strain in cyclopropane, cyclobutane: (Angle strain – torsional strain), Conformations of cyclohexane, Conformational analysis of monosubstituted cyclohexanes, Disubstituted cyclohexanes: cis-trans isomerism, Conformational analysis of disubstituted cyclohexanes, General methods of preparation of monocycloalkanes.

**Practical:** Identification of organic compounds part II.

**Chem. 251 BIOCHEMISTRY (1) (2 cr.).**

Prerequisite: Chem 241. Offered in spring.

**Chemistry of Carbohydrates:** Classification of carbohydrates, The D and L notation, Configuration of the Aldoses, Configuration of the Ketoses, Redox reaction of monosaccharides, Osazone formation, Chain Elongation; The Kiliani-Fisher Synthesis, Chain Shortening; The Ruff Degradation, Stereochemistry of Glucose; The Fisher Proof, Cyclic structure of monosaccharides: Hemiacetal formation, Stability of Glucose, Formation of Glycosides, Disaccharides and polysaccharides, Some naturally occurring products derived from carbohydrates. **Lipids:** Fatty acids, Waxes, Triacylglycerols, phospholipids, glycolipids, Sphingolipids, Prostaglandins, Lipoproteins.

**Chem. 252 BIOCHEMISTRY (2) (2 cr. + 1 cr. Lab.).**

Prerequisite: Chem 241. Offered in spring.

**Amino acids Peptides and Proteins:** Classification and Nomenclature of amino acids, Configuration of amino acids, Acid-base properties of amino acids, Isoelctric point, Separation of amino acids, Resolution of racemic mixtures of amino acids, Peptide bonds and disulfide bonds, Some biologically important peptides, strategy of peptide bond synthesis: N-protection and C-activation, Automated peptide synthesis, Protein structure, Determining the primary structure of proteins, Secondary structure of proteins, Tertiary structure of proteins, Quaternary structure of proteins, Protein denaturation, Classification of proteins. **Structure of Nucleosides, Nucleotides and Nucleic acids.**

**Practical:** part I .

**Chem. 341 PHYSICAL ORGANIC CHEMISTRY (2 cr. + 1 cr. Lab.).**

Prerequisites: Chem 241, Chem 242. Offered in fall.

Elucidation of Reaction Mechanism: Products and by-products, Kinetic methods, Reactive intermediates (Carbocations, carboanion, free radicals, carbene, nitrines, Arynes, tetrahedral addition, stable intermediates), Uses of Isotopes (Kinetic and non-kinetic), Stereochemistry, Acids

and bases (the strength of oxygen and nitrogen acids, nucleophilicity and electrophilicity), Structure Reactivity relationship. (Hammet - equation – Okamoto-Brown equation – Taft equation).

**Practical:** Physical organic chemistry experiments.

**Chem. 342 HETEROCYCLIC CHEMISTRY (2 cr. + 1 cr. Lab.).**

Prerequisites: Chem 241, Chem 242. Offered in fall.

Classification and Nomenclature, Aromaticity of Heterocyclic compounds, Chemical Reactivity of Heterocyclic compounds, Chemistry of functionally substituted heteroaromatic, Cycloaddition reactions, Three-member heterocycles, Four-member heterocycles, Synthetic routes of some five members π-excessive heteramatic compounds, Synthetic routes of some benzo-fused of some five member π-excessive, Synthetic routes of some six member π-deficient heteramatic compounds, Synthetic routes of some fused-six member π-deficient heteramatic compounds.

**Practical:** Investigation of Organic Compounds, Separation of Mixture of Organic Compounds.

**Chem. 343 NATURAL PRODUCTS (2 cr. + 1 cr. Lab.).**

Prerequisite: Chem 244. Offered in spring.

Alkaloids: Classification, Structure elucidation, some examples of alkaloids. Terpenes: Classification, structure, cyclic and acyclic monoterpenes, sesquiterpens, Diterpenes, triterpenes, tetraterpenes, polyterpenes. Steroids: Nomenclature, configuration and reactivity, sterols, bile acids, saponnins and sapogenins, synthesis of steroids. Hormones: Classification, Sex hormones, (Osetrogens, Gestogens, Androgens) Adrenal cortical hormones, Non-steroid hormones, plant hormones. Vitamins: Introduction, classification, Vitamin A-Vitamin B-Complex (Vitamin $B_1$, Vitamin $B_2$, Vitamin $B_6$, Vitamin $B_{12}$), Vitamin C and Vitamin D.

**Practical:** Functional Group Analyses, Synthesis of Organic Compounds.

**Chem. 344 PHOTOCHEMISTRY AND PERICYCLIC (2 cr. + 1 cr. Lab.).**

Prerequisite: Chem 244. Offered in spring.

**Photochemistry:** Introduction: energy levels, absorption and emission of light, spin conservation rules, Primary photochemical acts: excitation of atoms the gas phase, excitation of diatomic molecules, Reactions of species produced photochemically, Energy transfer, Single reactions of stable subject and triple state, Elimination reaction, Rearrangement reaction, Addition reaction, Abstraction reaction, Organic photo-substitutions.

**Pericyclic Recations:** Classification of pericyclic reactions, Theory of pericyclic reactions, Conservation of orbital symmetry, The frontier orbital symmetry, The aromaticity concept, Superficial and autarafacial geometries, Thermal cycloaddition, Diels- Alder reaction, Stero- and regio-specificity, Retro Diels- Alder reaction, Related six-electron cycloaddition, Thermal (2 + 2) cycloaddition.

**Practical:** Elucidation of the synthesized organic compounds (by spectroscopic methods).

**Chem. 345 APPLIED SPECTROSCOPY (2 cr.)**

Prerequisite: Chem 244. Offered in spring.

**Spectroscopic Methods of Analysis:** Infrared Spectroscopy, Ultraviolet Spectroscopy, Nuclear Magnetic Resonance Spectroscopy ($^1$H-NMR, $^{13}$C-NMR), Mass Spectrometry.

**Chem. 482 PRACTICAL ORGANIC CHEMISTRY (2 cr.).**

Offered in fall.

Isolation and extraction of Natural products, Multi-step synthesis.

**Chem. 484 PRACTICAL ORGANIC CHEMISTRY (2 cr.).**

Offered in spring.

Synthesis of Dye stuffs and polymeric compounds, Synthesis of some Drugs.

**Chem. 441 PETROLEUM AND PETROCHEMICALS (2 cr.).**

Offered in fall.

Introduction: Origin, Occurrence, Recovery, Classification, Composition, Evaluation, Fractionation, Identification, Asphaltic Constituents, Refining Chemistry, Refining: Distillation, Thermal Cracking, Catalytic Cracking, Hydroprocessing, Product Improvement, Treatment Processes, Gas Cleaning, Products, Petrochemicals: Chemicals from Paraffins, Olefins, Aromatics and Natural Gas.

**Chem. 442 ENVIRONMENTAL ORGANIC CHEMISTRY (2 cr.).**

Offered in fall.

Introduction: Chemistry-past, The cost of the waste, The greening of Chemistry, Principle of Sustainable and Green Chemistry, Chemistry and the Environment, Green Chemistry and Sustainable Development, Life-cycle Assessment: a Toll for Identification of More Sustainable Products and Processes, Industrial Processes using Solid Acid Catalyst, Micelle-templated Silicas in Green Chemistry, Green Biocatalytic Processes, Green catalysts for Industry (introduction, Supported reagents, Envirocates, Advantage of Envirocates, Activation of Envirocates, General methods for using Envirocates ), Sonochemistry: Introduction, Sonochemistry in Chemical Synthesis, Ultrasound in Electrochemistry, Ultrasound in Environmental Protection and waste control, Application of Microwaves for Environmentally Benign Organic Chemistry.

**Chem. 443 POLYMER CHEMISTRY (2 cr.).**

Offered in fall.

General classes of synthetic polymers, Chain-growth polymers, Stereochemistry of polymers. Ziegler-Natta catalyst, Polymerization of dienes (manufacture of rubber), Copolymers, Step-growth polymers, Physical properties of polymers, Biodegradable polymers.

**Chem. 444 CHEMISTRY OF NUCLEIC ACIDS (2 cr.).**

Offered in spring.

Nucleosides, Nucleotides and Nucleic acids: Nucleosides and Nucleotides, ATP: The carrier of chemical energy, Three mechanism for phosphoryl transfer reactions, The “High-Energy” Character of phosphoanhydride bonds, Kinetic stability of ATP in the cell, Other important nucleotide, The nucleic acids, Helical forms of DNA, Biosynthesis of DNA: Replication, Biosynthesis of messenger RNA: Transcription, Ribosomal RNA and Transfer RNA, Biosynthesis of proteins, Determining of the base sequence of DNA, Laboratory synthesis of DNA, Rational Drug Design.

**Chem. 445 SPECIAL TOPICS IN ORGANIC CHEMISTRY (2 cr.).**

Offered in spring.

More about Multistep Organic Chemistry: Functional group introduction, Removal and Interconversion, Restrosynthetic analysis. Disconnections, Restrosynthetic analysis of deoxygenated compounds, More about protecting group, Control of Stereochemistry, Selected examples of synthesis.

**Chem. 446 THE CHEMISTRY OF DRUGS (2 cr.).**

Offered in spring.

Naming Drugs, Lead compounds, Molecular modification, Random screening, Serendipity in Drug development, Receptors, Drugs and Enzyme inhibitors, Designing a suicide substrate, Quantitative structure-activity relationships, Molecular modeling, Combinatorial organic synthesis, Antiviral drugs, Economics of drugs, Governmental regulations.

**Chem. 447 COLOUR CHEMISTRY (DYES AND PIGMENTS) (2 cr.).**

Offered in spring.

Introduction (Classification of Colorants, History of dyes and pigment), Color of Organic compounds, Polyene and Polymethine Dyes, Di- and Triarylmethine Dyes and their Aza Analogues, Aza [18] annulenes, Nitro and Nitroso dyes, Azo Dyes and Pigments, Carbonyl Dyes and pigments, Sulfur Dyes Fluorescent Brighteners, Application of Dyes Organic Pigments, Photo-Thermal- and Electrochemical reactions of Dyes & Pigments, Dyes in Biochemistry, Biology, Medicine and Analytical Chemistry, Ecology and Toxicology of Dyes & Pigments.

## BIOCHEMISTRY

**Biochem. 253 BASIC BIOCHEMISTRY (2 cr.).**

Prerequisite: Chem 241. Offered in spring.

Classification of carbohydrates, The D and L notation, Configuration of the Aldoses, Configuration of the Ketoses, Osazone formation, Cyclic structure of monosaccharides: Hemiacetal formation,

Stability of Glucose, Formation of Glycosides, Disaccharides and polysaccharides. Fatty acids, Waxes, Triacylglycerols, Lipoproteins. Amino acids Peptides and Proteins: Classification and Nomenclature of amino acids, Configuration of amino acids, Acid-base properties of amino acids, Isoelctric point, Separation of amino acids, Some biologically important, Strategy of peptide bond synthesis: N-protection and C-activation, Protein structure, Determining the primary structure of proteins, Secondary structure of proteins, Tertiary structure of proteins, Quaternary structure of proteins, Protein denaturation, Classification of proteins. Structure of Nucleosides, Nucleotides and Nucleic acids.

**Biochem. 351 METABOLISM OF CARBOHYDRATES, FATTY ACIDS AND LIPIDS (2 cr.).**

Prerequisites: Chem 251, Z 211. Offered in fall.

**Metabolism of Carbohydrates:** Molecular properties of mono, di and poly saccharids, Carbohydrates digestion and absorption, Glycolysis, Endogenous and Exogenous sources of energy, Multifunctional aspects of citric acid cycle, Interrelationships between citric acid cycle & amino acids, Uronic acid pathway, Biphasic capacity of pentose phosphate pathway, Glycogen metabolism, Regulation of Carbohydrates metabolism, Metabolism of other sugars.

**Metabolism of Fatty acids and lipids:** Molecular properties of lipids, Enzymatic digestion, absorption and transport of lipids, Fatty acid oxidation, Ketone Bodies, Fatty acid biosynthesis, Metabolism of unsaturated fatty acids, Regulation of fatty acid metabolism, Cholesterol & Steroid metabolism, Bile acids synthesis and functions, Lipoprotein and lipid membrane, Phospholipids metabolism, Glycolipids.

**Biochem. 352 METABOLISM OF AMINO ACIDS AND PROTEINS (2 cr. + 1 cr. Lab.).**

Prerequisite: Chem 252. Offered in fall.

Molecular properties of amino acid, protein structure and function, Protein digestion and absorption, Intracellular protein degradation, Amino acid deamination, Nitrogen balance, The urea cycle, Breakdown of amino acids, Amino acid biosynthesis, Protein biosynthesis, Other products of amino acid.

**Practical: Paper chromatography:** Separation of different amino acids. Separation of different monoscharides. **Tissue chemistry:** Determination of Creatinine, Determination of Proteins, Determination of Calcium, Determination of Glycogen, Determination of Phosphors. Estimation of casein in milk, Estimation of lactose in milk.

**Biochem. 353 METABOLISM OF NUCLEOTIDES AND NUCLEIC ACIDS (2 cr.).**

Prerequisite: Chem 252. Offered in fall.

Molecular properties of purine & pyrimidine nucleotide (ATP, GTP, CTP, TTP, UTP), Biochemical function of nucleotides, Biosynthesis of purine & pyrimidine ribonucleotides in the living cells, Formation of deoxyribonucleotides, Nucleoside &nucleotide degradation, DNA structure and function, DNA and RNA relationship.

**Biochem. 354 VITAMINS AND INORGANIC METABOLISM (2 cr.).**

Offered in fall.

Classification of vitamins, Biosynthesis and intermediary metabolism of some Vitamins, Mobilization and circulation of vitamins, Detection of deficiency in man (vitamin A, D, E, K, C &$B_{complex}$ ($B_1$, $B_2$, $B_6$, $B_{12}$, folic acid, pantothenic & biotin, Metabolism of calcium, phosphate & sulphur, Metabolism of iron, & manganese, Metabolism of sodium, potassium, chloride, etc….. Trace elements, Hormone regulating mineral metabolism.

**Biochem. 355 ENZYMOLOGY (1) (2 cr. + 1 cr. Lab).**

Prerequisite: Chem 252. Offered in spring.

General properties of enzymes:-enzyme nomenclature, enzyme specificity, Activation energy & enzymatic reaction coordinate, Structure & catalytic function of enzymes, Preparation & purification of enzymes, Classification of enzymes: oxidoreductases, transferases, hydrolases, lyases, Isomerases, ligases, Structure &function of coenzymes, Methods of enzyme assays, Catalytic mechanism of enzymes: acid-base catalysis, covalent catalysis.

**Practical:** Preparation of different types of physiological buffers, Estimation of some enzymes, Salivary amylase, Pepsin, Trypsin, Catalase, Estimation of vitamin C, Urine report, Estimation of Uric Acid in Urine, Estimation of Ammonia in Urine, Estimation of Chloride in Urine.

**Biochem. 356 BIOLOGICAL FUNCTION AND BODY FLUIDS (2 cr.).**

Prerequisites: Biochem 351, Biochem 352. Offered in spring.

The biological function of the liver and metabolic pathways operating in this vital organ, The metabolic pathways operating in the kidneys, The metabolic pathways of the heart and its importance, The biological and biochemical pathways in the brain, Laboratory assessment of trace metal status, Measurement of hormone and related analytes, Biochemical analysis of electrolytes, Biochemical assessment of liver transaminases, Biochemical analysis of bilirubins, Clinical laboratory diagnosis of kidney and urinary tract disorders, Blood composition: erythrocytes, lecukocytes & platelets, Blood groups & blood coagulation factors, Composition of blood plasma, Urine: physical prop. Chemical composition, pathogenic constituents, and microscopic examination of urinary sediments, Composition of milk, milk-clotting, Factor influence milk secretion, Extravascular body fluids: cerebrospinal fluid, lymph, gastric juice, peritoneal fluid, pleural effusion, sweat, saliva, tear fluid, cervical … etc

**Biochem. 357 ENDOCRINOLOGY (2 cr.).**

Prerequisites: Biochem 351, Biochem 352. Offered in spring.

The organization of the mammalian endocrine system, Mechanism of hormone action, Regulation of hormone secretion, Hormone receptors, endocrine disorders, Biosynthesis, functions, deficiency & diseases of some hormones related to certain endocrine glands, Measurement of hormone and related analytes, somatostatint (SS)-thyrotropin - releasing hormone (TRH), Gonadotropin - releasing hormone (GnRH), luteinizing hormone (LH), corticotrpin-releasing hormone (LHRH), growth hormone-releasing hormone(GHRH), growth hormone- inhibiting hormone (GHIH),thyroid-stimulating hormone (TSH), prolactin(PRL), growthhormone(GH), follicle-stimulating hormone(FSH), β-Lipotropin (β-LPH), corticotropin (ACTH), vasopressin (ADH),α-melanocyte-stimulating hormone (α-MSH), insulin, adrenaline & noradrenaline.

**Biochem. 358 CHEMISTRY OF IMMUNE SYSTEM (2 cr.).**

Prerequisites: Biochem 351, Biochem 352. Offered in spring.

Immune system: the Cellular basis of immunity, organization of the immune system, The functional properties of antibodies, the structure of antibodies, The generation of antibody diversity, Principles of immunochemical techniques, Antigen-antibody binding, General immunoglobulin structure, Properties of Immunoglobulin clases(IgA, IgG, IgM, IgD, IgE), Structure and function of specific immunoglobulins, Molecular differences in epitope structure, The immune response system: exposure to an antigenic substance, the lymphoid system, cells involved in the immune response, events in the induction of the immune response, intracellular events occurring during cell maturation, phases of the humoral immune response, Immuno assay of biomolecules, Methods for analysis of immunoglobulins, Auto immune diseases.

**Biochem. 359 METABOLISM OF MACROMOLECULES (2 cr.)**

Prerequisite: Biochem 253. Offered in fall.

Molecular properties of mono, di and poly saccharids, Carbohydrates digestion and absorption, Glycolysis, Endogenous and Exogenous sources of energy, Multifunctional aspects of citric acid cycle, Glycogen metabolism, Regulation of Carbohydrates metabolism. Molecular properties of lipids, Enzymatic digestion, absorption and transport of lipids, Fatty acid oxidation, Fatty acid biosynthesis, Metabolism of unsaturated fatty acids, Regulation of fatty acid metabolism. Molecular properties of amino acid, protein structure and function, Protein digestion and absorption, Intracellular protein degradation, Amino acid deamination, Nitrogen balance, The urea cycle.

**Biochem 360 BODY FLUIDS (2 cr.)**

Prerequisite: Biochem 253. Offered in spring.

The biological function of the liver and metabolic pathways operating in this vital organ: Blood composition: erythrocytes, lecukocytes & platelets, Blood groups & blood coagulation factors,

Composition of blood plasma, Urine: physical prop. Chemical composition, pathogenic constituents, and microscopic examination of urinary sediments, Composition of milk, milk-clotting, Factor influence milk secretion, Extravascular body fluids: cerebrospinal fluid, lymph, gastric juice, peritoneal fluid, pleural effusion, sweat, saliva, tear fluid, cervical … etc

**Biochem. 451 DNA TECHNOLOGY (2 cr.).**

Prerequisites: Biochem 352, Biochem 353. Offered in fall.

DNA as genetic material, Structure of DNA and RNA, Bacterial restriction/modification system, DNA modifying enzymes, Introduction to Prokaryotic DNA replication, Prokaryotic DNA replication, cont, Introduction to bacteria, Extrachromosomal elements, plasmids, selectable markers, Central Dogma, genetic code, Gene and operon, lac operon, CAP site, lac operon, cont. DNA footprinting.

**Biochem. 452 PHOTOCHEMISTRY & PHOTOBIOLOGY (2 cr.).**

Prerequisites: Biochem 352, Biochem 353. Offered in fall.

Light interaction with tissue: photothermal, photoablative & photochemical (photoadition, photoisomerization, photofragmentation & photooxidation), Photosensitization: effect on biological substrates: Nucleic acids, proteins, fatty acids. Etc …., photochemotherapy: PUVA treatment, photobiological and photochemical aspects, mechanism of action on the molecular level of the cell, side effects, photodynamic therapy (PDT): types, mechanism of action on molecular and cellular level, types of photosensitizers, photothermal sensitization (PTT), Phototherapy.

**Biochem. 453 NOVEL DRUG DISCOVERY (2 cr.).**

Prerequisite: Biochem 355. Offered in fall.

**Antibiotics & other drugs:** Introduction to Antibiotics, Major Antibiotic Classes and Modes of Action, Antibiotics that Act on Bacterial Cell Wall Biosynthesis, Antibiotics that Block Bacterial Protein Synthesis, Antibiotics that Block DNA Replication and Repair, Producer Strain Immunity vs. Acquired Resistance, Aminocyclitol-aminoglycoside antibiotics, Use of radioactive intermediates to study aminocyclitol-aminoglycoside antibiotics, Anti-bacterial drugs: bacterostatic and bacterosidel, Anti-fungus drugs; anti-viral drugs; and anti-metabolite drugs, Chemistry and Mode of Action of antibiotics, Genetics and Biochemistry of Antibiotic Production, Peptide and peptide-Derived Antibiotics, Beta-Lactam Antibiotics.

**Biochem. 454 ENZYMOLOGY PART (2) (2 cr.).**

Prerequisite: Biochem 355. Offered in fall.

Regulation of enzyme activity, Activator and inhibitor of enzymes: competitive inhibition, uncompetitive inhibition, mixed inhibition, Enzyme kinetics-immobilization of enzymes, Mechanism of enzymes &isoenzymes, Methods of separation of isoenzymes, Lysozymes, Gene–enzyme relatioships, gene cloning of enzymes, restriction endonucleases, Enzyme utility in biotechnology.

**Biochem. 455 CANCER BIOLOGY (2 cr.).**

Prerequisites: Biochem 352, Biochem 353. Offered in spring.

Some important definitions, Cell cycle of normal and abnormal cells, Cell kinetics, Endogenous causes of cancer, Exogenous causes of cancer, Treatment of cancer by radiotherapy and chemotherapy, Tumor markers and its clinical utility in human cancer.

**Biochem. 456 CLINICAL BIOCHEMISTRY (2 cr.).**

Prerequisites: Biochem 351, Biochem 356. Offered in spring.

**Disorders of Carbohydrate metabolism**, glucose homeostasis, hormonal regulation of glucose, hypoergiycemia, diabetes mellitus. types complication, laboratory diagnosis, fructosamine, glycated hemoglobin hypoglycemia, treatment, **Disorders of plasma lipids and lipoproteins.** distribution of Lipoproteins in the body, separation, chemical structure of lipoprote ins hyperliproteinaemia, & hypolipoproteinaemia, **Tumor Markers** characterestics of ideal tumor markers, classification, clinical application, specific tumor markers, methods for measurement, **Disorders of Iron ,porphyrin and hemoglobin**, iron deficiency, causes, Iron poisoning, treatment, poiphyrin & heme synthesis, hemoglobin and its derivatives, methods for hemoglobin measurement, abnormal derivative of hemoglobin, **Disorders of purine metabolism**. Plasma urates, hyperuricaemia, gout, types, diagnosis, treatment, laboratory methods for measeument of uric acid, **Clinical enzymology**.

transaminasis, sources, clinical significance lactate dehydrogenore & its isoenzymes, changes in certain diseases creation kinase, alkaline phosphates, gamma glutamyl transferase, 5 -nucleotides, glucose 6 phosphate dehydrogenase. **Complete blood picture: Hb** conc. Total leucocytic count, differential count, Haematocrite, Red blood cells count, Platelets count & blood indices, **Calcium homeostasis**.

**Biochem. 457 BIOTECHNOLOGY (2 cr.).**

Prerequisites: Biochem 451. Offered in spring.

An introduction to biotechnology, Substrates for biotechnology, Genetics and biotechnology, Bioprocess and fermentation technology, Enzyme technology, Biological fuel generation, Single cell protein, Biotechnology and medicine, Environmental biotechnology, Food and beverage biotechnology, Safety in biotechnology.

**Biochem. 458 GENETIC ENGINEERING AND GENE THERAPY (2 cr.).**

Prerequisites: Biochem 451. Offered in spring.

Gene cloning and application of gene cloning in medical fields, pharmaceutical and agriculture, Genetic immunization, The flow of genetic information, Sequence analysis of the human genome "Sick & health" gene, Genes that cause disease, Genetic diagnosis, Genetic screening, Treatment of genetic disease.

**Biochem. 459 PROTEOMICS & BIOINFORMATICS (2 cr.).**

Prerequisites: Biochem 458. Offered in spring.

2 D Gel Electrophoresis, Moldi-ToF, Protein arrays, Application of bioinformatics for protein structure determination.

**Biochem 460 APPLIED CLINICAL BIOCHEMISTRY (2 cr.)**

Prerequisites: Biochem 253, Biochem 359, Biochem 360. Offered in spring.

**Disorders of Carbohydrate metabolism,** glucose homeostasis, hormonal regulation of glucose, hypoergiycemia, diabetes mellitus. types complication, laboratory diagnosis, fructosamine , glycated hemoglobin hypoglycemia, treatment. **Disorders of plasma lipids and lipoproteins. distribution of** lipoproteins in the body, separation, chemical structure of lipoproteins hyperliproteinaemia. & hypolipoproteinaemia**. Tumor Markers.** characterestics of ideal tumor markers, classification, clinical application, specific tumor m'zirkers, methods for measurement. **Disorders of Iron ,porphyrin and hemoglobin,** iron deficiency, cc/uses, Iron poisoning, treatment, poiphyrin & heme synthesis, hemoglobin cmnd its derivatives, methods for hemoglobin measurement., abnormal derivative of hemoglobin. **Disorders of purine metabolism.** Plasma urates, hyperuricaemia, gout, types, diagnosis, treatment, laboratory methods for measeument of uric acid. **Calcium homeostasis.**

**Biochem. 491 ESTIMATION OF SOME ENZYMES & ELECTROLYTES IN BLOOD (2 cr.).**

Offered in fall.

Estimation of AST, Estimation of ALT, Estimation of GGT, Estimation of Alpha-Amylase, Estimation of Sodium, Estimation of Potassium, Estimation of Calcium, Estimation of Magnesium, Estimation of Chloride, Estimation of Vitamin C.

**Biochem. 492 ESTIMATION OF SOME METABOLITES IN BLOOD (2 cr.).**

Offered in spring.

Estimation of total protein, Estimation of albumin, Estimation of cholesterol, Estimation of triglycerids, Estimation of HDL & LDL cholesterol, Estimation of Urea, Estimation of Creatinine, Estimation of Uric Acid, Complete blood picture.

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# BOTANY

## First: Academic Programs Offered by Botany Department

**The Department offers courses for students of the following groups:**

1- Chemistry /Botany (Chem/B)
2- Chemistry/ Microbiology (Chem/ MB)

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 1 | 1st | Bio. 101 | Introduction to Plant Science (1) | - | - | Other groups | ⅔ | 1 | - | 1 | 6 Cr. Compul. |
| | | B.101 | General Botany (1) | - | B, MB | | 2 | 3 | | 3 | |
| | 2nd | Bio.102 | Introduction to Plant Science (2) | Bio. 101 | - | Other groups | ⅔ | 1 | - | 1 | |
| | | B.102 | General Botany (2) | B.101 | B, MB | | 2 | 3 | | 3 | |
| 2 | 3rd | B. 221 | Introductory Plant Ecology | B.102 | Chem/B | - | 2 | 3 | - | 3 | 9 cr. Compul |
| | | B. 252 | Genetics | | Chem/MB Chem/B | - | 2 | 3 | - | 3 | |
| | | B. 261 | Plant Anatomy | | Chem/B | - | 2 | 3 | - | 3 | |
| | | B. 211 | Bacteriology | | Chem/MB | - | 2 | 3 | - | 3 | 5 Cr. Compul. |
| | | B. 212 | Actinomycetes | | | - | 1 | 3 | - | 2 | |
| | 4th | B. 210 | General Microbiology | B.102 or Bio.101 | Chem/B | - | 2 | 3 | - | 3 | 9 cr. Compul. |
| | | B. 222 | Environmental Factors | B.221 | | - | 2 | 3 | - | 3 | |
| | | B. 232 | Taxonomy | B.102 | | - | 2 | 3 | - | 3 | |
| | | B. 213 | Systematic Mycology | | Chem/MB | - | 2 | 3 | - | 3 | 9 cr. Compul. |
| | | B. 214 | Environmental Microbiology | B.211 | | - | 2 | 3 | - | 3 | |
| | | B. 291 | Protista | B.102 | | - | 2 | 3 | - | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 3 | 5th | B.319 | Phycology | B.102 | Chem/B | - | 2 | 3 | - | 3 | 9 cr. Compul |
| | | B.321 | Desert Ecology | B.222 | | - | 2 | 3 | - | 3 | |
| | | B.341 | Water Relations and Solutes Transport | B.102 | | - | 2 | 3 | - | 3 | |
| | | B.311 | Virology | B.211 | Chem/MB | - | 2 | 3 | - | 3 | 10 cr. Compul. |
| | | B.312 | Microbial Enzymes | B.211 , B.213 | | - | 1 | 3 | - | 2 | |
| | | B.381 | Molecular Biology | B.211 | | - | 2 | 3 | - | 3 | |
| | | B.382 | Radiation Biology | B.211, B.213 | | - | 1 | 3 | - | 2 | |
| | 6th | B.331 | Biosystematic | B.232 | Chem/B | - | 2 | 3 | - | 3 | 7 cr. Compul |
| | | B.332 | Medicinal Plants | | | - | 1 | 3 | - | 2 | |
| | | B.342 | Enzymes | B.102 | | - | 1 | 3 | - | 2 | |
| | | B.318 | Economic Botany | B.102 | - | Chem/B | 1 | 3 | - | 2 | 2 cr. Elect. |
| | | B.322 | Environmental Pollution | B.321 | - | | 1 | 3 | - | 2 | |
| | | B.323 | Phytogeography | | - | | 1 | 3 | - | 2 | |
| | | B.371 | Comparative Morphology | B.102 | - | | 1 | 3 | - | 2 | |
| | | B.313 | Microbial Pollutants | B.312 | Chem/MB | - | 2 | 3 | - | 3 | 6 cr. Compul. |
| | | B.314 | Microbial Physiology | | | - | 2 | 3 | - | 3 | |
| | | B.315 | Soil microbiology | B.312 | - | Chem/MB | 2 | 3 | - | 3 | 3 cr. Elect. |
| | | B.316 | Water and sewage biology | B.211, B.291 | - | | 2 | 3 | - | 3 | |
| | | B.317 | Bacterial Biodiversity | B.211, B.212 | - | | 2 | 3 | - | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 7th | B.421 | Vegetation science | B.222, B.341 | Chem/B | - | 1 | 3 | - | 2 | 9 cr. Compul |
| | | B.441 | Physiological stresses | B.341 | | - | 1 | 3 | - | 2 | |
| | | B.442 | Plant Pigments and Photosynthesis | B.342 | | - | 2 | 3 | - | 3 | |
| | | B.483 | Molecular Biology | B.210 | | - | 1 | 3 | - | 2 | |
| | | B.411 | Plant Pathology and Control | B.213, B.311 | Chem/MB | - | 2 | 3 | - | 3 | 9 cr. Compul |
| | | B.412 | Food Microbiology | B.211, B.312 | | - | 2 | 3 | - | 3 | |
| | | B.481 | Biotechnology | B.314, B.381 | | - | 2 | 3 | - | 3 | |
| | 8th | B.431 | Flora | B.222 | Chem/B | - | 1 | 3 | - | 2 | 7 cr. Compul |
| | | B.443 | Plant Hormones/Plant Cell and Tissue Culture | B.381, B.483 | Chem/B Chem/MB | - | 2 | 3 | - | 3 | |
| | | B.484 | Application of Molecular Biology | N.483 | Chem/B | - | 1 | 3 | - | 2 | |
| | | B.417 | Hydrobiology | B.210, B.319 | - | Chem/B | 1 | 3 | - | 2 | 2 cr. Elect. |
| | | B.422 | Conservation and Diversity of Plants | B.222 | - | | 1 | 2 | - | 2 | |
| | | B.491 | Metabolism and Secondary Products | B.342 | - | | 1 | 3 | - | 2 | |
| | | B.413 | Microbial toxins | B.412 | Chem/MB | - | 1 | 3 | - | 2 | 4 cr. Compul |
| | | B.414 | Resistance and immunity | B.211, B.311 | | - | 1 | 3 | - | 2 | |
| | | B.415 | Medical microbiology | B.211, B.213, B.311 | - | Chem/MB Chem/B | 1 | 3 | - | 2 | 2 cr. Elect. |
| | | B.416 | Biological control | B.411 | - | | 1 | 3 | - | 2 | |
| | | Stat 422 | Biostatistics for biologists | - | - | | 1 | 2 | 1 | 2 | |

# Second: Courses Offered by Botany Department

**B.101 GENERAL BOTANY (1) (3 cr. + 1 cr. Lab)**

Offered in fall.

**Systematic:** Classification of Kingdoms, characteristics of kingdom plantae.

**Morphology:** Introduction: angiospermae, structure of a typical flower, pollination, fertilization and seed development, the life cycle of an angiosperm. seeds and seed germination: structure of the seeds, factors affecting seed germination. Changes occurring during seed germination, dicotyledonous and monocotyledonous seeds and seedlings. Habitat of plants, habit of plants, the plant body: root system, origin of roots, functions of the roots, root zones, modification of roots. Shoot system, the buds, origin of buds, function of buds, structure of buds, classification of buds. The stem: Functions of the stem, origin of stem, branching of the stem, habit of the stem, metamorphosis of the stem. The leaf: different kinds of leaves, functions of the leaf, duration of the leaf, leaf insertion and arrangement, phyllotaxy, leaf structure, modification of leaves.

**Anatomy:** the structure of the plant cell, protoplast, the protoplasmic components, the non-protoplasmic components, the cell wall, pits, plant tissues, meristematic tissues, mature (permanent) tissues, complex vascular tissues, the epidermis.

**Bio. 101 INTRODUCTION TO PLANT SCIENCE (1) ( 2/3 cr. + 1/3 cr. Lab)**

Offered in fall

**Anatomy:** The structure of the plant cell, the protoplast, the protoplasmic components, the non-protoplasmic components, the cell wall, pits, plant tissues, meristematic tissues, mature (permanent) tissues, complex vascular tissues, the epidermis.

**Cell biology:** DNA structure and replication, RNA structure, types, role in protein synthesis, cell membrane, fluid mosaic model, transport across membrane.

**B. 102 GENERAL BOTANY (2) (3 cr. + 1 cr. Lab).**

Prerequisite:B101 Offered in spring

**Physiology,** colloidal systems: protoplasm and the cell, solutions, preparation of colloidal systems, properties of colloids: adsorption, electrical properties, precipitation, gelation and solation. Protoplasm: a polyphasic colloidal system. Water and Osmosis: diffusion, definition of diffusion. Factors affecting diffusion, the role of diffusion in plants life, Osmosis: types of membranes, osmoscopes, the plant cell as an osmotic system. Permeability: types of membranes, structure of plasma membrane, permeability of the cell: to water, to solutes, ionized and non-ionized substances. Factors affecting permeability. Enzymes: properties of enzymes, mechanism of enzyme action. Nomenclature of enzymes, distribution of enzymes. Specificity of enzymes. Classification of enzymes. Factors affecting enzyme activity. Respiration: types of respiration: aerobic respiration, anaerobic respiration. Mechanism of respiration. Stages of aerobic respiration. Factors affecting respiration. Photosynthesis: Structure of chloroplast (photosynthetic apparatus), Mechanism of photosynthesis, light reaction: Non cyclic photophosphorylation (electron transport), cyclic photophosphorylation, dark reaction (calvin cycle).

**Bio. 101 INTRODUCTION TO PLANT SCIENCE (2) (2/3 cr. + 1/3 Lab.)**

Offered in spring

Colloidal systems: protoplasm and the cell, solutions, preparation of colloidal systems, properties of colloids: adsorption, electrical properties, precipitation, gelation and solation. Protoplasm: a polyphasic colloidal system, enzymes: properties of enzymes, mechanism of enzyme action. Nomenclature of enzymes, distribution of enzymes. Specificity of enzymes. Classification of enzymes. Factors affecting enzyme activity. Respiration: types of respiration: aerobic respiration, anaerobic respiration. Mechanism of respiration. Stages of aerobic respiration, factors affecting respiration, fermentation, mechanism and products.

**B. 210 GENERAL MICROBIOLOGY (3 cr.+ 1 cr. Lab).**

Prerequisites: B102 or Bio 101 Offered in spring

Prokaryotic and eukaryotic cells. Bacteria. Fungi. Viruses. Nutritional requirements of microorganisms. Microbial growth. Control of microbial growth. Microbial genetics. Role of microorganisms in nature: cycles of matters (Carbon, nitrogen, and sulfur), sewage treatment, food and dairy products, food spoilage, in medicine, biocontrol, bioremediation, in mining, in modern biotechnology and genetic engineering.

**B. 211 BACTERIOLOGY (3 cr. + 1 cr. Lab).**

Prerequisite: B102. Offered in fall

Introduction to the science of bacteria, distribution of bacteria in nature, functions of bacteria in our life, ultra structure of bacterial cell, a typical bacteria (archaeobacteria), unusual types of bacteria (mycoplasma, chlamydia, rickcettsiae and L-Form), cyanobacteria. effect of environments upon bacteria. Structure and function of genetic material in bacteria, mutation in bacteria. Mutagens. Identifying mutants. Recombination in bacteria: transformation, conjugation and transduction.

**B. 212 ACTINOMYCETES (1 cr. + 1 cr. Lab).**

Prerequisite: B102. Offered in fall

Description of class actinomycetes in response to morphology-mature occurrence and the sub-classes, nature formation and activities of antibiotics produced-by actinomycetes, isolation and identification of antibiotics, production of antibiotics: by different species, by same organism (different antibiotics), assay methods: chemical and biological, increasing the commercial yields. Biogenesis of Antibiotics. Antimicrobial and antitumor activities of antibiotics. Mode of action of antibiotics. Development of resistance. Natural and acquired and mechanism of resistance, utilization of antibiotics in clinical - medicine and other applications.

**B. 213 SYSTEMATIC MYCOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: B 102 Offered in spring

Introduction, general characteristics, nutrition and growth, somatic structures, reproduction, Classification: division, mycota subdivision: myxomycotina, class: myxomycetes, subdivision: eumycotina: classes: chytridiomycetes, hypho-chytridiomycetes, oomycetes, plasmodiophoromycetes, zygomycetes, trichomycetes, ascomycetes, basidiomycetes, formclass, deuteromycetes, for each class: different orders, suborders, families, genera and species representative for the class, their characteristics and their life cycles are studied.

**B. 214 ENVIRONMENTAL MICROBIOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: B 102 Offered in spring

The nature of microbial communities, life at different concentrations of nutrients, physiological factors affecting the environmental fate of microorganisms, types of microbial interactions, neutralism, mutualism, commensalism, antagonism, microbial habitats, aquatic environments, microflora of the different aquatic environments, the marine environment, the fresh environment, terrestrial environments, microorganisms and higher plants, terrestrial microorganisms in soils and mycorrhiza, extreme environments, high temperature environments, extremely acidic environments, highly alkaline environments, high salinity environments, biogeochemical roles of microorganisms, carbon cycle, sulfur cycle, nitrogen cycle, microbes & other minerals.

**B. 221 INTRODUCTORY PLANT ECOLOGY (3 cr. + 1 cr. Lab).**

Prerequisite: B102 Offered in fall

Principles, concepts and specializations of plant ecology, population, community, ecosystem and allied concepts, species interactions that result in positive and negative association, system ecology, continuum concept and succession, plant adaptation and reproductive ecology, ecological genetics of populations, applications of plant ecology.

**B. 222 ENVIRONMENTAL FACTORS (2 cr. + 1 cr. Lab).**

Prerequisite: B 221 Offered in spring

Basic principles and concepts of the plant - environment factors (edaphic, climatic, physiographic and biotic factors) and their effect on plants, distribution of major vegetation and ecosystem types in response to interacting environmental factors, characteristic features and types of plants as an environmental indicators, Plant behavior in response to environmental factors.

**B. 232 TAXONOMY (2 cr. + 1 cr. Lab).**

Prerequisite: B 102 Offered in spring

Evolution of flower parts: evolution of flower from vegetative branch, evolution of sepal from vegetative leaf, evolution of petal from sepal, evolution stamen from petal, evolution of syncarpy from apocarpy. The structure of androecium and gynoecium, structure of anther, different types of pollination, formation of male and female gametophytes, fertilization, embryo and seed formation, seed and fruit formation, different types of fruits, different types of inflorescences, principals of artificial and natural systems of classification. Advanced and primitive characters of the plants, subclass: dialypetalae (petals free): ranales rananculaceae, leguminosae mimosaceae, caesalpinaceae, papillionaceae, rhoedales cruciferae, columniferae malvaceae, geraniales linaceae, umbelliflorae umbelliferae. Subclass: sympetalae (united free): contortae apocynaceae, tubiflorae convolvulaceae, labiatae, personatae solanaceae, crophulariaceae, bignoniaceae, synandrae compositae, class: monocotyledons: order liliflorae, family: liliaceae, family: Iridaceae, order glumiflorae, family: gramineae, order scitamineae, family: cannaceae.

**B. 252 GENETICS (2 cr. + 1 cr. Lab).**

Prerequisite:B102 Offered in fall

Transmission and distribution of genetic material, types of cell division. Mendelian principles. Cytological bases and chromosomal theory of inheritance. Varieties of gene expression. Allelic Relationships. Dominance relations, lethal genes, multiple alleles. Gene action and gene interaction. Pleiotropism, epistatic and non epistatic interactions. Degree of gene expression. Environmental Effects on gene expression, external and internal factors, phenocopies. Genetics of sex. Mechanisms of sex determination, inheritance related to sex – linkage, crossing over and gene mapping. Variation in genetic material. Change in chromosome structure and number. Inheritance through the cytoplasm.

**B. 261 PLANT ANATOMY (3 cr. + 1 cr. Lab).**

Prerequisite: B102 Offered in fall

Theories of structural development and differentiation: the histogen theory, apical cell theory, the Tunica-Corpus theory, stelar structure (stelar system): protostele, siphonostele, solenostele, dictyostele, atactostele, euostele. Leaf gap and leaf trace, evolution of siphonostele from protostele, expansion theory, invasion theory. The origin of the primary plant body. The origin of the secondary plant body: the origin of vascular cambium, fascicular cambium, interfascicular cambium, fusiform intials, ray intials. How the cambium produce new cells?. Callus or wound healing, bud grafting, stem grafting, function of cambium in wound healing. Common forms of secondary thickening in dicots and gymnosperms, in some herbaceous plants e.g. trifolium, cucurbita and rananculus, in other herbaceous plants e.g. salvia and medicago, in woody trees e.g. salix and pinus, in woody climbers plants e.g. vitis and luffa, in woody shrubs e.g. helianthus and prunus, in woody tree e.g. tilia. Characters of secondary phloem and xylem, characters of wood. Anomalous secondary growth in dicotyledons and gymnosperms, mirabilis stem, chenopodium stem, salvadora stem, bauhinia stem, bignonia stem. Anomalous secondary growth in monocotyledons: Dracaena stem. Normal secondary growth in dicot roots. Origin of lateral branch. Periderm: phellogen, phelloderm, phellum location and formation. Bark. Protective tissues in monocotyledons. Lenticel, formation and function, leaf abscission, wound cork, plant structure in relation to environment: morphological, anatomical and physiological adaptations of hydrophytes, xerophytes, and mesophytes. Effect of light on plant structure, kranz type of leaf anatomy.

**B. 291 PROTISTA (2 cr. + 1 cr. Lab).**

Prerequisite: B 102 Offered in spring

Kingdom protista, an introduction to algae, morphology: unicellular organization, rhizopodial type, protococcoidal type, flagellate unicells, colonial habit, filamentous habit, siphonaceous habit, parenchymatous organization. Habitats and communities of algae: freshwater habitats, marine habitats, terrestrial habitats, aerial habitats (epiphytic, epizooic, epilithic, epipelic, epipsammic). Communities, phytoplankton, climax communities, niche phytobenthos, epilithon, epipsammon

endolithon, endosammon, artificial surfaces, epiphyton, metaphyton, endophyton, epizoon, endozoon, rhizobenthos, coral reefs, the free living algal flora, general conditions of algal life, structure of algal cell, reproduction and life cycles of algae. Environmental factors affecting algal maintenance and distribution. Physical factors, chemical factors, biological factors, biological and economical aspects of algae, eutrophication and pollution.

**B. 311 Virology (2 cr. + 1 cr. Lab)**

Prerequisite: B 211 Offered in fall.

Fundamental characteristics of viruses. Laboratory cultivation of animal viruses, cultivation of plant viruses, classification of viruses, resistance to physical, chemical and therapeutic agents, chemical structure of viruses, bacteriophages, replication of viruses (human and animal DNA and RNA viruses and multiplication of viruses infecting plants), the interaction of antigen and antibodies, laboratory diagnosis of virus infections.

**B. 312 MICROBIAL ENZYMES (1 cr. + 1 cr. Lab).**

Prerequisites: B 211 & B 213 Offered in fall

Nature of enzymes, structure and mechanism of action, location of enzymes in microbes, factors influencing enzyme reaction rates, classification of enzymes, constitutive and induced enzymes, secretion of enzymes: extracellular enzymes, intracellular enzymes. Commercial uses of enzymes: detergent enzymes, enzymes in dairy products, enzymes in plant juice production, enzymes in textile manufacture, enzymes in leather manufacture, regulation of enzymes.

**B. 313 MICROBIAL POLLUTANTS (2 cr. + 1 cr. Lab).**

Prerequisite: B 312 Offered in spring

Definition of pollution, microbes as causes of pollution, mercury pollution and microbes, acid mine nrainage and microbes, microbes as pollutants, microbes as indicators of pollution, microbes as indicators of water pollution, microbial reduction of pollution, microbes and sewage, biodegradation and bioremediation.

**B. 314 MICROBIAL PHYSIOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: B 312 Offered in spring

Fundamentals of bacterial & fungal growth, responses to environmental stresses, control of microorganisms by: physical agents and chemical agents microbial metabolism: catabolism: energy, yielding biochemical processes: the embden, meyerhof, parnas pathway, the hexose monophosphate pathway the entner- doudoroff pathway, the phosphoketolase pathway, the tricarboxylic acid cycle fermentations, anabolism: energy, requiring biochemical processes: biosynthesis of amino acids & proteins, biosynthesis of carbohydrates, biosynthesis of fatty acids & lipids, autotrophy, photoautotrophy carbon dioxide fixation (assimilation).

**B. 315 SOIL MICROBIOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: B 312 Offered in spring

Microbial ecology : the soil environment, general description- profiles and horizons, differences among soils, physical and chemical considerations, organic (humus), microbial groups: distribution and abundance, environmental influences, microbial and generic group, nutrition and dominant flora, activity and function of: bacteria, actinomycetes, fungi, algae, protozoa, non-protozoan fauna. viruses, phage, lysis, lysogeny, practical and ecological significance, some aspects of microbial physiology: nutrition-growth, biochemical considerations, enzymatic activity in soil, the carbon cycle and organic matter decomposition, changes during decomposition, flora, assimilation and mineralization. Microbiology, factors governing decomposition, flora, biochemistry of: cellulose, hemicelluloses, lignin, other, polysaccharides (starch, pectic substances, inulin, chitin). The Nitrogen cycle: mineralization and immobilization, microbiology, environmental influences, nucleic acid, urea, nitrification, denitrification, nitrogen fixation. Microbial transformation of phosphorus, mineralization and Immobilization, solubilization, flora, microbial transformations of sulfur: mineralization and immobilization, transformations of other elements, pesticides: their effects, persistence, their metabolism.

**B. 316 WATER AND SEWAGE BIOLOGY (2 cr. + 1 cr. Lab).**

Prerequisites: B 211 & 291 Offered in spring

Introduction, aquatic and organic pollution, sewage and sewage treatment, primary treatment, secondary treatment, tertiary treatment, disinfection, small scale of water treatment, eutrophication, acidification, heavy metals and organochlorines, thermal and radioactive, oil pollution, the biological assessment of water quality.

**B. 317 BACTERIAL BIODIVERSITY (2 cr. + 1 cr. Lab).**

Prerequisites: B 211 & 212 Offered in spring

Survey of the major groups of bacteria, criteria for classification & identification of bacteria, the Gram-Negative bacteria, the spirochaetes, the aerobic spiral & curved rods, the Aerobic Rods & Cocci, the facultatively anaerobic bacteria, the anaerobic Rods & Cocci. The dissimilatory sulfate, reducing bacteria, rickettsiae & chlamydiae, the mycoplasma group, others Gram Negative bacteria. The Phototrophs, the chemotrophs, the gliding bacteria, the sheathed bacteria, the budding and/or appendaged bacteria. The Gram, positive bacteria. The Gram positive cocci, the lactic acid bacteria the Gram-positive Rods, the endospore, forming bacteria, the asporogenous Gram-Positive Rods, the streptomyces & related bacteria, the archaeobacteria, the methanogenic bacteria, the extreme halophiles, the sulfur, dependent extreme thermophiles.

**B. 318 ECONOMIC BOTANY (1 cr. + 1 cr. Lab).**

Prerequisite: B 102 Offered in spring

Essential oil: perfumery oils, oil of roses, jasmine, camphor, violet, Iris, fatty oils: coconut palm, olive, castor, sunflower, sesame, linseed and cotton seed oil, sugars: manufacture of sugars: cane and beet sugar, starch and starch products, rice starch, potato, wheat and corn starch glucose and dextrin and industrial alcohols, medicinal plants and the active principals and some drugs derived from them like: aconite, squills-aloe, belladonna, liquorice etc, non alcoholic beverages: coffee and methods of extraction from seeds.

**B. 319 PHYCOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: B 102 Offered in fall

Classification of different phyla, basis of classification algae, distribution, cellular organization, orders and representative forms for cyanophyta (cyanobacteria), euglenophyta, chlorophyta. Charophyta, phaeophyta, rhodophyta, bacillariophyta, xanthophyta, dinophyta, cryptophyta, pyrrophyta.

**B. 321 DESERT ECOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: B 222 Offered in fall

Biogeography, origin and evolution of deserts, Theoretical and practical perspectives on deserts, Man and desert relationships, Distribution, evolution and potential use of desert plants, structure, function relations of desert organisms.

**B. 322 ENVIRONMENTAL POLLUTION (1 cr. + 1 cr. Lab).**

Prerequisite: B 321 Offered in spring

Types and sources of soil, water and air pollution, basic principles and problems, chemical, physical and biological aspects of pollution, case study analysis on environmental pollution and global environmental issues of global warming , ozone depletion, and loss of biodiversity, solid wastes disposal and recycling. Dangerous and hazardous material management.

**B. 323 PHYTOGEOGRAPHY (1 cr. + 1 cr. Lab).**

Prerequisite: B 221 Offered in spring

Aims and principles of plant geography. Climate zones and species distribution. Interpreting disjunct and endemic distribution patterns. Plant strategies and associations in different phytogeographical Regions, floristic, realms and theory of island biography.

**B. 331 BIOSYSTEMATIC (2 cr. + 1 cr. Lab).**

Prerequisite: B 232 Offered in spring.

The scope of taxonomy, modern phenetic methods (taxometrics), modern phylogentic methods (cladistics), structural information, morphological and anatomical characters (seeds , pollen anatomy

& morphology), chemical information, compounds useful in plant taxonomy value of chemotaxonomy, chromosomal information (number, structure), molecular systematic.

**B. 332 MEDICINAL PLANTS (2 cr. + 1 cr. Lab).**

Prerequisite: B 232 Offered in spring

Introduction and history of medicinal plants, major constituents and medicinal values of medicinal plants, essential oils and fractions from medicinal plants, cultivation and harvesting of medicinal plants, major constituents and their sources, essential oils and their sources, toxicity of medicinal plants, common and scientific names of some medicinal plants in Egypt, plant species and diseases treated.

**B. 341 WATER RELATIONS AND SOLUTES TRANSPORT (2 cr. + 1 cr. Lab).**

Prerequisite: B 102 Offered in fall

Water relations of whole plant. Transport of solutes across cell membranes, mineral nutrition, translocation of nutrients, assimilation of inorganic nutrients, seed germination and seed dormancy, growth and development:

**B. 342 ENZYMES (2 cr. + 1 cr. Lab).**

Prerequisite: B 102 Offered in spring

Introduction to enzymes: enzymes as catalyst, activation energy and transition state, free energy change, chemical equilibria, active site, substrate specificity enzyme classification, enzyme purification. Factors affecting enzyme activity: enzyme assays, linked enzyme, enzyme velocity, substrate concentration, enzyme concentration, temperature, pH. coenzymes and prosthetic groups, inorganic ions and small organic molecules as enzyme cofactors. Enzyme kinetics and inhibition: michaelis menten model, lineweaver-Burk plot enzyme inhibition, irreversible inhibition, reversible competitive and non competitive inhibition. Control of enzyme activity: feed back regulation, allosteric enzymes, reversible covalent modification and proteolytic activation.

**B. 371 COMPARATIVE MORPHOLOGY (1 cr. + 1 cr. Lab).**

Prerequisite: B 102 Offered in spring

Introduction: including the main characteristics and differentiation of divisions. Division 1: hepatophyta. Class1: hepatopsida, orders, marchantiales, metzeriales, jungermanniales. Class 2: anthocerotopsida, order, anthocerotales. Division 2: bryophyta: Class 1: sphagnopsida, order: sphagnales. Class 2: mnionopsida (true mosses), orders, funariales, eubryales, polytrichales. vascular plants: main organs, vascular elements and the evolution of vascular system, gametophytes of vascular plants, life eycle and fossilization. Division 3: rhyniophyta: order: rhyniales. Division 4: psilophyta: order: psilotaes. Division 5: microphyllophyta: Class 1: aglossopsida order 1: asteroxytales. Class 2: glossopsida, orders hepidodendrales, selaginellales, Isoetales, Division 6: Arthrophyta: Order: Equisetales, Division 7: Pterophyta: Class 1: eusporomgiopsida, orders cphioslossales, marattioles. Class 2: leptosporangiopsida orders filicales, marsiliales, gymnospermae: Division 1: cycadophyta. Class 1: pteridospermopsida. Class 2: cycode oidopsida, order: bennettitales. Class 3: cycadopsida, order: cycadales. Division 2: oinkgophyta: Class: oinkgophyceae order: oinkgoales. Division 3: coniferophyta: Class 1: cordaitopsida. Class 2: coniferopsida, order: Coniferales Class 3: taxodopsida. Division 4: onetophyta: Class: gnetopsida, orders ephedrales, gnetales, welwitschiales.

**B. 381 MOLECULAR BIOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: B 211 Offered in fall.

The chromosome, gene, nucleic acid molecules, DNA replication, RNA and protein synthesis. Regulation of gene expression. Repression. Induction, operon model of gene expression, DNA technology, gene manipulation, restriction enzymes, vectors, method of inserting foreign DNA into cells, DNA source. Gene libraries, complementary DNA, synthetic DNA, selecting clone, application of genetic engineering in medicine, agriculture, DNA fingerprint, PCR, safety issues, future of molecular biology.

**B. 382 RADIATION BIOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: B 211 & B 213 Offered in fall

Nature of radioactivity. Radioactivity, interaction of radioactivity with matter, scintillation counter, solid scintillation counter, liquid scintillation counter, quenching of liquid scintillation, application of radioisotopes in biological science metabolism analytical application: enzymatic studies, isotope dilution analysis (IDA), radioimmunoassay, radiodating, molecular biology, clinical diagnosis, sterilization of food and equipment, mutagen,

**B. 411 PLANT PATHOLOGY AND CONTROL (2 cr. + 1 cr. Lab).**

Prerequisites: B 213 & B 311 Offered in fall.

Characterization of the disease, classification, causal agents, diseases and their economic loss. Symptoms, methods of attack by the causative agents, environmental and physiological diseases, examples and life cycles and control of viral bacterial, algal ,nematodal, higher plants parasitizing plants, fungal diseases due to: myxomycetes, phycomycetes, ascomycetes, basidiomycetes, Methods of avoiding and controlling the disease, Biological control, Biology and biochemistry of pesticides, fungal diseases which attacks some plants, symptoms and methods of controlling diseases: diseases caused by ascomycetes: leaf curl diseases, powdery mildew disease of cereals, cucurbita ornamentals, legumes roses, and vitis, Black spot diseases of grasses, ergot disease of graminae, diseases caused by basidiomycetes, wheat rusts and rust of other plants, smuts wheat, barley, sorghum and corn. Diseases caused by deuteromycetes, early blight of tomato and potato diseases and damping of diseases.

**B. 412 FOOD MICROBIOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: B 312 Offered in fall

Food as substrate for microorganisms, factors affecting the growth a survival of microorganisms in foods, microbial growth, substrate limitation, environmental limitations, microorganisms important in food microbiology and industrial importance, contamination of foods, spoilage of food, factors affecting kinds & numbers and growth of microorganisms in food, chemical changes caused by microorganisms, food preservation, contamination, preservation and spoilage of different, kinds of foods, fermented foods, food in relation to diseases, bacterial agents of food born illness, methods for microbiological examination of food, controlling the microbiological quality of foods.

**B. 413 MICROBIAL TOXINS (2 cr. + 1 cr. Lab).**

Prerequisite: B 412 Offered in spring

Toxigenic microorganisms: molds, bacteria and others, natural occurrence of microbial toxins, structure and biosynthesis of microbial toxins, implications of microbial toxins in animal and plant diseases: biochemical and biological effects, mutagenecity neurotoxcity, control of microbial toxins, prevention, degradation and detoxification.

**B. 414 RESISTANCE AND IMMUNITY (2 cr. + 1 cr. Lab).**

Prerequisites: B 211 & B 311 Offered in spring

Means of pathogen transmission, entry of pathogen, types of diseases, toxins (exo- and endotoxins), types of protection against infection: non susceptibility, natural resistance, general, physical, chemical and biological barrier. Immunity: innate, acquired, characteristic of immune system, properties of antigens, properties of antibodies, classes of immunoglobulins, cells of tissues of immune system, properties and factors modifying immune responses, immunological disorders, hypersensitivity or allergy, auto immune disorders, immunodeficiency diseases.

**B. 415 MEDICAL MICROBIOLOGY (2 cr. + 1 cr. Lab).**

Prerequisites: B 213 & B 311 Offered in spring

Classification of medically important pathogens, normal flora, pathogenesis, laboratory diagnosis, antimicrobial drugs: mechanism of action, resistance, vaccination. Clinical bacteriology, overview of the major pathogens and infecting different stems, bacterial pathogens introduction to anaerobic bacteria, Gram+ ve Cocci & Rods, Gram- ve Cocci & Rods, mycobacteria, mycoplasmas, chlamydiae & richettsiae. Classification of medically important viruses: pathogenesis, host defense, laboratory diagnosis, DNA & RNA enveloped viruses, DNA & RNA nonenveloped viruses, examples. hepatitis, tumor viruses, AIDS, Overview of the major mycological diseases: cutaneous &

subcutaneous mycoses, systemic mycosis, opportunistic mycosis, parasitology, intestinal & urogenital protozoa.

**B. 416 BIOLOGICAL CONTROL (2 cr. + 1 cr. Lab).**

Prerequisite: B 411 Offered in spring

What is biological control, managing of biological balance, factors involved in biological control, role of the pathogen, the antagonist , the host and the physical environments in biological control, mechanisms of biological control, colonization and inoculum, competition, antibiotics and endolysis, hypoparasitism and exolysis, fungistatis and bacteriostatis, host defense mechanism, agricultural cropping systems.

**B. 417 HYDROBIOLOGY (2 cr. + 1 cr. Lab).**

Prerequisites: B 210 & B 313 Offered in spring

Introduction, aquatic and organic pollution, eutrophication, acidification, heavy metals and organochlorines, thermal and radioactive, oil pollution,

**B. 421 VEGETATION SCIENCE (1 cr. + 1 cr. Lab).**

Prerequisites: B 222 & B 321 Offered in fall

The nature of quantitative plant ecology and vegetation science, plant community concepts and attributes, methods of sampling and analysis of plant communities, distribution models and diversity indices of species abundance relations.

**B. 422 CONSERVATION AND DIVERSITY OF PLANTS (1 cr. + 1 cr. Lab).**

Prerequisite: B 222 Offered in spring

The ecological basis of conservation theory, types on site and off site conservation, conservation and sustainable development in arid lands, concepts and measurement of plant diversity, conservation of species, population, community and ecosystem levels, importance and value of plant diversity, human impact and threats to plant diversity.

**B. 431 FLORA (1 cr. + 1 cr. Lab).**

Prerequisite: B 222 Offered in spring

The natural vegetation: historical background- current studies, phytogeographical affinities and territories, vegetation types in the different phytogeographical territories, floristic features of the vegetation types with special reference to examples of the sites visited during field trips. The cultivated plants: egypt as a reputed country for its agriculture since the predynastic time (+ 6000 years BP), ornamental plants of parks and gardens as well as street trees, crop plants: vegetables and fruits, medicinal plants of drug bazars in old Cairo.

**B. 441 PHYSIOLOGICAL STRESSES (2 cr. + 1 cr. Lab).**

Prerequisite: B 341 Offered in fall

Different types of stresses, water stress, water potential and its contributors, proline accumulation: physiological aspects, response, distribution and accumulation, control of accumulation by water potential, proline loss with relief of water deficit, consequence of proline accumulation function of proline, osmoregulation, sink for soluble nitrogen, proline accumulation and stress resistance, proline metabolism: biosynthesis and oxidation, salinity stress. Temperature stress, heat stress, chilling stress.

**B. 442 PLANT PIGMENTS AND PHOTOSYNTHESIS (2 cr. + 1 cr. Lab).**

Prerequisite: B 342 Offered in fall

Pigment of photosynthesis, chlorophylls (types & distribution), biosynthesis, phycobiliproteins (chemistry & biosynthesis), photosynthetic apparatus, structure of chloroplast (ultrastructure), formation of chloroplast, mechanism of photosynthesis light and dark reaction, (evidence in support light and dark), oxidation reduction in photosynthesis, electron transport and photophosphorylation, dark reactions C3 plants, C4 plants, CAM plants, factors affecting the process of photosynthesis. photosynthesis in bacteria photorespiration, general aspects, mechanism of photorespiration.

**B. 443 PLANT HORMONES/PLANT CELL AND TISSUE CULTURE (2 cr. + 1 cr. Lab).**

Prerequisite: B 381 or B 483 Offered in spring

Plant hormones: historical introduction, transport, biosynthesis, inactivation, mode of action and physiological effects of auxins, gibberellins, cytokinins, abscisic acid and ethylene, other hormone, like compounds in plants. Growth inhibitors, applications of synthetic growth regulators in agriculture and horticulture. Plant cell and tissue culture: historical introduction, tissue nutrition and growth hormones, tissue (callus cultures) and cell suspension cultures, meristem and shoot tip cultures, organogenesis, embryogenesis and the influence of hormone, haploid cultures (pollen grains and anthers), isolation and regeneration of plant protoplasts, fusion of protoplosts for somatic hybridization, transformation of cells and genetic engineering, cryopreservation of germplasms, production of secondary metabolites.

**B. 481 BIOTECHNOLOGY (2 cr. + 1 cr. Lab).**

Prerequisites: B 314 & B 381 Offered in fall

Introduction, strain development, fermentation media, fermentation systems, product recovery, wastes and by-products, product quality and safety, microbial enzymes, fuels and industrial chemicals (amino acids, organic acids, solvents), health care products (antibiotics, vaccines, steroids, insulin, interferon, and collagen), food and beverage fermentations, food additives and supplements, microbial biomass production, single cell protein, biomining, bio- insecticides, herbicides and fungicides.

**B. 483 MOLECULAR BIOLOGY (1 cr. + 1 cr. Lab).**

Prerequisite: B 210 Offered in fall

The chromosome, the gene, nucleic acid (chemical structure), DNA replication, RNA and protein synthesis: transcription, translocation, genetic code, regulation of gene expression, repression & induction, DNA-technology: recombinant DNA procedures, biotechnology tools and techniques, restriction enzymes, vectors, methods of inserting foreign DNA into cells, source of DNA, gene libraries, complementary DNA, synthetic DNA, selecting clone, print polymerase chain reaction (PCR).

**B. 484 APPLICATION OF MOLECULAR BIOLOGY ( 1 cr. + 1 cr. Lab).**

Prerequisite: B 483 Offered in spring

The organization and expression of plant genes, techniques and vectors for plant transformation, genetic manipulation of herbicides and pests resistance, strategies for engineering stress tolerance, improvement of crop yield and quality.

**B. 491 METABOLISM AND SECONDARY PRODUCTS (1 cr. + 1 cr. Lab).**

Prerequisite: B 342 Offered in spring

Metabolism and energy production, mitochondria, respiratory chain, oxidative phosphorylation, Factors affecting respiration, overview of secondary metabolism, branch point enzymes, major classes of secondary products: phenolic metabolites, polyketides, isoprenoids, nitrogen containing secondary metabolites, Functions of secondary metabolites.

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# ZOOLOGY

## First: Academic Programs Offered by Zoology Department

**The Department offers courses for students of the following groups:**

1- Chemistry/Zoology (Chem/Z).
2- Biophysics (Biophys).
3- Chemistry/Biochemistry (Chem/Biochem).
4- Geology (G).

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 1 | 1st | Bio. 101 | Introductory Zoology (1) | - | Biophys, G | - | 2/3 | 1 | - | 1 | |
| | | Z. 101 | Basic Zoology (1) | - | Chem/Z Chem/Biochem | B, E | 2 | 3 | - | 3 | |
| | 2nd | Bio. 102 | Introductory Zoology (2) | Bio.101 | Biophys, G | - | 2/3 | 1 | - | 1 | |
| | | Z. 102 | Basic Zoology (2) | Z.101 | Chem/Z Chem/Biochem | B, E | 2 | 3 | - | 3 | |
| 2 | 3rd | Z.211 | Cell Biology (1) | Z.102 | Chem/Biochem Chem/Z | - | 2 | 2 | - | 3 | 9 cr. compuls for chem/Z |
| | | Z.261 | Basic Ecology | | Chem/Z | - | 2 | 3 | - | 3 | |
| | | Z.221 | Invertebrate Zoology | | | - | 2 | 2 | - | 3 | |
| | | Z.213 | Cytology & Genetics | Bio.101 | Biophys | - | 2 | 3 | - | 3 | |
| | | Z.201 | Invertebrates & Vertebrates | Bio.102 | G | - | 2 | 3 | - | 3 | |
| | 4th | Z.212 | Genetics | Z.102 | Chem/Biochem Chem/Z | - | 2 | 2 | - | 3 | 6 cr. compuls + 3 cr. elective for chem/Z |
| | | Z.231 | Vertebrates | | Chem/Z | - | 2 | 2 | - | 3 | |
| | | Z.202 | Immunology & Molecular Biology | Bio. 101 | Biophys | - | 2 | 3 | - | 3 | |
| | | B.210 | General Microbiology | - | - | Chem/Z | 2 | 2 | - | 3 | |
| | | G 222 | Biostratography | Z.102 | - | | 2 | 2 | - | 3 | |
| | | Met.218 | Basic Meteorology | - | - | | 2 | 2 | - | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 3 | 5th | Z.311 | Cell Biology (2) | Z.211 | Chem/Z | - | 2 | - | - | 2 | 9 cr. compuls. for chem/Z |
| | | Z.331 | Comparative Anatomy | Z.231 | | - | 2 | 2 | - | 3 | |
| | | Z.351 | Physiology (1) | Z.211 | | - | 3 | 3 | - | 4 | |
| | | Z.353 | Human Physiology | Bio.101 | Biophys | - | 2 | 3 | - | 3 | |
| | 6th | Z.321 | Protozoology & Parasitology | Z.221 | Chem/Z | - | 2 | - | - | 3 | 8 cr. compuls. + 1 cr. electivefor chem/Z |
| | | Z.341 | Immunology (1) | Z.311 | | - | 2 | - | - | 3 | |
| | | Z.352 | Physiology (2) | Z.351 | | - | 2 | - | - | 2 | |
| | | Z.322 | Invertebrate Zoology (2) | Z.221 | - | Chem/Z | 1 | - | - | 1 | |
| | | Z.361 | Desert Ecology | Z.261 | - | | 1 | - | - | 1 | |
| | | Z.362 | Environmental Pollution | - | - | | 1 | - | - | 1 | |
| 4 | 7th | Z.400 | Seminar | - | Chem/Z | - | 1 | - | - | 1 | 9-10 cr. compuls |
| | | Z.411 | Molecular Biology | Z.311 | | - | 2 | 2 | - | 3 | |
| | | Z.431 | Embryology | Z.331 | | - | 2 | 2 | - | 3 | |
| | | Z.451 | Physiology (3) | Z.351 | | - | 2 | 3 | - | 3 | |
| | 8th | Z.400 | Seminar | - | Chem/Z | - | 1 | - | - | 1 | 6 – 7 cr. compuls., 2 cr. elective. |
| | | Z.412 | Histochemistry | Z.311 | | - | 1 | 3 | - | 2 | |
| | | Z.452 | Physiology (4) | Z.352 | | - | 2 | 4 | - | 4 | |
| | | Z.432 | Developmental Biology | Z.431 | - | Chem/Z | 2 | - | - | 2 | |
| | | Z.441 | Immunology (2) | Z.341 | - | | 2 | - | - | 2 | |
| | | Z.456 | Toxicology | Z.352, Z.451 | - | | 2 | - | - | 2 | |
| | | Z.457 | Biological Analysis | | - | | 2 | - | - | 2 | |
| | | Z.461 | Aquatic Ecology | Z.261 | - | | 2 | - | - | 2 | |
| | | Z.462 | Animal Behavior | | - | | 2 | - | - | 2 | |
| | | Z.481 | Biotechnology | Z.411 | - | | 2 | - | - | 2 | |
| | | Stat. 422 | Biostatistics for biologists | - | - | | 1 | 2 | 1 | 2 | |

# Second: Courses Offered by Zoology Department

**Bio. 101 INTRODUCTORY ZOOLOGY (1) (2/3 cr. + 1/3 cr. Lab)**

Offered in fall.

**Animal Physiology:** nutrients (carbohydrates, proteins, lipids and vitamins), digestive system and digestion, metabolism (catabolism and anabolism), circulatory system (the heart, blood vessels, blood and immunity), respiratory system, excretory system, nervous and muscular systems, endocrine system and reproduction. **Cytology, Histology & Embryology:** the cell (components and ultrastructure), cell division (mitosis and meiosis), different body tissues (epithelial, connective, muscular and nervous), early embryonic stages of amphioxus,

**Practical: Anatomy (Bufo regularis):** external features and buccopharyngeal cavity, general viscera and urinogenital system, heart and circulatory system (venous system proper, venous portal system and arterial system), skeletal system (skull, vertebral column & limbs). **Histology:** examples of connective tissues (areolar C.T., hyaline cartilage, T.S. in bone, blood film of man & toad), examples of muscular tissues (skeletal, cardiac & smooth), V.S. in mammalian skin, T.S. in the digestive system of mammals (oesophagus, stomach & intestine, section in liver of pig), section in endocrine glands (thyroid & pancreas), T.S. in spinal cord and sciatic nerve, T.S. in gonads (ovary & testis), T.S. in kidney of toad, T.S. in trachea of rabbit.

**Bio. 102 INTRODUCTORY ZOOLOGY (2) (2/3 cr. + 1/3 cr. Lab)**

Prerequisite: Bio 101. Offered in spring.

**Invertebrate Zoology:** basis of animal kingdom classification, general characters, classification and examples of: protozoa (e.g. Amoeba, Paramecium, Trypanosoma and Plasmodium), sponges, coelenterates(e.g. Hydra), platyhelminthes (e.g. Schistosoma, Taenia and Fasciola), aschelminthes (e.g. Ascaris, Ankylostoma and Enterobius), annelids (e.g. Allolobophora), arthropods, insects, molluscs, echinoderms.

**Vertebrate Zoology:** general chararcters of chordates, classification of phylum chordata, internal systems of amphioxus (digestive, nervous, muscular and reproductive), general characters of vertebrates, external features and different systems of: cartilaginous fishes (e.g. Dogfish), bony fishes (e.g. Tilapia), general characters and internal systems of amphibians and pentadactyl limb structure of tetrapods, general characters of reptiles (e.g. Chalcides), general characters of birds (e.g. Columba), general characters of mammals (e.g. rabbit).

**Practical: Classification of animal kingdom:** examples of protozoa, hydra, fasciola, schistosoma, taenia, ascaris, allolobophora (T.S.), external features of cockroach, cimex, pulex and pediculus (male & female) amphioxus, dogfish, tilapia, section in skin of lizard, pigeon, rabbit.

**Z. 101 BASIC ZOOLOGY (1) (2 cr. + 1cr. Lab).**

Offered in fall.

**Invertebrates: i**ntroduction to the history and basis of animal kingdom classification with special reference to the scientific binomial nomenclature of living organisms, demonstration of the main phyla of the animal kingdom, their main characteristics, some examples from Protozoa to Echinodermata.

**Vertebrates: Phylum Chordata:** introduction, general characters, classification. Urochordates, & vertebrates, agnatha, chordrichthyes, osteichthyes & amphibia. Reptilia, Aves & Mammalia. **Evolution**: introduction, evidences of evolution, darwinism & neo-darwinism.

**Cell Biology & Embryology:** cellular organization, cell structure, cell division and the cell cycle, principles of inheritance, embryogenesis of chordates, embryonic development.

**Practical: Invertebrates:** identification, diagrammatic representation, general systematic position of the main examples of invertebrate animals.

**Z. 102 BASIC ZOOLOGY (2) (2 cr. + 1cr. Lab).**

Prerequisite: Z 101. Offered in spring.

**Physiology:** digestive system, respiratory system, circulatory system, immune system, excretory system, muscular system, nervous system, endocrine system, adaptation.

**Histology:** epithelial tissues, connective tissues, muscular tissues, nervous tissues.

**Practical: Anatomy (Bufo regularis):** external features and buccopharyngeal cavity, general viscera and urinogenital system, heart and circulatory system (venous system proper, venous portal system and arterial system). Nervous system, skeletal system (skull, vertebral column & limbs). **HISTOLOGY:** microscopic sections of connective tissues, microscopic sections of muscular tissues, microscopic sections of nervous tissues, microscopic sections in various mammalian and non-mammalian organs.

**Z. 201 INVERTEBRATES & VERTEBRATES (2 cr. + 3cr. Lab).**

Prerequisite: Bio. 102. Offered in fall.

**Protozoa:** general characters, classification and description of groups with skeletal structures and could be found as fossils: phylum sarcomastigophora, Rhizopods including classes Lobosea, Filosea, Granuloreticulosea, Radiolarians including classes Acantharea, Polycystinea and Phaeodorea.

**Metazoa:** general characters and classification of each phylum and class mentioned below: phylum porifera, identification and skeletal structures of sponges, phylum cnidaria. Coelentrates represented in fossil records. Class Anthozoa (Subclasses; Alcyonaria and Zoantharia), phylum arthropoda structure of exoskeleton, moulting and external features of representatives from each major group. Class Crustacea (*Penaeus, Neptunus, Eupagurus, Daphnia, Artemia, Cyclop*). Class Insecta (*Periplaneta, Cimex,Pediculus, Pulex*). Class Myriapoda (*Scolopendra, Julus*). Class Arachnida (*Leiurus, Lycosa, Argas*). phylum mollusca, structure of shells and soft parts of *Chiton, Anodonta, Eremina, Sepia,* phylum echinodermata, structure of the exoskeleton and endoskeleton, and regeneration phenomenon (*Astropecten, Ophiocoma, Echinometra, Holothuria, Heterometra, Antedon*).

**Practical:** *Euglena,* foraminifer tests, *Ascetta,* calcareous spicules, spongin fibres, *Hydra, Obelia* (part of colony and medusa), *Alcyonium* (polyp, T.S. through and below stomodaeum), *Xenia* (polyp, colony T.S.), stony corals. *Penaeus japonicus,* (external features and appendages), *Neptunus, Procambarus, Eupagurus ,Daphnia, Artemia, Cyclop. Scolopendra* (whole, mouth parts, isolated abdominal segment), *Julus* (whole, isolated abdominal segment), *Leiurus, Lycosa. Periplaneta* (mouth parts), *Cimex, Pediculus, Pulex*. *Chiton* (dorsal, ventral and T.S.), *Anodonta* (soft parts, shell), *Eremina* (whole, shell), *Sepia, Loligo, Octopus. Astropecten, Linckia, Ophiocoma, Echinometra, Tripneustes, Clypeaster, Lovenia, Holothuria, Heterometra, Antedon.*

**Vertebrates:** Study of chordates (vertebrates), their characteristics, classification into different classes and orders giving examples. Study of the origin and the extinction (fauna) of vertebrates in the different geological times, concentrating on subjects which are necessary for geology students such as: the effect of instability of the climate on the vertebrates, the transfer from aquatic life to terrestrial life, the first land vertebrate, the pentadactyl limb skeleton and its modifications in the different classes, the evolution of reptilian skull, dinosaurs, and other subjects that help the geology students in the field of paleontology.

**Practical:** examples of the animals that belong to different vertebrate classes with special emphasis on the skeletal system (exoskeleton & endoskeleton).

**Z. 202 Immunology & Molecular Biology (2 cr. + 1cr. Lab).**

Prerequisite: Bio.101. Offered in spring.

**Basic Immunology:** eosinophils, basophils, neutrophils, monocytes and macrophages: structure, function and hemopoiesis, the t-lymphocyte: structure and function of the thymus, the b-lymphocyte: structure and function of the bursa of fabricius and the bone marrow, secondary lymphoid organs, structure and function of the spleen, lymph nodes, GALT and BALT, basic structure of the immunoglobulin (Ig), IgM, IgA, IgD, IgE and IgG subclasses: structure and function, the major histocompatibility complex (MHC)-encoded antigens class 1 and class 2: structure and function, the T cell receptor for antigen: structure and function, the complement system, phagocytosis, immunization, definition and types of antigens; antigen presentation, activation of T helper lymphocytes, activation of B cells, production and role of cytokines, cell mediated immunity, production of antibodies, $1^{ry}$ and $2^{ry}$ immunization, memory response.

**Practical:** anatomy of thymus, spleen, lymph nodes and GALT in mice, bleed mice, prepare serum and make a lymph node suspension, count lymphocytes after staining with trypan blue, make a spleen cell suspension:lyse blood cells by hypotonic shock, wash and count lymphocytes, preparation of blood smear to study morphology of blood cells, histology of thymus, spleen, lymph nodes, GALT and blood of human, separate mononuclear cells from peripheral blood by gradient centrifugation. Count cells in buffy coat, preparation of sheep RBCs, immunization of mice by different routes, bleeding of mice, preparation and heat-inactivation of mouse serum, preparation of serum dilutions, agglutination of sheep RBCs in tubes and in microtiter plates, preparation of rabbit complement, hemolysis of sheep RBCs with mouse anti-sheep RBCs serum, agglutination: blood groups (ABO system). Immunodiffusion; and/or immunofluorescence, ELISA, proliferation assay, skin graft rejection. Revision.

**Molecular Biology:** DNA replication/organization, control of DNA replication, genome structure, gene regulation in prokaryotes and eukaryotes, the role of RNA in coding and transferring the genetic information, RNA processing, DNA cloning essentials, restriction enzymes, cloning vectors, construction of genomic and cDNA libraries.

**Practical:** How to use correct procedures to store, handle, and dispose of biological, chemical radioactive, sharps and glass materials/waste, select sterilization procedures. Preparation and properties of media and reagents used in molecular biology. Preparation of standard operating procedure for each technique. Isolation of genomic DNA, plasmid DNA, restriction endonuclease digestion of plasmid and gemonic DNA, isolation of RNA, selection of poly (A) RNA by different methods, introduction to PCR.

**Z. 211 CELL BIOLOGY (1) (2 cr. + 1 cr. Lab).**

Prerequisite: Z 102. Offered in fall.

Introduction to the course, emergence of modern cell biology, cell chemistry: the importance of synthesis by polymerization: self-assembly and molecular chaperones, proteins: amino acids, peptide bond, levels of protein structure: folding, modifications and degradation of proteins, proteins: functional design: antibodies, enzymes, prosthetic groups, regulatory mechanisms of protein function. Nucleic acids: nucleotides: DNA structure, denaturation and renaturation: circular DNA. Nucleic acids: RNA and varied conformations: roles of RNA in protein synthesis, protein synthesis: ribosomes, their structure in prokaryotes and eukaryotes: stepwise formation of proteins, carbohydrates: monosaccharides, disaccharides and polysaccharides, carbohydrate-containing macromolecules. Lipids: properties, structure and classification, cell membranes: historical review of models, fluid mosaic model, membrane lipids, fluidity of membrane lipids, factors affecting it and regulation, cell membranes: membrane proteins, types, mobility, membrane carbohydrates: membrane assymetry, transport across cell membranes: categories of transport (cellular, intracellular and transcellular), mechanisms of membrane transport, passive, facilitated, transport proteins, active transport, energy production in the cell: glycolysis, energy production and the mitochondrion: structure of the mitochondrion, aerobic respiration and localization of respiratory functions on the mitochondrion. TCA cycle, electron transport, oxidative phosphorylation, electrochemical proton gradient, intracellular compartments: endoplasmic reticulum, types and structure, role of SER in hydroxylation, detoxification, lipid synthesis, glycogen catabolism, ion transport, golgi complex: structure, polarity, associated vesicles, combined role with ER in glycozylation of proteins, Golgi complex: role in protein sorting, secretory pathways; exocytosis and endocytosis, coated vesicles, lysosomes and cellular digestion: intracellular digestion, extracellular digestion, lysosomal storage diseases, Peroxisomes: occurrence, biogenesis, role in oxidation reactions. Nucleus: nuclear envelope, nuclear pore complex, transport across nuclear envelope and import of proteins into the nucleus, nuclear matrix, nucleolus and nucleolar organizer region. Cytoskeleton: structure and functions of microfilaments, intermediate filaments and microtubules.

**Practical: Microscopy:** use of light microscope, types of microscopy, magnification, resolution, **Electron microscope:** visit to EM unit, comparison with light microscope, TEM & SEM, **Prokaryotic & eukaryotic cell structure:** electron micrographs, prokaryotic & eukaryotic cells in buccal smear,

measurement of cells (use of micrometers), **Cell membranes:** preparation of ghost cells, techniques in studying cell membranes (lipid chromatography, SDS-gel electrophoresis, freeze-fracture), electron micrographs of cell membranes, glycocalyx, **Internal membrane system:** differential centrifugation and isolation of cell organelles, slides and electron micrographs of rough and smooth endoplasmic reticulum, **Golgi complex:** slides and electron micrographs, autoradiography, **Mitochondria:** slides and micrographs, **Lysosomes and peroxisomes:** slides and micrographs, **Nuclei:** slides and electron micrographs, cell division, mitosis & meiosis, **Cytoskeleton:** methods of studuing cytoskeleton (immunofluorescence, quick-freeze deep-etching), electron micrographs of microvilli, cilia & flagella, centrioles & basal bodies.

**Z. 212 GENETICS (2 cr. + 1 cr. Lab).**

Prerequisite: Z102. Offered in spring.

**The molecular structure of prokaryotic and eukaryotic chromosomes**, packaging of prokaryotic chromosomes, packaging of eukaryotic chromosomes, specialized sequences in eukaryotic chromosomes (centromeres and telomeres). **Mechanism of DNA replication**, prokaryotic origins of replication, eukaryotic origins of replication, priming DNA synthesis, leading strand and lagging strand, replication at chromosome tips (telomeres), helicases and topoisomerases. **Molecular biology of gene function.** Transcription and mRNA synthesis, transcription and RNA polymerase, Initiation, elongation, termination. **Transcription in eukaryotes**, RNA processing mechanism, mechanisms of gene splicing. **Regulation of gene transcription**, the operator and the operon, characterization of the lac repressor and the lac operator, gene regulation in eukaryotes corepromotor and promotor- proximal elements, enhancers. **Genetic material and cell cycle**, cell cycle in prokaryotes, cell cycle in eukaryotes, DNA replication and cell cycle. **Extrachromosomal genetic material**, mitochondrial DNA, expression of mitochondrial genes, chloroplast DNA, expression of chloroplast genes. **Mechanism of gene mutation,** molecular basis of gene mutations, spontaneous mutations, induced mutations. **Chromosome Mutation,** changes in chromosome structure, deletions, duplications, inversions, translocations. **Changes in chromosome number**, aberrant euploidy, aneuploidy. **Biological repair mechanisms**, prevention of errors before happen, direct reversal of damage, excision - repair pathways. **Postreplication repair**, mismatch repair, repair defects and human diseases, xeroderma pigmentosum (XP), hereditary non-polyposis colorectal cancer (HNPCC).

**Practical:** preparation of chromosomes from bone marrow cells of mice, staining of prepared chromosomes, photographing, ordering and karyotype analysis, Karyotype preparation of rat, preparation of human karyotype, variation in chromosome number, variation in chromosome structure, identification of human mitotic chromosomes using G-banding technique, sex determination, preparation of giant (polytene) chromosomes of drosophila, population genetics (genetic equilibrium), disruption of genetic equilibrium,

**Z. 213 CYTOLOGY & GENETICS (2 cr. + 1cr. Lab).**

Prerequisite: Bio.101. Offered in spring.

**Cytology : introduction:** discovery of the cell, cell theory, relationship between cytology and other branches of biology. **Protoplasmic Components: Plasma membrane:** ultrastructure, functions, transport through the plasma membrane. **Endoplasmic reticulum:** types, functions, relationship between endoplasmic reticulum, plasma membrane and nuclear membrane. **Ribosomes:** ultrastructure, functions. **Golgi apparatus:** ultrastructure, types, functions. **Lysosomes:** ultrastructure, types, functions. **Mitochondria:** ultrastructure, origin, functions. **Centrioles:** ultrastructure, functions. **Microtubules and Microfilaments:** ultrastructure, functions. **Nucleus:** shape, size, number, localization, ultrastructure, types of cell division. **Chemical composition and properties of the protoplasm: Organic components:** carbohydrates, lipids, proteins, nucleic acids. **Inorganic components:** water, salts, gases. **Physical properties.**

**Genetics:** brief account on the general structure of the genetic material, organization of the genetic material in viruses, bacteria and eukaryotic organisms, general structure of prokaryotic and eukaryotic genes, extra chromosome genetic material (mitochondrial and chloroplast genomes),

different structural and numerical chromosomal abnormalities with detailed description of the involved mechanisms, brief account on mutations as part of changes in the genetic material.

**Practical: Plasma membrane:** (Several models). **Nissl bodies** in nerve cells (LM). **Golgi apparatus:** ultrastructure, developmental stages in nerve cells (LM). **Mitochondria:** ultrastructure, localization in different tissues (Ultrastructure), pathological features (Ultrastructure). **Centrioles and Cilia** (Ultrastructure). **Microtubules and Microfilaments** (Structure). **Nucleus:** LM, ultrastructure, barr body (sex chromatin) in nerve and epithelial cells (micrographs). **Cell Division:** mitosis (LM), meiosis (LM). **Organic components** (LM). **Carbohydrates:** general carbohydrates (PAS), glycogen (Best carmine), Acid and neutral mucopolysaccharides (Alcian blue + PAS). **Proteins** (Bromophenol blue). **Nucleic Acids** DNA (Feulgen), RNA+DNA (Methyl green – pyronine).

**Z. 221 INVERTEBRATE ZOOLOGY (2 cr. + 1cr. Lab).**

Prerequisite: Z102. Offered in fall.

**Phylum Annelida:** main characteristics* class polychaeta *Nereis, aphrodite, arenicola, sabella, spirorbis,* class oligochaeta *Allolobophora#, pheretima,* class hirudinoidea (Hirudinida) *Hirudo.* **Phylum Arthropoda:** main characteristics* subphylum trilobitomorpha (Trilobita), subphylum chelicerata, class merostomata, class arachnida: order scorpiones *Leiurus,* order araneae *Lycorma,* order pseudoscorpiones *Chelifer,* order solpugida *Galeodes,* the acari, order parasitiformes *Dermacentor, ixodes, argas,* order acariformes *Sarcoptes,* class pycnogonida pycnogonum, nymphon, subphylum crustacea: class branchiopoda, order anostraca *Artemia,* order notostraca *Triops,* order cladocera *Daphnia,* class maxillopoda, subclass ostracoda *Cypris,* subclass copepoda *Cyclops, centropages, calanus,* class malacostraca, subclass phyllocarida *Nebalia,* subclass eumalacostraca, superorder peracarida, order Isopoda *Ligia, porcellio,* order amphipoda *Gammarus*, superorder eucarida, order decapoda, suborder dendrobranchiata, infraorder penaeidea *Penaeus#*, suborder pleocyemata, infraorder astacidea *Procambarus, astacus.* Infraorder palinura *Palinurus,* Infraorder anomura hermit crabs, infraorder brachyura *Portunus, ocypode.* Subphylum Uniramia: the myriapods, class chilopoda *Scolopendra,* class diplopoda *Iulus,* class hexapoda (Insecta). **Phylum Mollusca:** main characteristics** subphylum placophora, class polyplacophora *acanthopleura,* Subphylum Conchifera, Class Gastropoda, Torsion & detorsion, Subclass Prosobranchia, Order Diotocardia *Tectus, Nerita,* Order Caenogastropoda *Bellamya, Pirenella, Strombus, Cypraea, Murex, Conus, Terebra.* Subclass Opisthobranchia *Aplysia, Hexabranchus,* Subclass Pulmonata *Lymnaea, Bulinus, Biomphalaria, Eremina#,* Class Pelecypoda (Bivalvia) *Anadara, Lithophaga, Mytilus,Pinctada, Spathopsis, Mutela, Coelatura, Pholas, Teredo,* Class Cephalopoda (Siphonopoda) *Sepia, Loligo, Octopus.* **Phylum Echinodermata:** Main characteristics***Subphylum Eleutherozoa, Class Asteroidea *Astropecten, Linckia,* Class Ophiuroidea, *Ophiocoma*, *Gorgonocephalus,* Class Echinoidea, *Tripneustes, Heterocentrotus, Clypeaster, Lovenia,* Class Holothuroidea, *Holothuria, Synapta,* Subphylum Pelmatozoa, Class Crinoidea, *Heterometra, Antedon.*

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* These include the body & its divisions, body wall, coelom, digestive system, respiration, circulatory system, excretory organs, nervous system & sense organs, reproduction, development, classification in phyla Annelida & Arthropoda and their classes studied in the course.

** These include the shell, head, foot, mantle, visceral hump, digestive system & feeding, respiratory organs, circulatory system, excretory organs, nervous system & sense organs, reproduction, development, classification in phylum Mollusca &its classes studied in the course.

*** These include the body wall & coelom, water vascular system, digestive system, respiratory organs & circulation, excretion, nervous system, reproduction, development in phylum Echinodermata & its classes studied in the course.

#These animals will be dissected

**Practical: Phylum Annelida:** Class I. Oligochaeta: *Allolobophora* (whole, T.S.), *Pheretima* (whole, T.S.), Class II. Polychaeta, *Nereis* (whole, T.S.), Heteronereis (modified parapodium), Class III. Hirudinea, *Hirudo* (whole, T.S.). **Phylum Arthropoda:** Subphylum: Mandibulata, Class: Crustacea, Sub-class: Malacostraca, Order: Decapoda, Sub-order: Natantia, Section: Penaeidea. **Ex.** *Penaeus japonicus*, (appendages, gills & epipodite, dissection, Nervous system). Sub-order: Reptantia,

Section: Macrura, **Ex.** *Astacus & Procambarus,* Section: Brachyura, **Ex.** *Portunus (Neptunus) pelagicus,* Section: Anomura, **Ex.** *Eupagurus,* L.S. of compound eye of *Penaeus japonicus,* larvae of crustacea: zoaea of *penaeus*, zoaea of crab.mysis larva & Nauplius larva, Sub-class: Branchiopoda, Order: Diplostraca, Sub-order: Cladocera, **Ex.** *Daphnia,* Order: Anostraca, **Ex.** *Artemia,* Sub-class: Copepoda, **Ex.** *Cyclops,* Myriapodous arthropods, Class: Chilopoda (Centipeds), **Ex.** *Scolopendra,* Class: Diplopoda (Millipeds), **Ex.** *Julus (Iulus),* Sub-phylum: Chelicerata, Class: Arachnida, Order: Scorpionida, **Ex.** *Leiurus (Buthus),* Order: Araneae, **Ex.** *Lycosa,* Order: Acarina, **Ex.** *Argas,* Order: Solpugida, **Ex.** *Galeodes,* **Phylum Mollusca:** Class: Polyplacophora, **Ex.** *Acanthopleura* (Chiton), Class: Bivalvia (Pelecypoda), Sub-Class : Lamellibranchia, Order: Schizodonta, **Ex.** *Anodonta & Unio (shell, T.S. of animal & T.S. of gill plate),* Order Anisomyaria, **Ex.** *Mytillus,* Class: Gastropoda, Sub-class: Pulmonata, Order: Stylommatophora, **Ex.** *Eremina,* Order: Basommatophora, **Ex.** *Lanistes,* Class: Cephalopoda, Sub-class: Dibranchia, Order: Decapoda, **Ex.** *Sepia & Loligo,* Order: Octopoda, **Ex.** *Octopus* **Phylum Echinodermata:** Sub-phylum: Eteutherozoa, Class: Asteroidea, **Ex.** *Astropecten* (Star fish), *Linckia* (Regeneration), Class: Ophiuroidea, **Ex.** Ophicoma (Brittle Star-fish), Class: Echinoidea, **Ex.** *Tripneustes & Echinometra,* Class: Holothuridea, **Ex.** *Holothuria* (Sea-cucumber), Sub-phylum: Pelmatozoa, Class: Crinoidea, **Ex.** *Antedon & Heterometra,* Revision.

**Z. 231 VERTEBRATES (2 cr. + 1 cr. Lab).**

Prerequisite: Z102. Offered in spring.

Introduction, General characteristics of phylum chordata, classification of phylum chordata, **Protochordata:** Class (1): cephalochordata e.g. *Amphioxus* (external features, digestive system, vascular system, nervous system, excretory system, reproductive system, skeletal and muscular systems). Class (2): urochordata e.g. *Ascidia*, **Vertebrata:** general characteristics. Group (I) agnatha. Class: cyclostomata, e.g. *Petromyzon* (external features, digestive, respiratory, vascular, nervous, urinogenital systems). Group (II) Gnathostomata. **Superclass: Pisces:** class (I): chondrichthyes e.g. *Scyllium* (dogfish). General characteristics of chondrichthyes, (external features of dogfish, skeletal, digestive, vascular, respiratory, unrinogenital and nervous systems). Class (2): osteichthyes e.g *Tilapia* (Bolti), general characters of osteichthyes, external features of *Tilapia, d*igestive, vascular, respiratory, urinogenital and nervous systems), classification of osteichthyes, **Superclass: Tetrapoda,** affinities between fishes and amphibia, typical structure of pentadactyl limb in tetrapoda. Class (I): **Amphibia,** modification of the pentadactyl limb in Amphibia, heart and associated blood vessels in amphibia (*Bufo*), sense organs of Amphibia, Class(2): **Reptilia,** general characteristics of Reptilia, e.g. skink (lizard), (external features of lizard, digestive, circulatory, respiratory, urinogenital, nervous systems), classification of reptiles. Class (3)**: Aves (Birds),** general characteristics, e.g. pigeon (*Columba livia*), (external features, digestive, respiratory, circulatory, urinogenital, skeletal and nervous systems), classification of birds. Class (4)**: Mammalia** e.g. Oryctolagus (rabbit), general characteristics, external features of rabbit, digestive, respiratory, circulatory, urinogenital, skeletal and nervous systems, classification of mammals.

**Practical: Phylum Chordata: Subphylum (I) Protochordata (Acrania),** Class: **Cephalochordata** e.g. ***Amphioxus*****:** larva (photo and specimen), adult (photo and specimen), T.S. of pharyngeal region(photo and specimen). T.S. of trunk region (specimen). T.S. of tail region (specimen), **Subphylum (II) Vertebrata (Craniata), Group (A) Agnatha, Class: Cyclostomata,** e.g. ***Petromyzon*****:** ammocoetes larva (photo and specimen), adult (specimen). T.S. of pharyngeal region, T.S. of trunk region (photo + specimen). T.S. of caudal region. **Group (B): Gnathostomata, Superclass (1) Pisces (fishes). Class (A) Chondrichthyes (Cartilaginous fishes), e.g. *Scyllium* (dog fish).** External features (male &female), Isolated placoid scale, Dissected dogfish (photo + specimen). T.S. of pharyngeal region of dogfish (photo + specimen). T.S. of trunk region of dogfish (photo + specimen). T.S. of caudal region of dogfish (photo + specimen). **Class (B) Osteichthyes (Bony fishes), e.g. *Tilapia* (Bolti):** External features (male & female)**,** dissection of *Tilapia* (+photo), Cycloid & Ctenoid scales, T.S. of pharyngeal region of *Tilapia,* T.S. of trunk region of *Tilapia*, T.S. of caudal region of *Tilapia*. **Superclass (2) Tetrapoda, Class (1) Amphibia: (e.g. 24 hour Rana**

**larva), Class (2) Reptilia:** External features of *Scincus* (lizard**),** Dissection of lizard, Skin of lizard **.** **Class (3) Aves: e.g. *Columba* (pigeon).** External features, dissection of pigeon. Skull of pigeon(Dorsal, lateral and ventral views). Pectoral girdle of pigeon, fore limb of pigeon, pelvic girdle of pigeon, hind limb of pigeon. **Class (4) Mammalia: e.g. rabbit (*Oryctolagus*),** external features of rabbit, dissection of rabbit, skull of rabbit (Dorsal, lateral and ventral views). Vertebral column of rabbit, girdles & limbs of rabbit. **Revision.**

**Z. 261 BASIC ECOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: Z102. Offered in fall.

Ecology in relation to other branches, the physical environment, the living environment, periodic changes in communities, ecological succession, the distribution of plants and animals (topographic barriers, dispersal), geographic distribution (faunal & zoogeographic distribution, geologic distribution), climatic gradients in plants and animals (e.g. *size of animals in relation to temperature, *number of species and individuals, *size of body extremities, *number of vertebrae: fishes that live at low temperatures tend to have more vertebrae than do fishes of warmer waters; unbalance in animal numbers), biological clocks (photoperiodism), ecological strategies, habitats and adaptations, ecological design, biodiversity, conservation, pollution,

**Practical:** The study of aquatic habitat, the study of physical factors (temp, light….), chemical analysis of water: estimation of pH of a water sample, determination of salinity of water, determination of dissolved oxygen in water, determination of free carbon dioxide (acidity) in water, determination of alkalinity in water, determination of hardness degree in water, determination of calcium in water, determination of primary productivity of aquatic habitat. The study of terrestrial habitat: study of climatic factors (temp, light, humidity), mechanical analysis of soil (sieve analysis), determination of chlorides in soil, determination of organic carbon in soil, determination of glycogen in fish tissue, Air pollution, Egyptian fauna, Fish, Amphibia, Reptilia, Aves, Mammals.

**Z. 311 CELL BIOLOGY (2) (2 cr. + 0 cr. Lab).**

Prerequisite: Z 211. Offered in fall.

Synthesis and targeting of mitochondrial and peroxisomal proteins, translocation of secretory proteins across ER membrane, insertion of membrane proteins into ER membrane, post-translational modification and quality control in ER, receptor-mediated endocytosis and the sorting of internalized proteins, molecular mechanisms of vesicular traffic. Cell - cell signaling, signaling molecules, cell-surface receptors. Cell - cell adhesions and communication, cell - matrix adhesion, actin assembly, actin motor proteins, actin and myosin in nonmuscle cells, cell locomotion, microtubule assembly microtubule organizing centres, microtubule structures and associated proteins, cell cycle control and checkpoints, cell death, programmed cell death, tumor cells and the onset of cancer: mutations causing loss of cell cycle.

**Z. 321 PROTOZOOLOGY & PARASITOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: Z221. Offered in spring.

**Protozoology:** history and discovery of Protozoa, Protozoa as a cell and organism, development of the general taxonomy of Protozoa and the different factors affecting this development. Electron microscopy and Protozoa, economical importance of Protozoa, modern classification of Protozoa, Biological activities and Protozoa: Nutrition, Respiration, Excretion, Reproduction..... etc, Alternation of generation, Models and examples of the different groups of the subkingdom Protozoa, their characteristics, systematic position, life cycles and life performance, Protozoa and diseases, Hazards of parasitic Protozoa, **Helminthology: Parasitism: what is a parasite?** Animal associations, Commensalism, Phoresis, Parasitism, General considerations, Metabolic dependence, Mutualism and symbiosis, Types of parasites, **Habitats and environments,** Habitats: general comments, The vertebrate alimentary canal, General properties, Intestinal physiology, Physio-chemical characteristics, Blood, Tissues and other habitats, Invertebrate habitats, Importance of nutritional levels of environment in parasite life cycles, **Helminth Parasites: Platyhelminthes:** Class Trematoda: Introduction, Subclass Monogenea type example: *Polystoma integerrimum.* Subclass Aspidogastrea type example: *Aspidogaster conchicola,* Subclass Digenea: Classification,

Subclass: Digenea, Family Bucephalidae, Type example: *Bucephaloides gracilescens,* Family Fasciolidae, Genus *Fasciola*, type example: *Fasciola hepatica, F. gigantica,* Genus Fascioloides, *Ex: Fascioloides magna*, Ex. *Fascioloides buski,* Family Opisthorchiidae. *Clonorchis sinensis,* Family Dicrocoeliidae. Type example: *Dicrocoelium dendriticum,* Family Plagiorchudae, Type example: *Haplometra cyclindracea,* Family Echinostomatidae, Type example: *Parorchis acanthus,* Family Heterophyidae, Type example: *Cryptocotyle lingua,* Other Heterophyidae, *Heterophyes heterophyes, Metagoninus yokogawai,* Family Troglotrematidae, Type example: *Paragonimus westermani,* Family: Schistosomatidae, Type example: *Schistosoma mansoni,* Other species infecting man *Schistosoma haematobium, Schistosoma japonicum,* Schistosomiasis as a world problem, Other species, Unisexual infections-General account, Hybridization in schistosomes, Cercarial dermatitis: 'swimmers itch', Families Strigeidae and Diplostomatidae type example: *Diplostomum phoxini* type example: *Diplostomum spathaceum,* Family Paramphistomatidae Examples: *Paramphistomum cervi, Gastrodiscoides hominis.* **Physiology of trematodes, Class Cestoda: Subclass Cestodaria,** Subclass Eucestoda, Classification, Subclass Eucestoda: Order Pseudophyllidea, Genus Diphyllobothrium, Type example: *Diphyllobothrium dentritcium,* Other: examples. *D. latum, Spirometra* sp, Subclass Eucestoda: Order *Cyclophyllidea,* Family Hymenolepididae: *Hymenolepsis diminuta,* Other examples: *H. mana, H. microstoma,* Family Taeniidae, Genus Taenia: taeniasis and cystocer cosis in man, Genus *Echinococcus*: hydatid disease, **Physiology of cestodes, Class Nematoda,** Classification, Type example: *Rhabditis maupasi,* Subclass Secernentea (Phasmidia), Order Rhabditida. Family Strongyloidae, Genus *Strongycoides,* Order Ascaridida. Superfamily Ascaridoidea Genus, *Ascaris,* Order Oxyrida, Order strongylida. Type example: *Nyppostrongylus brasiliensis,* Other examples: *Haemonchus contortus, Strongylus equinus, Ancylostoma duodenale, Metastrongylus* sp., *Syngamus trachea,* Order Spirurida. Type example: *Litomosoides carinii,* Other examples: Filaria in dogs: *Dirofilaria immitis,* Human filariasis, Suborder Callamainina, ex: *Dracunculus medinensis,* Suborder Spirurina, Genus *Thelazia.* **Subclass Adenophorea (Aphasmidia),** Superfamily Trichuroidea, Family Trichuridae, ex: *Trichuris* sp, Family Trichinellidae, ex: *Trichinella spiralis,* **Physiology of nematodes, Phylum Arthropoda,** Class: Arachnida. Order: Acarina, Family: Dermanyssidae ex: *Dermanyssus galliane Ornithanyssus buesa, O. bacoti,* Family Argasidae, ex. *Omithodoros mubata, Ixods ricinus*, *I. pilosus, Rhipicephalus appendiculus,* Family: Chyletidae, ex. *Psorergates ovis,* Family: Sarcoptidae, ex. *Sarcoptes scabiei,* Genus: *Sarcoptes,* **Pathogenecity and treatments of Helminthes and Arthropods.**

**Practical: Subkingdom Protozoa:** Phylum: Sarcomastigophora Ex.: *Ceratium, Noctiluca, Euglena*, *Volvox*, *Trypanosoma* sp., *Opalina, Protoopalina,* Foramineferans, Phylum: Apicomplexa *Monocystis, Gregarina, Haemogregarina, Eimeria, Plasmodium,* Phylum: Ciliophora *Balantidium, Paramecium, Blepharisma, Nyctotherus,* Phylum: Platyhelminthes, Class: Monogenea Ex.: *Polystoma,* Class: Digenea Ex.: *Fasciola* & life cycle, *Schistosoma* & life cycle, *Heterophyes, Dicrocoelum, Opisthorchis,* Class: Cestoda Ex.: *Diphyllobothrium, Taeniarhynchus, T. solium, T. pisorfmis, Dipylidium, Echinococcus,* Phylum: Nematoda, *Trichnella spiralis, Contracaecum, Enterobius, Wuchereria bancrofti,* Phylum: Acanthocephala Ex.: *Echinorhynchus,* Phylum: Annelida Ex. *Hirudo,* Phylum: Arthropoda, Class: Crustacea, Ex.: *Sacculina,* Class: Arachnida, Ex.: *Sarcoptes, Argus,* Class: Insecta, *Pulex, Pediculus, Cimex*.

**Z. 322 INVERTEBRATE ZOOLOGY (2) (1 cr. + 0 cr. Lab).**

Prerequisite: Z 221. Offered in spring.

Subkingdom Metazoa: Branch parazoa, Phylum Porifera. Branch Eumetazoa, Division Radiata, phylum Cnidaria, phylum Ctenophora, Division Bilateria, The acoelomates, phylum Platyhelminthes, phylum Nemertea, The pseudocoelomates, phylum Aschelminthes, phylum Acanthocephala, The coelomates, phylum Annelida, phylum Mollusca, phylum Arthropoda, phylum Echinodermata.

**Z. 331 COMPARATIVE ANATOMY (2 cr. + 1 cr. Lab).**

Prerequisite: Z231. Offered in fall.

**Introduction**, comparative anatomy concept, general characteristics of chordates, homology and anology concept, phylogony and ontogony concept, biogenetic law, ancestry of chordates, directions and planes, classification of phylum chordate. **Integumentary system:** colour of the skin, glands of the skin, comparative anatomy of the skin glands, comparative anatomy of the skin, exoskeletal structures among vertebrate groups, development of the exoskeletal structures (ontogony and phylogony), teeth of vertebrates. **Skeletal system: Axial skeleton:** comparative anatomy of the cranium, the cranium (neurocranium, viscerocranium), development of the chondrocranium of vertebrates, osteocranium, replacing bones of the cranium, dermal bones of the cranium, skull of modern amphibia, skull of reptilia, skull of birds, skull of mammalia, fate of the mandibular and hyoid arches in tetrapoda (middle ear), vertebral column: development of the vertebrae, comparative anatomy of the vertebral column, comparative anatomy of the sternum & ribs. **Appendicular skeleton, Circulatory system,** blood vascular system (heart, venous and arterial systems), fate of aortic arches among vertebrates, comparative anatomy of heart among vertebrates, lymphatic system. **Excretory system and genital ducts:** primitive vertebrate kidney (holonephros), pronephros, mesonephros and metanephros, urinary bladder. **Reproductive system** (among vertebrates). **Muscular system, Nervous system:** brain, spinal cord, sense organs.

**Practical: Integumentary system:** Class: Cephalochordata, Skin of *Amphioxus*, T.S. of pharyngeal region, T.S. of trunk region, T.S. of tail region, Class: Cyclostomata, Skin of *Petromyzon* T.S. of trunk region, T.S. of caudal region, Horny teeth (T.S. of buccal funnel), Class: Chondrichthyes, Placoid scale (Isolated), Development of placoid scale. (early, intermediate & late stages), Class: Osteichthyes, Types of bony scales (cycloid, ctenoid & ganoid), Development of the leptoid scales. (early, intermediate & late stages), Class: Amphibia, V.S. of skin of *Bufo* (showing skin glands), Class: Reptilia, V.S. of skin of lizard (horny scales), Finger of lizard (claw), Shell of turtle (horny scales & bony plates), Class: Aves, Types of feathers, Development of feathers (early, intermediate & late stages), Class: Mammalia, Development of hair (early, intermediate &. late stages). **Skeletal system:** Class: Chondrichthyes, Chondrocranium of *Trigon kholi* (D. & L.), Chondrocranium of *Rhinobatus halavi* (D), Chondrocranium of *Mustelus manzo* (D. & L.), Class: Reptilia, Skull of *Chelone mydas* (V. & L.), Skull of *Uromastyx aegypticus* (D. & V.), Class: Aves, Skull of *Milvus aegypticus* (L. & V.), Class: Mammalia, Skull of' *Canis familiaris* (L. & V.), Vertebral column in vertebrates, **Nervous system:** Brain in vertebrate classes, Sense organs in vertebrate classes: taste buds, olfactory epithelium, choana, Jacobson's organ, turbinals (concha), columella auris and middle ear ossicles in mammals, Eye in different classes of vertebrates, Revision.

**Z. 341 IMMUNOLOGY (1) (2 cr. + 1 cr. Lab).**

Prerequisite: Z311. Offered in spring.

Overview of the immune system, Cells and organs of the immune system, Antigens, Immunoglobulins: structure and function, Histocompatibility complex, Antigen processing and presentation, T-cell receptor, T-cell activation, B-cell generation, activation and differentiation, Complement system.

**Practical:** The mouse lymphoid system, The human lymphoid system, Histological examination of lymphoid organs, Microscopic examination of peripheral blood leukocytes, Preparation of lymphocytes suspension, Preparation of peripheral blood mononuclear cells, Immunization, Preparation of serum and heat inactivation, Preparation of complement, Rosette formation, Haemagglutination test. Heamolysis test.

**Z. 351 PHYSIOLOGY (1) (3 cr. + 1 cr. Lab).**

Prerequisite: Z211. Offered in fall.

**Digestive & absorptive functions of the gastrointestinal system (an outline), Regulation of GI function:** The enteric nervous system, Extrinsic innervation, Peristalsis, Gastrointestinal hormones (Gastrin, cholecystokinin…etc), Control of HCl secretion, Gastric motility & emptying & its regulation, Liver & biliary system, Regulation of intestinal secretion & motility, Malabsorption, constipation & diarrhea, **Metabolism:** basic concepts and design, Glycolysis, Citric acid cycle, Electron transport chain & oxidative phosphorylation, Gluconeogenesis, Hexose monophosphate pathway, Sugar

interconversions, Glycogen metabolism and regulation, **Metabolism of lipids;** absorption; secretion: Fatty acids de novo synthesis; oxidation of fatty acids; mobilization of stored fat; prostaglandins & related compounds, Phospholipids metabolism, Glycolipid metabolism (glycosphingolipids), Cholesterol & steroids: synthesis of cholesterol, degradation of cholesterol, plasma lipoproteins, steroid hormones, **Amino acid metabolism:** Removal of nitrogen from amino acids, urea cycle, metabolism of ammonia, Catabolism of carbon skeleton of amino acids, Biosynthesis of non-essential amino acids, Conversion of amino acids to specialized products, **Integration of metabolism,** Metabolic effects of insulin & glucagon, Metabolism in well-fed state, starvation, Diabetes mellitus and injury, nutrition, vitamins, **Metabolism of nucleotides:** De novo synthesis of purines and their catabolism, gout, Synthesis of pyrimidine nucleotides and their catabolism.

**Enzymology:** Enzymes as protein molecules, Enzyme classification, Enzymes & catalysis, **Mechanism of action of enzymes**, Active site (proximity & orientation, induced fit), Acetylcholine esterase, Chymotrypsin, Carbonic anhydrase, **Enzyme cofactors and role of vitamins and trace elements** in the function of enzymes, Enzyme systems, **Enzyme kinetics,** Michaelis-Menten equation, Michaelis-Menten constant, Transformation of Michaelis-Menten equation, **Enzyme inhibition:** Irreversible & reversible, competitive, non-competitive, Factors affecting reaction velocity (temperature, pH ...), **Regulation of enzyme activity:** Induction & repression of enzyme systems, Allosteric enzymes, Homotropic effectors, Heterotropic effectors, Feed-back inhibition, Kinetics of allosteric enzymes, Isozymes, Covalent modification, Zymogens, **Role of enzymes in signal transduction cascades,** Receptor tyrosine kinase, Protein kinase A, Protein kinase C, **Applications of enzymes:** Enzyme inhibitors as drugs, Enzymes in clinical diagnosis, Enzymes & food technology.

**Practical: Salivary digestion:** Test for mucin in alkaline medium & dilute acetic acid, Test for nitrites, Salivary amylase, Digestion of starch by salivary amylase, Effect of temperature, Effect of pH, Effect of NaCl, Estimation of amylase unit, **Gastric digestion:** Detection of pepsin, Effect of pH, Detection of rennin, Determination of total acidity, Determination of total chloride in the gastric juice, **Pancreatic digestion:** Pancreatic lipase, Pancreatic trypsin, Effect of pH. Tryptic digestion of casein (Formal titration), Test for glucose, Test for maltose, lactose, starch, cellulose, lipid & protein, Qualitative determination of total free amino acids, **Experiments on milk:** Protein precipitation, Test for precipitated protein (Solubility test & Biuret test), Test for casein, Detection of preservatives, Quantitative determination of fat in milk, Gerber tube, Gerber centrifuge, Quantitative determination of lactose in milk, Milk enzymes, xanthine oxidase (methylene blue), lactoperoxidase (benzidine test), Blood glucose level in normal and diabetic samples, Glucose tolerance test, Experiments on glucose absorption from the entire gastrointestinal tract, Quantitative determination of liver glycogen, Experiments on bile, Test for bile pigments, Test for bile acids, Tests for normal and pathological conditions: Total lipids, Triglycerides, Total cholesterol, Total protein, Revision.

**Z. 352 PHYSIOLOGY (2) (2 cr. + 0 cr. Lab).**

Prerequisite: Z351. Offered in spring.

**Endocrine System:** Role of hormones, types of hormones, biosynthesis, secretion and transport of hormones, control of the endocrine system, **Molecular basis of hormone action:** Mechanisms of hormone actions, membrane and intracellular receptors, G proteins, second messengers, **Hypothalamopituitary axis:** Hypothalamic hormones, mechanism of action and their control of anterior pituitary function, anterior pituitary hormones(synthesis, effects, mechanism of action and regulation), **Adrenal gland:** Function of the different zones of the adrenal cortex, (cortisol, aldosterone) and medulla: catecholamines (synthesis, effects, mechanism of action and regulation), **Thyroid gland:** Thyroid hormones(synthesis, effects, mechanism of action and regulation), **Pancreas and Gastrointestinal hormones:** Synthesis and secretion of insulin and glucagon, somatostatin and pancreatic polypeptide, gastrin, secretin, cholecystokinin, **Reproductive endocrinology:** Male sex hormones (androgens) their synthesis, secretion and actions, Ovarian hormones, their effects on the uterus and vagina, regulation of menstrual cycle, pregnancy and menopause.

**Z. 353 HUMAN PHYSIOLOGY (2 cr. + 1cr. Lab).**

Prerequisite: Bio. 101. Offered in fall.

**Digestion, Absorption & Metabolism: Digestion:** Digestion in mouth, Digestion in stomach, Digestion in small intestine. **Absorption**: Absorption of carbohydrates, Absorption of proteins, Absorption of lipids, Absorption of vitamins, Absorption of water and minerals, **Metabolism:** Metabolism of carbohydrates, Metabolism of proteins, Metabolism of lipids. **Circulatory System: Blood and hemostasis:** Blood components, Blood clotting, Blood groups, **Organization of the circulatory system:** Blood vessels, The heart, Structure of heart, Origin and conduction of heart beats, Regulation of the heart beats, Heart sounds, The electrocardiogram, The lymphatic system, **Respiratory System:** Structure and function of the respiratory system, Mechanism of breathing, Exchange of gases, Transport of gases, Control of breathing, **Excretory System:** Elements of renal function, Structure of the kidney, Urine formation, Control of water excretion, Artificial kidney, **Nervous System:** Organization of the nervous system, Cells of the nervous system, Nerve impulse, The electroencephalogram, Synapses, The reflex arc, The central nervous system, The peripheral nervous system, The sense organs, **Muscular System:** Types of muscles, Mechanism of muscle contraction, **Endocrine System:** Types of hormones, The hypothalamus and pituitary gland, The pineal gland, The thyroid gland, The parathyroid glands, The adrenal gland, The pancreas, The hormones of digestion, The hormones of reproduction, The hormones of the kidney.

**Practical: Salivary digestion:** Test for mucin, Test for nitrites, Salivary amylase, Digestion of starch, Effect of acid, Effect of temperature, Effect of NaCl, Estimation of amylase unit, **Gastric digestion:** Detection of pepsin, determination of the most favourable acidity, Detection of rennin, Determination of total acidity and total chlorides in gastric juice, **Pancreatic digestion,** Detecion of trypsin, Detection of amylase, Detection of lipase, **Experiments on bile and urine,** Tests for bile pigments & bile acids, Qualitative tests for normal and pathological constituents of urine, Quantitative determination of chlorides, ammonia and uric acid in urine, **Blood:** Detection of blood**,** Deproteinization of blood, Erythrocyte sedimentation rate, Hematocrit value (packed cell volume), Determination of hemoglobin content, Blood groups, **Red blood cells count, White blood cells count (total, differential), Estimation of blood glucose, Skeletal muscle:- Simple muscle twitch, Factors affecting simple muscle twitch:** Two successive stimuli, Multiple (repeated) stimuli, Temperature, Fatigue, Load, Strength of stimulus, **Cardiac muscle**: Normal cardiogram, Effect of temperature, Refractory period and extrasystole, Effect of Stannius ligatures.

**Z. 361 DESERT ECOLOGY (1 cr. + 0 cr. Lab).**

Prerequisite: Z261. Offered in spring.

**Climate, Soils, Vegetation:** Soil moisture and plant life, drought-evading plants, seed dispersal, drought-resisting plants, water storage, increased water uptake and translocation, salt resistance, animal perdition, **Invertebrate animals:** Evasion of desert conditions (e.g. aestivation, diapause, quiescence, etc.), avoiding of desert conditions (burrowing, diurnal rhythms, seasonal rhythms, heat death, food), **Vertebrates:** (amphibians, reptiles, birds, mammals & man), **Ecology and development:** Animal coloration, man-made desert and dustbowl, nomadism, the future of desert lands, water supplies, energy, disease, **Physiological adaptation to desert habitat**.

**Z. 362 ENVIRONMENTAL POLLUTION (1 cr. + 0 cr. Lab).**

Offered in spring.

Ecosystem, Sources of pollution, Industrial effluents, Agricultural drainage, Sewage, Oil spills, Thermal pollution, Types of pollutants (air & water pollution), Indication of pollution: Toxicity tests, Lethal & sublethal doses, Factors affecting toxicity: Eutrophication, Green house effects, Biological effects of pollution.

**Z. 411 MOLECULAR BIOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: Z311. Offered in fall.

**Introduction:** DNA replication/organization, Control of DNA replication, Genome structure, Gene regulation in prokaryotes and eukaryotes, **The process by which the genetic information is stored, replicated and expressed in living organisms** (Central Dogma of Molecular Biology):

Most eukaryotic genes are mosaics of introns and exons, The role of RNA in coding and transferring the genetic information, RNA processing, Splicing and alternative splicing, Epigenetic phenomena, **DNA Technology:** Gene manipulation, Cloning essentials, Restriction enzymes, Cloning vectors, Construction of genomic and cDNA libraries, Library screening strategies, DNA sequence, Oligonucleotide synthesis and use, Hybridization, PCR technology, Expression of cloned genes.

**Practical: Introduction to good laboratory practices:** How to use correct procedures to store, handle, and dispose of biological, chemical, radioactive, sharps and glass materials/waste. Select sterilization/decontamination procedures: biological contamination, nucleic acid contamination. Preparation and properties of media and reagents used in molecular biology. Preparation of standard operating procedure for each technique. **Recombinant DNA methodology and preparation of genomic library,** Isolation of genomic DNA, isolation of plasmid DNA, restriction endonuclease digestion of plasmid and genomic DNA, DNA vector-insert ligation, agarose gel electrphoresis, Bacterial transformation, gene cloning, Antibody screening of genomic libraries, **Working with mRNA,** isolation of RNA, selection of poly $(A)^+$ RNA by different methods, **Introduction to PCR,** PCR: An overview, Primer design, Components and conditions for PCR optimization, PCR programing, Research applications of PCR.

**Z. 412 HISTOCHEMISTRY (1 cr. + 1 cr. Lab).**

Prerequisite: Z311. Offered in spring.

**Chemistry of fixation:** Aims, principles of fixation, methods of fixation, coagulant and non-coagulant fixatives, **Dyes:** General structure of dye molecules, chromophores, auxochromes, fluorescent compounds, classification of chromophoric systems, **Histochemistry of proteins and organic functional groups:** Methods for general proteins, carboxyl groups, amino groups, specific amino acids functional groups, blocking procedures, aldehydes, ketones, **Histochemistry of carbohydrates:** Histochemical classification and localization of carbohydrate-containing macromolecules, fixation, chemical methods, staining methods, enzymatic extraction and blocking procedures, lectin histochemistry, **Histochemistry of lipids:** Classification and distribution of lipids, fixation and processing, extraction methods, oil-soluble dyes, methods for unsaturation, acidic groups, glycozylation, acetal phosphatides, free fatty acids & triglycerides, choline containing lipids and cholesterol, **Histochemistry of nucleic acids**: Fixation, demonstration with basic dyes and fluorochromes, Feulgen method, hybridization histochemistry, detection of apoptosis, nucleolar organizer regions and DNA synthesis, **Enzyme histochemistry:** Essential requirements in enzyme histochemical reactions, fixation and processing, examples from hydrolytic enzymes and oxido-reductases, **Immunohistochemistry:** Principles, antigen & antibody, antibody production, labels, detection methods.

**Practical: Microtechnique: Fixation**, physical and chemical methods, coagulant and non-coagulant fixatives, mixture fixatives, factors affecting fixation, Experiments on fixation, **Microscopic preparation,** a preview of methods, teasing & squash preparations, supravital staining, **Permanent preparation of wet whole mounts, Smear preparation, Paraffin section preparation:** fixation by perfusion and immersion, embedding & casting, section cutting, **Staining of paraffin sections:** cytologic stains, acidophilia & basophilia, types of staining procedures, staining with haematoxylin and eosin, **Connective tissue stains, Preparation of sections for EM**. **Histochemistry: Representative techniques for protein histochemistry & immunohistochemistry**, Representative techniques for **carbohydrate histochemistry, Cryostat sectioning,** representative techniques for **lipid histochemistry, Enzyme histochemistry,** representative techniques for various enzymes.

**Z. 431 EMBRYOLOGY (2 cr. + 1 cr. Lab).**

Prerequisite: Z331. Offered in fall.

**DESCRIPTIVE EMBRYOLOGY: Introduction, Gametogenesis:** Spermatogenesis, Oogenesis, Vitellogenesis, **Fertilization:** External fertilization, Internal fertilization, **Cleavage:** Pattern of cleavage, Blastulation, **Gastrulation:** Fate maps, **Embryonic development of Amphioxus:** The embryonic period of development, Cleavage, Blastula formation, Gastrulation, Formation of the

primary organ rudiments, The larval period of development, **Embryonic development of the frog:** The early development, Cleavage and blastula formation, Gastrulation, Formation of the organ rudiments, The late development, **Embryonic development of the Chick:** Cleavage and blastula formation, Gastrulation, The primitive streak, The structure of the 24-hour chick embryo, The structure of the 33-hour chick embryo, **The embryonic membranes:** Amnion and chorion, allantois, yolk sac, The embryonic membranes of mammals. **Experimental Embryology: Fertilization:** Agglutination, Membrane penetrating substances, Cortical reaction, Blocks to polyspermy, **Parthenogenesis:** substances stimulating parthenogenesis, Role of the sperm, Sex of the embryo, Restore of the diploid number of chromosomes, **Cleavage:** Types & mechanism of cleavage, **Gastrulation:** Types & mechanism of gastrulation, **Neurulation:** Types & mechanism of neurulation, **Main aspects of the activities of the early embryo:** The equivalence of nuclei, Isolation of early blastomeres, Delayed nuclear implantation technique, Nuclear transplantation technique, Cloning, **Induction:** Primary embryonic induction, Determination and Spemann's primary organizer, Neural induction in Amphibia, Induction of the primitive streak in birds, Induction of the eye lens in man, Mechanism of induction, **Heteroploidy:** Identifying and production of heteroploid individuals, **Some experimental methods in embryological research:** Altering environmental conditions, Microsurgical techniques, Application experiments, Grafting, Explantation, Interplantation, Cellular dissociation, Inhibitory agents and teratogens.

**Practical: Gametogenesis:** S. in 96 h. chick embryo, to show genital ridge, Same, magnified to show primordial germ cells inside genital ridge, **Spermatogenesis:** S. in testis of rat, to show spermatogenesis, Sperm smear of rabbit, to show general shape of spermatozoa, **Oogenesis:** S. in ovary of cat, to show oogenesis, S. in ovary of cat, to show corpora lutea, S. in ovary of birds, to show polylecithal eggs growing inside ovarian follicles, S. in ovary of frog, to show mesolecithal eggs growing inside ovarian follicles, **Effect of yolk on cleavage and blastula formation: Amphioxus: Equal holoblastic cleavage:** Uncleaved egg, 2-blastomere stage, 4-blastomere stage, 8-blastomere stage, 16-blastomere stage, Morula stage, Blastula stage: single – layered spherical structure with central blastocoel, **Frog: Unequal holoblastic cleavage:** Early cleavage (2, 4 & 8 blastomeres), Late cleavage (Morula stage), Blastula: many – layered spherical structure with blastocoel above equator, **Chick: Meroblastic (Discoidal) cleavage:** Vertical section in early blastula, showing disc of blastoderm over slit-like blastocoel (all above yolk), Sagittal section in mature blastula (secondary), showing endodermal cells splitting from lower posterior blastoderm migrating anteriorly into blastocoel, **Effect of yolk on gastrulation:** Gastrula of Amphioxus, to show simple invagination of macromeres and a double – layered structure arises, Sagittal section in early gastrula of frog, to show appearance of furrow in the macromeres just below equator representing dorsal lip of blastopore, Sagittal section in late gastrula of frog, to show deepening of the furrow into macromeres to form beginning of archenteron and appearance of ventral lip of blastopore and yolk plug, Embryology of Frog: Sagittal section of early neurula of frog; showing neural plate, notochordal plate below, lateral mesoderm on its sides, and axial mesoderm below ectoderm, Sagittal section of intermediate neurula of frog, showing neural folds, notochord, axial and lateral mesoderm below ectoderm, and gut, Sagittal section of late neurula of frog, showing neural tube and same structures as in intermediate neurula, **General shape of frog embryo:** Dry preparations of early frog embryos, Whole mount of stained frog embryo (6 mm), Sagittal S. of frog embryo showing: Brain, spinal cord, parts of vertebrae, oral cavity, parts of gut, (myotomes)…etc, **Organogenesis: Cross and sagittal sections of frog embryo in different regions:** Anterior region to show olfactory sac, external and internal nostrils (choana), Forebrain (Diencephalon) region to show development of eye, showing optic cup, optic stalk connected to floor of diencephalon, and lens vesicle as well as pituitary gland, Region of hindbrain to show otic vesicle, Region of pharynx, to show tubular heart, Trunk region (early), to show differentiation of mesoderm, gut full of yolk ... etc, Trunk region (late), to show coelom around gut, Tail region, to show absence of gut and presence of caudal artery and caudal vein, Frontal S. in Molge larva (Amphibia), to show structure of the eye, brain, gills, heart, parts of alimentary canal, liver, limb bud … etc, V.S. in eye region of frog (or Molge), showing the typical structure of a

vertebrate eye, V.S. in an eye of monkey, for detailed structure of retinal layers, **Embryology of the Chick:** Whole mount of 16 and 20 h. chick embryo, W.M. of 21 and 22 h, chick embryo, W.M. of 24 h, chick embryo, **Cross sections in 24 h, chick embryo in:** Region of primitive streak, for primitive folds and primitive groove, Region of primitive pit, for depression, Region of primitive knot, for thickening, Region of mesodermal somites, Region of anterior intestinal portal, showing formation of foregut, **Cross sections in heart region of different stages of chick embryo, showing development of heart:** In 25-26 h, showing thickening of splanchnic mesoderm and formation of two thin-walled blood vessels far from one another, In 27 h, showing blood vessels approaching each other below forming foregut, In 28 h, showing adhering of the two blood vessels below foregut, In 30 h, showing tubular heart with epimyocardium, pericardial cavity, and pericardium. Dorsal mesocardium is still present and the ventral disappeared, W.M. of 36 h, chick embryo, W.M. of 48 h, chick embryo, T.S. in 72 h, chick embryo through trunk region, showing formation of amnion and serosa, L.S. in chick embryo, showing formation of heart fold, foregut and subscephalic pocket, T.S. in chick embryo, showing formation of limb bud, Dry preparations of whole mount of about 4 days of chick embryo, for general structure of more flexion throughout the whole body (C-shaped embryo), Revision.

**Z. 432 DEVELOPMENTAL BIOLOGY (2 cr. + 0 cr. Lab).**

Prerequisite: Z431. Offered in spring.

**Introduction:** Definitions of Comparative Embryology, Evolutionary Embryology, Descriptive Embryology, Medical Embryology, Experimental Embryology, Developmental Embryology, **Principles of Development:** Stages of animal development, Effect of environment on development, Environment and sex determination. Adaptation of embryos to their environment, **Genome Constancy:** Evidences of genomic equivalence, Metaplasia, Amphibian cloning, Transgenes and transgenic animals, Mammalian cloning. Importance of cloning mammals, Differential gene expression, **RNA Localization Techniques:** In situ hybridization. Whole- mount in situ hybridization. The polymerase chain reaction (PCR), The function of genes during development, **Fertilization:** Structure of gametes. Recognition of egg and sperm. Blocking of polyspermy: Fast reaction and Slow reaction, **Mechanisms of Development:** Mechanisms of Cleavage, Gastrulation and Neurulation, **Embryonic Induction During Vertebrate Development:** Mesoderm and neural induction in Amphibia, Induction of a secondary embryonic axis in Birds, Induction of the eye lens of Vertebrates, Regeneration.

**Z. 441 IMMUNOLOGY (2) (2 cr. + 0 cr. Lab).**

Prerequisite: Z341. Offered in spring.

Overview of basic Immunology, Innate immunology and natural defense mechanisms, Nature of antigens and their immunogenicity, Ig structure and function, Isotypes and class switching, Genetical basis for Ig formation, Antigen and antibody interaction and detection, Interaction molecules (MHC, TCR and complement), Molecular basis for immune defense mechanism, Transplantation immunology, Hypersensitivity and Tumor immunology, Immunization and tolerance induction, Vaccines.

**Z. 451 PHYSIOLOGY (3) (2 cr. + 1 cr. Lab).**

Prerequisite: Z351. Offered in fall.

**Circulatory system: Blood:** Bone marrow, White blood cells, Immune mechanisms, Red blood cells, Blood types, Plasma, Platelets, Hemostasis & blood coagulation, **Lymph: The heart:** Chambers and valves of the heart, The conducting system of the heart, Coronary circulation, The heart as a pump, The cardiac cycle, Heart sounds, The electrocardiogram, Abnormalities of heart conduction, Cardiac output, **Dynamics of blood & lymph flow:** Arterial & Arteriolar circulation, Capillary circulation, Lymphatic circulation & interstitial fluid volume, Venous circulation, **Cardiovascular regulatory mechanisms:** Local regulatory mechanisms, Systemic regulatory mechanisms, **Blood pressure,** Velocity of blood flow, Relationship between pressure, resistance & flow, Physical factors in the regulation of blood pressure, Variations of arterial blood pressure &

heart rate, The arterial pulse, Regulation of arterial blood pressure, Venous pressure & venous return, **Circulation through special regions:** Cerebral circulation, Cerebrospinal fluid, The blood-brain barrier, Cerebral blood flow, Regulation of cerebral circulation, Brain metabolism & Oxygen requirements, Coronary circulation, Splanchnic circulation, Circulation of the skin, Placental & Fetal circulation, **Cardiovascular homeostasis in health & disease:** Compensations of gravitational effects, Exercise, Hemorrhage & Hemorrhagic Shock, Other forms of shock, Fainting, Hypertension, Heart failure, **Physiology of the Respiratory and Excretory systems, Introduction** (Structural function of respiratory system), **Physical aspects of respiration**, Mechanics of breathing, Lung volumes, Compliance of the lung and chest wall, Alveolar surface tension, Work of breathing, **Chemical aspects of respiration**, Gases transport, Factors affecting the affinity of Hb for oxygen, Hypoxia(oxygen deficit), oxygen toxicity, **Regulation of respiration,** Chemical aspects, Nervous aspects, **Structural function of excretory system, Renal handling of the different substances, Role of the kidneys in the control and maintenance of the internal body constituents,** Renal clearance, Countercurrent multiplication, Renal regulation of E.C.F. H-ion concentration, **Renal hemodynamics,** Renin, angiotensin system,

**Practical: Experiments on blood:** Preparation of blood film, Coagulation and anticoagulants precipitation of protein, Detection of blood, Osmotic behavior of corpuscles, Fragility of erythrocytes, **Blood cell count:** Total erythrocytes count, Total leucocytes count, Differential count of WBCs. **Determination of:** Hematocrit, Sedimentation rate, Hemoglobin content, Coagulation time, Bleeding time, **Blood type:** The ABO system, The Rh system, Calculation of blood indices, Blood pressure, Estimation of blood glucose, Determination of lung volumes by water spirometer, Determination of the oxygen consumption of a laboratory animal, Determination of the composition of exhaled air-study the total respiratory exchange of gases, Urine composition tests (qualitative study), Quantitative study : Estimation of: total acidity, chlorides, ammonia, and uric acid, General revision.

**Z. 452 PHYSIOLOGY (4) (2 cr. + 2 cr. Lab).**

Prerequisite: Z352. Offered in spring.

**Physiologyy of the nervous system: Cellular organization:** Organization of the nervous system, Cellular composition, Microscopic anatomy of the neuron, Central nervous system: Forebrain functions, Brainstem functions, Peripheral nervous system, Transmission of information: Nerve impulse, Synapses, Transmitter substances, Reflexes, **Autonomic nervous system:** Organization, Functions, **Receptors & Special senses,** Receptors, Visual system, Auditory system, Vestibular system: Chemical sensory system, Olfaction, Gustation, **Higher functions of the nervous system:** Electroencephalogram, Evoked potentials.

**Physiology of muscle tissues: Transport through the cell membrane: Diffusion:** Diffusion through the cell membrane, Net diffusion through the protein channels of the cell membrane and factors that affect it, Osmosis across selectively permeable membranes, **Active transport:** Basic mechanism of active transport, Secondary active transport: Sodium "Cotransport" of glucose and amino acids, **Membrane potentials and action potentials. Basic physics of membrane potentials:** Donnan equilibrium, Membrane potentials caused by diffusion, Membrane potentials caused by active transport "The sodium potassium electrogenic pump", Measuring the membrane potential, The cell membrane as an electrical capacitor, Origin of the normal resting membrane potential, The voltage-gated sodium and potassium channels, Summary of the events that cause the action potential, The spike potential and the after-potentials, Plateau in some action potentials, **Contraction of skeletal muscle: Physiologic anatomy of skeletal muscle:** The skeletal muscle fiber, **Molecular mechanism of muscle contraction:** Molecular characteristics of the contractile filaments, Degree of actin and myosin filament overlap: Effect on tension developed by the contracting muscle, Relation of velocity of contraction to load, **Initiation of muscle contraction: Excitation-Contraction coupling:** The muscle action potential, Release of calcium ions by the sarcoplasmic reticulum, Excitability changes: Strength-duration relationship, Phases of excitability, **The source of energy for muscle contraction, Characteristics of a single muscle twitch, Mechanics of skeletal muscle contraction:** The motor unit, Summation of muscle contraction, Skeletal muscle tone, Muscle fatigue, The lever systems of the body, Heat production in muscle, **Special features and abnormalities of skeletal muscle function:** Muscle hypertrophy, Muscle atrophy, Prevention of muscle atrophy by electrical stimulation, Physical contracture of muscle

following denervation, Rigor mortis, Familial periodic paralysis, The electromyogram, **Neuromuscular transmission: Transmission of impulses from nerves to skeletal muscle fibers:** The neuromuscular junction, Molecular biology of acetylcholine formation and release, Drugs that affect transmission at the neuromuscular junction, Myasthenia gravis, **Contraction of smooth muscle:** Types of smooth muscle, The contractile process in smooth muscle, Membrane potentials and action potentials in smooth muscle, Excitation-Contraction coupling, Role of calcium ions, Neuromuscular junctions of smooth muscle, Smooth muscle contraction without action potentials: Effect of local tissue factors and hormones, Mechanical characteristics of smooth muscle contraction, **Heart muscle; the heart as a pump, Physiology of cardiac muscle:** Physiologic anatomy of cardiac muscle, Action potentials in cardiac muscle, Contraction of cardiac muscle, **The cardiac cycle:** Systole and diastole, Relationship of the electrocardiogram to the cardiac cycle, Function of the ventricles as pumps, Function of the valves, The aortic pressure curve, Relationship of the heart sounds to heart pumping, Work output of the heart, Energy for cardiac contraction, **Regulation of cardiac function:** Intrinsic regulation of cardiac pumping: The Frank-Starling law of the heart, Control of the heart by parasympathetic and sympathetic nerves, Effect of heart debility on cardiac function: The hypoeffective heart, Effect of chronic increase in heart work load: The hypereffective heart, Effect of various ions on heart function, Effect of temperature on the heart, **Rhythmic excitation of the heart, the special excitatory and conductive system of the heart:** The sinoatrial node, Internodal pathways and transmission of the cardiac impulse through the atria, The atrioventricular (A-V) node and the Purkinje system, Transmission in the Purkinje system, Transmission of the cardiac impulse in the ventricular muscle, Summary of the spread of the cardiac impulse through the heart, **Control of excitation and conduction in the heart:** The S-A node as the pacemaker of the heart, Role of the Purkinje system in causing synchronous contraction of the ventricular muscle, Control of heart rhythmicity and conduction by the autonomic nerves, **Abnormal rhythms of the heart:** Heart block, The phenomenon of "Re-Entry" and abnormal rhythms, Premature contraction: Ectopic foci, Cardiac tachycardias, Cardiac arrest.

**Practical: Amphibian physiology: experiments on nerve and muscle:** Study of apparatus, Dissection of gastrocnemius muscle-sciatic nerve preparation, Excitability of the nerve-muscle preparation, Simple muscle twitch, Effect of changing the strength of stimulus on muscle contraction, Effect of temperature on muscle contraction, Velocity of nerve impulse, Effect of two successive stimuli, Genesis of tetanus (Effect of many successive stimuli), The phenomenon of fatigue and its site, Effect of load and length on muscle contraction, **Experiments on frog's heart:** Exposure of frog's heart and naked-eye observation of its activity, Normal cardiogram, The effect of temperature on frog's heart, The effect of adrenalin and acetylcholine on the heart, Refractoriness of cardiac muscle: Extrasystole and compensatory pause, The effect of vago-sympathetic and white crescentic line stimulation, The phenomenon of vagal escape, The effect of nicotine and atropine on the heart, Stannius ligatures, Perfusion of the frog's heart, **Experiments on laboratory mammals: Mammalian experiment:** Perfusion of the isolated heart of rabbit, Recording of intestinal movements of rabbit in vitro.

**Z. 456 TOXICOLOGY (2 cr. + 0 cr. Lab).**

Prerequisites: Z352, Z451. Offered in spring.

**Scope of Toxicology:** Dose-response relationships, Absorption, distribution and excretion of toxicants, Biotransformation of toxicants, Toxic responses and toxic testing of various body organs : liver, nervous system, immune system, kidney, blood, respiratory system, heart, skin, reproductive system, and eyes, Chemical carcinogenesis & genotoxic agents, Oxidative stress, Mechanisms of necrotic and apoptotic cell death. **Toxic agents:** Toxic effects of pesticides, Toxic effects of metals, Toxic effects of radiation, Toxic effects of solvents & vapours, Toxic effects of animal toxins, Toxic effects of plant toxins. **Environmental toxicology:** Food additives: contaminants and pollutants, Applications of toxicology.

**Z. 457 BIOLOGICAL ANALYSIS (2 cr. + 0 cr. Lab).**

Prerequisites: Z352, Z451. Offered in spring.

**Sample preparations, Differential centrifugation** (Subcellular fractionation), **Biochemical techniques**, Chromatography: Paper chromatography, Column chromatography, Thin-layer chromatography, Gas-liquid chromatography, Ion-exchange chromatography, Electrophoresis,

Electrofocusing, Chromatofocusing, **Methods of enzymatic analysis,** Choice of substrate, Enzyme preparations, Choice of assay method, Spectrophotometric methods, Manometric methods, Electrode methods, Fluorescence methods, Sampling methods, Biological methods, Radioactive isotope methods, **Enzymes in clinical diagnosis,** Assessment of cell damage and proliferation, Causes of raised plasma enzyme activities, Abnormal plasma enzyme activities, Transaminases, lactate dehydrogenase, creatine kinase, $\alpha$-amylase, alkaline phosphatase, acid phosphatase, $\gamma$-glutamyl transferase, Plasma enzyme patterns in disease: Myocardial infarction, liver disease, muscle disease, Enzymes in malignancy, Haematological disorders, Plasma cholinesterase and suxamethonium sensitivity, **Proteins in plasma and urine**, Functions of plasma proteins, Qualitative methods of assessing plasma proteins, Electrophoretic patterns in disease, Albumin and causes of hypoalbuminaemia, Proteins in urine: Renal proteinuria, Proteinuria with normal renal function, Nephrotic syndrome, Laboratory findings: Protein abnormalities, Lipoprotein abnormalities, **Tumour markers,** Definition of tumour markers, Clinical limitation of tumour markers, Classification of tumour markers, Laboratory testing of tumour markers, **Measurement of cerebral blood flow:** Whole brain (Kety method), Regional flow.

**Z. 461 AQUATIC ECOLOGY (2 cr. + 0 cr. Lab).**

Prerequisite: Z261. Offered in spring.

Physical and chemical properties of water, Challenges of aquatic life, Water quality criteria, Estuaries, Salt marches, Limnology (ecology of fresh water): Ecology of the River Nile, Ecology of fresh water fish, Oceanography (Marine ecology): Ecology of the Red Sea, Coral reefs, Marine animals, Osmoregulation and salinity adaptations. Lakes (thermal stratification),Interrelationships, Methods (to study the structure of a community, to compare communities, to detect pollution....etc.).

**Z. 462 ANIMAL BEHAVIOR (2 cr. + 0 cr. Lab).**

Prerequisite: Z261. Offered in spring.

**Neural Bases of Behavior:** Environmental stimuli and information reduction, Innate and acquired releasing mechanisms, Key stimuli, Dummies, and releasing mechanisms, Habituation phenomena, **Determinants of Behavior:** Motivation and change of meaning, Reticular formation, Appetitive behavior and consummatory acts, Control of the motivated behavior, **Behavior Patterns:** Feeding and predatory behavior, Courtship and mating behavior, Grouping behavior and dominance hierarchies, Social behavior and parental care, Communication and orientation behavior, **Learning in Animals:** Classic reflex conditioning, Operant conditioning, Latent learning. Insight learning, Learning set tests, Imprinting.

**Z. 481 BIOTECHNOLOGY (2 cr. + 0 cr. Lab).**

Prerequisite: Z411. Offered in spring.

Introduction to the basic techniques in molecular biology used to introduce recombinant DNA into bacterial, fungal, plant, and animal cells, Structure of selected plasmid and phage vectors, techniques used to introduce DNA into different host cells, Autocrine growth of normal and transformed cells, Tissue cultures for pro- and eukaryotic cells in biotechnology of growth factors, Production of natural and recombined growth factors, Bioreactors used in the production of secretory proteins, The application of growth factors in biology and medicine, Immobilization of proteins and cells for their use in biotechnology, biocatalyst immobilization, adsorption, ionic binding, covalent binding, cross-linking, matrix entrapment, membrane confinement, combined methods, Immobilization of coenzymes, Reactors for immobilized biocatalysts, stirred reactors, loop reactors, bed reactors, membrane reactors, special constructions, Major fields of industrial applications of immobilized biocatalysts, General and stereoselective organic synthesis, food processing, waste-material utilization, miscellaneous, Biosensors such as enzyme electrodes, bioaffinity sensors, enzyme thermistors and transistors, optoelectronic biosensors, Analytical techniques with enzyme reactors, Enzyme-linked assays on protein-absorbing plastic multiwell microplates (ELISA), Chromatography on immobilized proteins, affinity chromatography including immunochromatography, chiral chromatography.

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# GEOLOGY

## First: Academic Programs Offered by Geology Department

**The department offers courses for students of the following groups:**

1- Geology (G) 3- Zoology, Geophysics (Z), (Geophys)
2- Chemistry/Geology (Chem/G)

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 1 | 1st | G101 | Geology (1) | - | G, Geophys. | - | 2 | 3 | 0 | 3 | 6 cr. compuls |
| | 2nd | G102 | Geology (2) | G101 | | - | 2 | 3 | 0 | 3 | |
| 2 | 3rd | G 201 | Structural Geology (1) | G101 | G | - | 1 | 3 | 0 | 2 | 8 cr. compuls. for Chem/G, 16 cr. compuls. + 2 cr. elective for G |
| | | G 203 | Lithostratigraphy | G102 | | - | 1 | 3 | 0 | 2 | |
| | | G 205 | Macropaleontology (1) | G102 | | - | 1 | 3 | 0 | 2 | |
| | | G 207 | Optical Mineralogy | G101 | | - | 1 | 3 | 0 | 2 | |
| | | G 209 | Crystallography | G 101 | G | - | 1 | 3 | 0 | 2 | |
| | | Chem 221 | Analytical Chemistry | Chem 101 | | - | 1 | 3 | 0 | 2 | |
| | | Chem 441 | Petroleum Chemistry | - | | - | 1 | 3 | 0 | 2 | |
| | | Z 201 | Invertebrates & Vertebrates | G 102 or Bio 102 | | - | 1 | 3 | 0 | 2 | |
| | | G 211 | Field training | G 102 | - | G | - | 6 | - | 3 | |
| | | Chem 241 | Organic chemistry | Chem 101 | - | | 1 | 3 | 0 | 2 | |
| | 4th | G 202 | Micropaleontology (1) | G 102 | Chem/G & G | - | 1 | 3 | 0 | 2 | 10 cr. compuls. for Chem/G, 14 cr. compuls. + 4 elective for G. |
| | | G 204 | Sedimentary Petrology (1) | G 207 | | - | 1 | 3 | 0 | 2 | |
| | | G 206 | Rock-forming Minerals | G 207 | | - | 1 | 3 | 0 | 2 | |
| | | G 208 | Biostratigraphy | G 205 | | - | 1 | 3 | 0 | 2 | |
| | | G 210 | Geomorphology & Photogeology | G 201 | | - | 1 | 3 | 0 | 2 | |
| | | G 212 | Structural G. (2) | G 201 | G | - | 1 | 3 | 0 | 2 | |
| | | G 214 | Macropaleontology (2) | G 205 | | - | 1 | 3 | 0 | 2 | |
| | | G 216 | Field training (2) | G 211 | - | G & Chem/G | 0 | 6 | 0 | 2 | |
| | | G 218 | Paleoecology | G 205 | - | | 1 | 3 | 0 | 2 | |
| | | G 220 | Vertebrate Paleontology | G 205 | - | | 1 | 3 | 0 | 2 | |
| | | G 222 | Biostratigraphy | Z 102 | Z | - | 2 | 2 | - | 3 | Z |
| | | G224 | Minerals and Rocks | - | Geophys | - | 2 | 2 | - | 3 | Geophys |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 3 | 5th | G 301 | Igneous Petrology (1) | G 207 | G & Chem/G | - | 1 | 3 | 0 | 2 | 12 cr. compuls. + 6 cr. elective for G., 6 cr. compuls. + 2 cr. elective for Chem/G. |
| | | G 303 | Geochemistry | G 201 | | - | 1 | 3 | 0 | 2 | |
| | | G 305 | Geophysics (1) | G 201 | | - | 1 | 3 | 0 | 2 | |
| | | G 309 | Micropaleontology (2) | G 202 | G | Chem/G | 1 | 3 | 0 | 2 | |
| | | G 311 | Advanced Stratigraply | G 208 | | | 1 | 3 | 0 | 2 | |
| | | G 313 | Rock Mechanics | G 201 | | | 1 | 3 | 0 | 2 | |
| | | G 315 | Palynology | G 202 | - | G & Chem/G | 1 | 3 | 0 | 2 | |
| | | G 317 | Ichnofossils | G 205 | - | | 1 | 3 | 0 | 2 | |
| | | G 319 | Laboratory Techniques | G 207 | - | | 1 | 3 | 0 | 2 | |
| | | G 321 | Structural Mineralogy | G 206 | - | | 1 | 3 | 0 | 2 | |
| | | G323 | Structural and Field Geology & Surveying | - | Geophys | - | 2 | 3 | - | 3 | Geophys |
| | 6th | G 302 | Metamorphic Petrology (1) | G 301 | G & Chem/G | - | 1 | 3 | 0 | 2 | 16 cr. compuls. + 2 cr. elective for G, 8 cr. compuls. + 2 cr. elective for Chem/G. |
| | | G 304 | Basement Rocks of Egypt | G 301 | | - | 1 | 3 | 0 | 2 | |
| | | G 306 | Ore Geology | G 206 | | - | 1 | 3 | 0 | 2 | |
| | | G 308 | Field Geology + Field trip | G 301 | | - | 1 | 3 | 0 | 2 | |
| | | G 310 | Sedimentary Petrology (2) | G 204 | G | Chem/G | 1 | 3 | 0 | 2 | |
| | | G 312 | Igneous Petrology (2) | G 301 | | | 1 | 3 | 0 | 2 | |
| | | G 314 | Subsurface Geology | G 201 | | | 1 | 3 | 0 | 2 | |
| | | G 316 | Introduction to Engineering Geology | G 313 | | | 1 | 3 | 0 | 2 | |
| | | G 318 | Volcanology | G 301 | - | G & Chem/G | 1 | 3 | 0 | 2 | |
| | | G 320 | Quaternary Geology | G 204 | - | | 1 | 3 | 0 | 2 | |
| | | G 322 | Geology of Africa | G 301 | - | | 1 | 3 | 0 | 2 | |
| | | G324 | Sedimentary Petrology | - | Geophys | - | 2 | 2 | - | 3 | Geophys |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 7th | G 401 | Phanerozoic rocks of Egypt.(1) + Field Trip | G 204 | Chem/G & G | - | 1 | 1 | 0 | 2 | 14 cr. compuls + 4 cr. elective for G., 6cr. compuls. + 2 cr. elective for Chem/G |
| | | G 403 | Petroleum Geology (1) | G 204 | | - | 1 | 1 | 0 | 2 | |
| | | G 405 | Hydrogeology (1) | G 204 | | - | 1 | 1 | 0 | 2 | |
| | | G 407 | Sedimentation | G 204 | G | Chem/ G | 1 | 1 | 0 | 2 | |
| | | G 409 | Ore Mineralogy | G 306 | | | 1 | 1 | 0 | 2 | |
| | | G 411 | Remote Sensing (1) | G 210 | | | 1 | 1 | 0 | 2 | |
| | | G 413 | Engineering for Geology Students | G 316 | | | 1 | 1 | 0 | 2 | |
| | | G 415 | Advanced Geochemistry | G 308 | - | Chem/ G & G | 1 | 1 | 0 | 2 | |
| | | G 417 | Metamorphic Petrology (2) | G 302 | - | | 1 | 1 | 0 | 2 | |
| | | G 419 | Non-metallic Deposits | G 204 | - | | 1 | 1 | 0 | 2 | |
| | | G 421 | Clay Mineralogy | G 204 | - | | 1 | 1 | 0 | 2 | |
| | | G 423 | Ore Dressing | G 306 | - | | 1 | 1 | 0 | 2 | |
| | | G 425 | Marine Geology | G 407 | - | | 1 | 1 | 0 | 2 | |
| | 8th | G 402 | Geotectonic | G 201 | G | Chem/ G | 1 | 1 | 0 | 2 | 10 compuls. + 8 cr. elective for G, 10 cr. elective for Chem/G |
| | | G 404 | Field Mapping + Field trip | G 308 | | | 1 | 1 | 0 | 2 | |
| | | G 406 | Phanerozoic Geology of Egypt (2) | G 401 | | | 1 | 1 | 0 | 2 | |
| | | G 408 | Geostatistic | Math 101 | | | 1 | 1 | 0 | 2 | |
| | | G 410 | Environmental Geology | G 308 | | | 1 | 1 | 0 | 2 | |
| | | G 412 | Petroleum Geology (2) | G 403 | - | Chem/ G & G | 1 | 1 | 0 | 2 | |
| | | G 414 | Hydrogeology (2) | G 405 | - | | 1 | 1 | 0 | 2 | |
| | | Geo 416 | Special topics | Dept. | - | | 1 | 1 | 0 | 2 | |
| | | G 418 | Isotope Geology | G 303 | - | | 1 | 1 | 0 | 2 | |
| | | G 420 | Volcanoclastics | G 301 | - | | 1 | 1 | 0 | 2 | |
| | | G 422 | Organic Geochemistry | G 303 | - | | 1 | 1 | 0 | 2 | |
| | | G 424 | Gemology | G 206 | - | | 1 | 1 | 0 | 2 | |
| | | G 426 | Applied Mineralogy | G 206 | - | | 1 | 1 | 0 | 2 | |
| | | G 428 | Remote Sensing (2) | G 411 | - | | 1 | 1 | 0 | 2 | |
| | | G 430 | Geophysics (2) | G 305 | - | | 1 | 1 | 0 | 2 | |
| | | G432 | Petroleum and Subsurface Geology | - | Geophys | - | 2 | 2 | - | 3 | Geophysics |
| | | G434 | Geology of Egypt and Economic Ore Deposits | - | | - | 2 | 2 | - | 3 | |
| | | G436 | Hydrogeology | - | | - | 2 | 2 | - | 3 | |

# Second: Courses Offered by Geology Department

**G 101. GEOLOGY (1) (2 cr. + 1 cr. Lab.)**

Offered in fall.

Origin of the Earth, present is the key to the past, dating the earth, fossils and fossilization. Geological time scale, index fossils, crystalline state, symmetry elements, crystallographic axes and angles, study of the holosymmetric classes of the seven systems, parallel growth and twin crystals.

**G 102. GEOLOGY (2) (2 cr. + 1 cr. Lab.)**

Prerequisite: G 101. Offered in spring.

Weathering and soil, Rock sliding, running water, stages of valley development, cycles of landscape evolution, groundwater, processes in arid climates, transportation of sediment by winds, wind erosion and wind deposits, waves and wave erosion, continental margins, submarine canyons and turbidity currents, physical properties of minerals, classification, systematic study of mineral groups, Igneous rocks, sedimentary rocks, metamorphic rocks

**G 201. STRUCTURAL GEOLOGY (1) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 101. Offered in fall.

Primary structures of sedimentary and volcanic rocks, bedding planes, joints, folds and faults, reading of structural maps, stereographic projection of structural elements. Types of scales, construction of geologic maps and cross-sections.

**G 202. MICROPALEONTOLOGY (1) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 102. Offered in spring.

Collecting and processing microfossils, classification of microfossils, application of microfossils, the general characters of the foraminifera, variation in the structures of the foraminiferal test, classification of order foraminifera, foraminifera through time.

**G 203. LITHOTRATIGRAPHY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 102. Offered in fall.

Introduction, stratigraphic units, code of stratigraphy, geologic time scale, principles of lithostratigraphy and cyclo-stratigraphy, sequence-stratigraphy, facies analysis, correlations.

**G 204. SEDIMENTARY PETROLOGY (1) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 207. Offered in spring.

Lecture: basic concepts classifications methodology, terrigenous clastic sediments mudrocks carbonate limestones–dolomites dedolomitization and silicification evaporites, ironstones, phosphate cherts and siliceous sediments, volcaniclastic sediments, identification of hand-specimen and systematic petrographic study of various sedimentary rocks.

**G 205. MACROPALEONTOLOGY (1) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 102. Offered in fall.

Fossils and fossilization names and classification, phylum Porifera (sponges), phylum cnidaria (Coelenterate), phylum bryozoa (moss animals), phylum brachiopoda (Lampshells), phylum mollusca, class bivalvia (Pelecypoda), class gastropda, class cephalopda, class echinoidea, class crinoidea, phylum arthropda, phylum hemicordata

**G 206. ROCK- FORMING MINERALS (1 cr. + 1 cr. Lab.)**

Prerequisite: G 207. Offered in spring.

General Principals: crystalline state, formation of crystals, space lattice and types of unit cells, point group and space group, internal symmetry elements, chemistry of minerals: atomic structure, atomic bonding, ionic size, coordination, isomorphism, solid solution and exsolution, defect lattice structure, pseudomorphism, polymorphism, systematic mineralogy: structural classification of silicates.

**G 207. OPTICAL MINERALOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 101. Offered in fall. spring.

Elementary concept of light, polarizing microscope, properties of minerals in ordinary light in plane polarized light, and between crossed nicols, conoscopic examination. Adjustment of the polarizing microscope, examples of selected minerals.

**G 208. BIOSTRATIGRAPHY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 205. Offered in spring.

Introduction to earth, life and geologic time correlation and dating of the rock record, index fossils-biozones, radioactivity and absolute ages, accuracy of correlation time-parallel surfaces in rocks, Paleozoic Era: life-major events–time, terminal permian extinction. Mesozoic Era: life-major events-time, the terminal, cretaceous extinction: impact theory, the life-major events- time, cenozoic life history, pleistocene glaciation, human evolution.

**G 209. CRYSTALLOGRAPHY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 101. Offered in fall.

The stereographic projection, the inversion axes of symmetry, systematic study of the 32 classes of symmetry, cubic system, tetragonal system, orthorhombic system, monoclinic system, triclinic system, trigonal system and hexagonal system. study of crystal models of the 32 classes of symmetry combinations.

**G 210. GEOMORPHOLOGY & PHOTOGEOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 201. Offered in spring.

Relief of the earth geomorphic agents and processes geomorphic processes endogenic processes streams and valleys desert, karst definition, karst process and hydrology, glaciers geomorphology statistical and applied geomorphology, types of aerial photographs errors in flying reference information, geometrical parameters, geomorphological interpretation, structural interpretation, lithological interpretation application of photogeology introduction to remote sensing. Applications on the geological and photogeological maps.

**G 211. FIELD TRAINING (1) (2 cr. Lab.)**

Prerequisite: G 102. Offered in fall.

Planning a field project, field equipments, safety, field notebook, field observations, sedimentary rocks, field relations, Igneous rocks field relations, metamorphic rocks field relations, preparation of field reports, training on mapping, compass survey.

**G 212. STRUCTURAL GEOLOGY (2) (2 cr. + 1 cr. Lab.)**

Prerequisite: G 201. Offered in spring.

Extensional tectonics and applications, compressional tectonics and applications, wrench tectonics and applications, inversion tectonics and applications, tectonites. Map reading, stereographic projection, orthographic projection.

**G 214. MACROPALEONTOLOGY (2) (2 cr. + 1 cr. Lab.)**

Prerequisite: G 205. Offered in spring.

Evolutionary theory, taxonomy: analyzing pattern, fossil and phylogeny, speciation gradual, punctuated or what ?. Adaptation and functional morphology, biogeography, mass extinctions, rule and laws of taxonomic turnover, taxonomy of macrofossils, functional morphology macrofossils.

**G 216. FIELD TRAINING (2) (2 cr. Lab.)**

Prerequisite: G 211. Offered in spring.

Relationship to other geological disciplines, equipments and tools, mapping and projection methods, compass, clinometer, strike measurements, presentation of data, plane table description and theory, theodolites description and theory, advantages and disadvantages, GPS description, uses, resolution and controls. Writing a geological report.

**G 218. PALEOECOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 205. Offered in spring.

Geologic environments and ecosystems sediments and environments, organism and environments, geochemical evidences, environmental analyses, ancient environmental reconstruction and remodeling, advances and applications. Exercises for facies modeling and environmental construction.

**G 220. VERTEBRATE PALEONTOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 205. Offered in spring.

Introduction to the history of vertebrates as revealed in the fossil record. Vertebrate fossils, evolution, taxonomy and classification of pisces, amphibian, reptilian, aves and mammalian, with special emphasis to the Egyptian vertebrate fossil. Taxonomy of pisces amphibian, reptilia, aves and mammilia

**G 222. BIOSTRATIGRAPHY (2 cr. + 1 cr. Lab.)**

Prerequisite: Z 102. Offered in spring.

Geologic time scale, the evolving earth, selected minerals and rocks, paleontology (Key fossils), paleocology, mode of preservation, Ichon fossils, biostratigraphy.

**Practical: i**dentification of key fossils, carbonate minerals, phosphates, silicates, mode of preservation, map reading.

**G. 224 MINERALS AND ROCKS (2 cr. + 1 cr. Lab.)**

Offered in spring.

Introduction to mineral and rocks, classification of mineral and rocks, igneous activity and metamorphism, sedimentary rocks and environment of deposition, mineral resources (Organic and Inorganic).

**G 301. IGNEOUS PETROLOGY (1) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 207. Offered in fall.

Magma, chemical composition of igneous rocks, classification, igneous rock forming minerals, orthomagmatic crystallization, late stage crystallization, origin and nature of magma, magmatic differentiation. Microscopic study of the different igneous rock families.

**G 302. METAMORPHIC PETROLOGY (1) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 301. Offered in spring.

Types of metamorphism, metamorphic rocks forming minerals, classification, textures, thermal metamorphism, burial metamorphism, dynamic metamorphism, assemblages. Microscopic study of the characteristic mineral textures, metamorphic rock types.

**G 303. GEOCHEMISTRY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 206. Offered in fall.

Historical review, origin of elements, crystal chemistry, geochemical differentiation of, magma Rock-forming minerals geochemistry: geochemistry of the residual melt, atmosphere, chemical weathering, hydrosphere, clay minerals, geochemistry of carbonates, biosphere, geochemical cycles, personal safety. Definitions: sample preparation. application of simple and rapid analytical methods, C.I.P.W. norm calculations, interpretation of geologic setting of igneous rocks

**G 304. BASEMENT ROCKS OF EGYPT (1 cr. + 1 cr. Lab.)**

Prerequisite: G 301. Offered in spring.

Arabian nubian shield, Egyptian basement rocks, lithologies, classification, evolution, economic resources. Geologic maps, studying rock sample and thin-sections of different rock units.

**G 305. GEOPHYSICS (1) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 201. Offered in fall.

Physics of the earth's crust, mantle and core. Laplace's equation and spherical harmonic expression of gravity and magnetic fields. Elastic wave equation in geologic media. Body and surface seismic waves, equations of state, thermal structure of the earth.

**G 306. ORE GEOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 206. Offered in spring.

Classification and distribution of the ore deposits, ores in igneous rocks, ores of veins association, economic aspects, starboard and stratiform ore deposits, stratabound residual deposits and supergene enrichment, ores of metamorphic affiliation.

**G 308. FIELD GEOLOGY + FIELD TRIP (1 cr. + 1 cr. Lab.)**

Prerequisite: G 201. Offered in spring.

Relationship to other geological disciplines equipments and tools planning for field project, mapping projection methods, compass uses, methods and errors clinometer strik and dip measurements, Plane tabling description and theory advantages, disadvantages theodolites equipment and theory advantages and disadvantages GPS description and Uses resolution, controls, exercises on field and surveying tools, and application on geological maps, short field trips to Cairo environ.

**G 309. MICROPALEONTOLOGY (2) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 202. Offered in fall.

Ostracoda (general characteristics and taxonomy), nannofossils (general characteristics and taxonomy), principles of paynology: a) Pollen and spores. b) Dinoflagellates. Morphology of the ostracod carapase, morphology of the calcareous nannoplanktons, morphology of the pollen and spores, morphology of the dinoflagellates.

**G 310. SEDIMENTARY PETROLOGY (2) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 204. Offered in spring.

Textural and mineralogical evolution of the sedimentary rocks reflecting depositional and burial processes. Laboratory work emphasizes thin sections study of rocks.

**G 311. ADVANCED STRATIGRAPHY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 208. Offered in fall.

Biostratigraphic units: The Biozones, The species as a unit, Stratigraphical record and global rhythm, Trace fossils. Chrono-stratigraphy, seismic stratigraphy, magmeto-stratigraphy, interpreting the stratigraphical records. Interpreting biostratigraphic records and correlations.

**G 312. IGNEOUS PETROLOGY (2) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 301. Offered in spring.

Igneous activities in oceanic crusts, igneous activities in continental crusts, igneous activities above SBZ zones, Rock associations. Petrogenesis of the different rock families, modal analysis. Accurate measurements of mineral components. Exsolution phenomena, nomenclature.

**G 313. ROCK MECHANICS (1 cr. + 1 cr. Lab.)**

Prerequisite: G 201. Offered in fall.

Scope of rock mechanics, stress and strain, physical properties and classification of rock materials. Rock mass discontinuities nature and significance, in situ stresses, stability of rock slopes. Physical and mechanical properties of rock materials, instrumentation.

**G 314. SUBSURFACE GEOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 301. Offered in spring.

Introduction, subsurface structural maps, wireline log cross sections, preparation and uses of thickness maps, qualitative interpretation of logging diagrams. Radioactivity well logging. Geologic application of drilling time parameter. Geologic application of drill-stem test data, criteria for subsurface faulting, analysis of sedimentary basins.

**G 315. PALYNOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 202. Offered in fall.

Introduction, palynological techniques, pollen grains and spores, dino flagellates, acritarchs, chitinogoa, corodonts, microscopic identification of the different palynological texa for age dating and paleoenvironments.

**G 316. PRINCIPLES OF ENGINEERING GEOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 313. Offered in spring.

Scope of engineering geology, investigation of the suitability and characteristics of sites as they affect the planning. Engineering geological maps, same engineering geological aspects of roads, bridges, coastal works, dams of tunnels. Measurements of stress and strain, physical properties of rocks and soils, instrumentation: mechanical properties of soil and rock material.

**G 317. ICHNOFOSSILS (1 cr. + 1 cr. Lab.)**

Prerequisite: G 205. Offered in fall.

Ichnofossils of plant and animal traces. Implicit to this definition is that the traces mad by plants and animals reflect some sort of behavior. Ichnology can be divided into two major subdivisions: pleoichnology and neoichnology. Most icgnologists are involved in paleoichnology but a considerable number also study neoichnology for the comparison of modern equivalents to ancient traces. Biogenic structures, advantages of trace fossils, taphouomy paleontology and ichnology: differences

**G 318. VOLCANOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 301. Offered in spring.

Introduction, the facies description, properties of magma. General characteristics, lava flows, types of pyroclastic deposits and their eruptions, transport and deposition of subaerial pyroclastic flows, subaquous pyroclastic flows, crystal rich volcanoclastic, modern and ancient volcanoes, volcanism and tectonic setting. Study of rock samples, microscopic examination, data processing.

**G 319. LABORATORY TECHNIQUES (1 cr. + 1 cr. Lab.)**

Prerequisite: G 207. Offered in fall.

Safety in laboratories, preparation of samples for chemical and mineral analyses, mineral separation, X-Ray diffraction analysis, scanning electron microscope, electron microprobe, chemical analysis techniques, data treatments and presentation.

**G 320. QUATERNARY GEOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 204. Offered in spring.

Introduction, the quaternary system, historical development of definition and subdivision, terminology and nomenclature today, sedimentological and petrological characteristics, importance for archaeological sciences, worldwide quaternary (climatic) events, the quaternary of Egypt and case studies.

**G 321. STRUCTURAL MINERALOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 206. Offered in fall.

Systematic Mineralogy: native elements, sulfides, oxides; hydroxides, halides, sulfates, carbonates, phosphates, silicates, structural classification of silicates, systematic identification of mineral groups in hand-specimen and under the microscope.

**G 322. GEOLOGY OF AFRICA (1 cr. + 1 cr. Lab.)**

Prerequisite: G 301. Offered in spring.

Foliated boundaries, geologic map of Africa, volcanoes, lakes, rivers, structures, cratons, and resources. Applications on regional geological maps and satellite images.

**G 323 STRUCTURAL AND FIELD GEOLOGY & SURVEYING (2 cr. + 1 cr. Lab.)**

Offered in fall.

Primary structures of sedimentary and volcanic rocks, bedding planes, joints, folds and faults, reading of structural maps, stereographic projection of structural elements. Types of scales, construction of geologic maps and cross-sections. Planning a field project, field equipments, safety, field notebook, field observations, sedimentary rocks field relations, igneous rocks field relations, metamorphic rocks field relations, preparation of field reports, training on mapping, compass survey,

**G. 324 SEDIMENTARY PETROLOGY (2 cr. + 1 cr. Lab.)**

Offered in fall.

Basic concepts, classifications and methodology, clastic and nonclastic sediment, identification of hand-specimen and systematic petrographic study of various sedimentary rocks, textural and mineralogical evolution of the sedimentary rocks reflecting depositional and burial processes.

**G 401. PHANEROZOIC GEOLOGY OF EGYPT (1) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 204. Offered in fall.

General outlines, geomorphic units mountainous areas, pediplains, plateaus, depressions, great sand sea, old river system, paleodelta, nile valley, nile delta, coastal area, phanerozoic, paleozoic, mesozoic, cenozoic.

**G 402. GEOTECTONICS (1 cr. + 1 cr. Lab.)**

Prerequisite: G 201. Offered in spring.

Early ideas on orogenic movements and emmergence of plate tectonics, plate boundaries, hot pots and triple junctions, types of mountain belts, ophiolites and melanges, recognition of ancient plate boundaries.

**G 403. PETROLEUM GEOLOGY (1) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 204. Offered in fall.

Commercial accumulations and critical risk, evolution of petroleum, exploration techniques, properties and composition of hydrocarbon, origin, digenesis of organic matter, maturation, migration, reservoirs, sedimentary basins, hydrocarbons exploration in egypt, main hydrocarbon provinces

**G 404. FIELD MAPPING + FIELD TRIP (1 cr. + 1 cr. Lab.)**

Prerequisite: G 308. Offered in spring.

Geologic mapping of selected areas. Six days field trip (Departmental)

**G 405. HYDROGEOLOGY (1) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 204. Offered in fall.

Water cycle, evapotranspiration infiltration and runoff, aquifer properties, aquifer parameters, equilibrium and non equilibrium methods, leaky aquifer, sea water intrusion, safe yield, underground water movement effect on quality, relationship of water quality to geologic conditions, water quality. composition of ground water, underground water exploration using seismic and electric methods, hydrogeochemistry of contaminants, applications of Isotopes in hydrogeology.

**G 406. PHANEROZOIC GEOLOGY OF EGYPT (2) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 401. Offered in spring.

Basin analysis and economic potentiality: western desert, eastern desert, nile delta, red sea, gulf of suez and gulf of aqaba rifts, sinai

**G 407. SEDIMENTATION (1 cr. + 1 cr. Lab.)**

Prerequisite: G 204. Offered in fall.

Introduction, facies construction, alluvial sediments, lakes, deserts, siliciclastic shore line, shallow seas, shallow marine carbonate environments, pelagic environments, sedimentation and tectonics.

**G 408. GEOSTATISTICS (1 cr. + 1 cr. Lab.)**

Prerequisite: Math. 101. Offered in spring.

Elementary statistics, matrix algebra, analyses of sequence of data, spatial analysis, analysis of multivariate data, such as factor analysis, cluster analysis, r-mode analysis.

**G 409. ORE MINERALOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 306. Offered in fall.

Preparation of polished samples, mineral identification, ore mineral textures, paragenesis and paragenetic sequences, ore mineral assemblages, application of ore microscopy in mineral technology. preparation of polished samples, mineral identification, ore mineral textures, paragenesis and paragenetic sequences, ore mineral assemblages, application of ore microscopy in mineral technology.

**G 410. ENVIRONMENTAL GEOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 308. Offered in spring.

Environmental science- introduction, basic concepts and definitions, environmental impacts due to mineral resources, water resources assessment of the rapid environmental changes using geoindicators. data processing, environmental geochemical maps, techniques of analysis of the environment sensitive elements.

**G 411. REMOTE SENSING (1) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 210. Offered in fall.

Fundamentals, definitions, history and scope of remote sensing, electromagnetic radiations, elements of visual image interpretation, multispectral and hyperspectral remote sensing, active

microwave and lidar, thermal infrared radiation. applications on different landsat images such as Tm, SPOT, LKONOs, SIR-C and RADARSAT.

**G 412. PETROLEUM GEOLOGY (2) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 403. Offered in spring.

Sedimentary basins and their hydrocarbon potentialities, basin modeling and geohistory, evolving play concepts and analogues, develop is prospects for exploration, risk analyses and economics, reserve calculation and development plans, giant oil and gas occurrences exploration in Egypt .

**G 413. ENGINEERING GEOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 316. Offered in fall.

Introduction, engineering properties of soil and rocks, soil mechanics, site investigation and civil engineering, rock masses, engineering problems related to dams and land-sliding.

**G 414. HYDROGEOLOGY (2) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 405. Offered in spring.

Evaporation and precipitation, running water, reservoirs, well investigation, reservoir parameters, equilibrium and disequilibrium, sea water intrusion, factors controlling chemical composition of water. Presentation of Geochemical Data.

**G 415. ADVANCED GEOCHEMISTRY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 303. Offered in fall.

Environmental geochemistry, geochemical exploration, geochemistry of selected groups of elements such as ree, pge, hfse or heavy metals, geochemistry of ore deposits (metallic or non-metallic), other modern approaches. Data processing and geochemical mapping, treatments and presentation.

**G 416. SPECIAL TOPICS (1 cr. + 1 cr. Lab.)**

Offered in spring.

It is a departmental issue, where selected topics on modern advances can be provided and nominated beforehand.

**G 417. METAMORPHIC PETROLOGY (2) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 302. Offered in fall.

Equilibrium aspects and kinetics of metamorphic action, reactions in politic, mafic and ultramafic systems. Metamorphic differentiation, paragenesis of metamorphic mineral assemblages, facies series, microtectonics, applications.

**G 418. ISOTOPE GEOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 308. Offered in spring.

Introduction, age of the earth, decay of radioactives atoms, age dating methods (K-Ar, Ar-Ar, Rb-Sr, Sm-Nd, and U-, Th-Pb), oxygen, hydrogen, carbon and sulfur. Dating calculation, exercises and problems.

**G 419. NON-METALLIC DEPOSITS (1 cr. + 1 cr. Lab.)**

Prerequisite: G 204. Offered in fall.

Introduction, classifications, non-metallic ore deposits, industrial materials, ornamental stones, non-metallic deposits in egypt: phpsphorites, coal, black shales, limestones, glass sand, basement rocks, among others, economic prospects.

**G 420 VOLCANICLASTICS (1 cr. + 1 cr. Lab.)**

Prerequisite: G 301. Offered in spring.

Facies description, nomenclatures, properties of magma volcaniclastic deposits: fragmentation and general characteristics, lava flows, types of pyroclastic deposits and their eruptions, modern pyroclasic, transport and deposition of subaerial pyroclastic flows, ignimbrites, subaqueous pyroclastic. classification of modern and ancient volcaniclastic rocks, case studies from Egypt

**G 421. CLAY MINERALOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 204. Offered in fall.

Origin of clay minerals, chemical weathering, soil formation and secondary transported soils, structure of clay minerals and classification, diagenesis of clay mineral, clay as ore deposit, organic matter and clay mineral relationship, laboratory methods for clay minerals identification: (SEM, XRD, DTA, GTA, EMPA)

**G 422. ORGANIC GEOCHEMISTRY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 303. Offered in spring.

Introduction, application of hydrocarbon exploration, organic richness, source rock developments, kerogen formation and maturation, bitumen compounds, composition of bitumen and petroleum, maturation and biomarkers, source rock evaluation.

**G 423. ORE DRESSING (1 cr. + 1 cr. Lab.)**

Prerequisite: G 206. Offered in fall.

Introduction, ore deposit characteristics, mechanical separation, floatation, magnetic separation, using ore microscopy in mineral beneficiation of different ore deposits.

**G 424. GEMOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 206. Offered in spring.

The prime requirements, for gems, the geological formation and occurrence of gemstones, the chemical composition of gemstones, physical and optical properties of gemstones, gemstone types, the fashioning of gemstones, cutting styles, grading of gemstones, important gem minerals.

**G 425. MARINE GEOLOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 407. Offered in fall.

Marine environment, physical chemistry of sea water, intertidal environment, estuaries, the sea bottom productivity, plant-growth and the pelagic habitates. study of the biota and lithofacies characters of the different rocks in different environments. study of different biota events under microscope

**G 426. APPLIED MINERALOGY (1 cr. + 1 cr. Lab.)**

Prerequisite: G 206. Offered in spring.

Introduction, mineral resources and industry, modern technology, standard specifications, minerals in metallurgy, alloys, drilling, cement, ceramics, glass, electronics, semi-conductors, supermagnets, fertilizers, energy supply, precious stones, ornamental stones, building stones.

**G 428. REMOTE SENSING (2) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 411. Offered in spring.

Radiometric and geometric corrections, digital image analyses, image classifications, earth science applications, environmental applications, survey applications, hydrological applications.

**G 430. GEOPHYSICS (2) (1 cr. + 1 cr. Lab.)**

Prerequisite: G 305. Offered in spring.

Introduction, magnetic, gravity and seismic methods, applied geophysics, case study on Egypt. Application on petroleum exploration, environmental problems.

**G 432 Petroleum and Subsurface Geology (2 cr. + cr. Lab.)**

Offered in spring.

Introduction, commercial accumulations and critical risk, evolution of petroleum, exploration techniques, properties and composition of hydrocarbon, origin, digenesis of organic matter, maturation, migration, reservoirs, sedimentary basins and their hydrocarbon potentialities, hydrocarbons exploration in Egypt, main hydrocarbon provinces. risk analyses and economics, reserve calculation and development plans, giant oil and gas occurrences exploration in Egypt. subsurface structural maps, wireline log cross sections, preparation and uses of thickness maps, qualitative interpretation of logging diagrams, radioactivity well logging, geologic application of drilling time parameter, geologic application of drill-stem test data, criteria for subsurface faulting, analysis of sedimentary basins.

**G 434 Geology of Egypt and Economic Ore Deposits (2 cr. + cr. Lab.)**

Offered in spring.

Tectonic framework of Egypt, basement complex in Egypt, geology of selected areas in Egypt (Western Desert- Delta- Red Sea- Gulf of Suez- and Sinai), geological eras (Distribution of Egypt), mineral identification, ore mineral textures, paragenesis and paragenetic sequences, ore mineral assemblages, preparation of polished samples, mineral identification, ore mineral textures, paragenesis and paragenetic sequences, ore mineral assemblages.

**G 436 Hydrogeology (2 cr. + cr. Lab.)**

Offered in spring.

General introduction, aquifer properties, aquifer parameters, underground water movements, relationship of water quality to geologic conditions, water quality, underground water exploration using seismic and electrical methods, reservoirs, well investigations, reservoir parameters, equilibrium and disequilibrium.

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# ENTOMOLOGY

## First: Academic programs Offered by Entomology Department

**The following courses are offered for the following specialties:**

1- Chemistry/ Entomology and Environment-Health (Chem./Ent.)
2- Biophysics (Biophys.)
3- Geology (G)

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 1 | 1st | Bio. 101 | Introductory Entomology (1) | - | Biophys., G, Biochem. | All Students | 2/3 | 1 | - | 1 | Bio 101, 102 are completed from other departments |
| | | Ent. 101 | Entomology and Environment-Health (1) | - | Chem/ Ent. | - | 2 | 2 | - | 3 | |
| | 2nd | Bio 102 | Introductory Entomology (2) | Bio 101 | Bioplys, Geol, Biochem | All students | 2/3 | 1 | - | 1 | |
| | | Ent 102 | Entomology and Environment-Health (2) | Ent 101 | Chem/Ent | - | 2 | 2 | - | 3 | |

| LEVEL | SEMESTER | SUBGECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 2 | 3rd | Ent 211 | Cell Biology | Z102 | Chem./Ent | - | 2 | - | - | 2 | 10 cr compuls. |
| | | Ent 212 | Insect Anatomy and Histology | - | | - | 2 | 2 | - | 3 | |
| | | Ent 213 | Insect Morphology | - | | - | 2 | 2 | - | 3 | |
| | | Ent 214 | Insect Collectinos and Preservations | | | - | - | 6 | - | 2 | |
| | 4th | Ent 215 | Insect Embryology, and Metamorphosis | - | | - | 2 | 2 | - | 3 | 9 cr compuls |
| | | Ent 216 | Insect Interrelations in the Biosphere | - | Chem./Ent. | - | 2 | 2 | - | 3 | |
| | | Ent 281 | Insect Control | - | | - | 2 | 2 | - | 3 | |
| | | Ent 251 | Principles of Insect Physiology | Bio.102 | Biophys. | - | 2 | 3 | - | 3 | Bio-phys |
| 3 | 5th | Ent 331 | Insect Ecology and Behavior | Ent. 216 | Chem./Ent. | - | 2 | 2 | - | 3 | 6cr compuls |
| | | Ent 321 | Insect Taxonomy and Classification | Ent. 213 | | - | 2 | 2 | - | 3 | |
| | | Ent 371 | Pathogens, Epidemiology, and Diagnosis | - | - | Chem./Ent | 2 | 2 | - | 3 | 3 cr elective |
| | | Ent 372 | Parasitology, Epidemiology, and diagnosis | - | - | | 2 | 2 | - | 3 | |
| | 6th | Ent. 311 | Insect Pests, and Disease Transmission | Ent. 321 | Chem./Ent | - | 2 | 2 | - | 3 | 6 cr compuls |
| | | Ent. 341 | Medical and Veterinary Entomology and Acarology | Ent. 321 | | - | 2 | 2 | - | 3 | |
| | | Ent. 373 | Insect Pathology and Immunology | Ent321 Ent. 371 | - | Chem./Ent. | 2 | 2 | - | 3 | 3 cr elective |
| | | Ent. 374 | Insect Microbiology and Immunology | | - | | 2 | 2 | - | 3 | |

| LEVEL | SEMESTER | SUBGECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 7th | Ent. 451 | Insect Physiology | Ent. 212 | Chem./ Ent | - | 2 | 3 | - | 3 | 6 cr compuls |
| | | Ent 491 | Molecular Analysis, Tissue Culture, and Histological Techniques | Ent. 461 or Ent. 462 | | - | - | 6 | - | 3 | |
| | | Ent. 461 | Insect Biochemistry | Ent. 212 | - | Chem./Ent. | 2 | 3 | - | 3 | 3 cr elective |
| | | Ent. 462 | Insect Metabolism | | | | 2 | 3 | - | 3 | |
| | 8th | Ent 400 | Seminar | - | Chem./ Ent. | - | 1 | - | - | 1 | 6 cr compuls |
| | | Ent. 482 | Integrated Pest Management | Ent. 281 | | - | 2 | 3 | - | 3 | |
| | | Stat.422 | Biostatistics for Biologists | - | | - | 1 | 2 | 1 | 2 | |
| | | Ent. 465 | Toxicology and Pollution | Ent. 461 | - | Chem./Ent. | 2 | 2 | - | 3 | 3 cr elective |
| | | Ent. 466 | Environmental Residuals and Pollutants | Ent. 462 | - | | 2 | 2 | - | 3 | |

## Second: Courses Offered by Enotmology Department

**Bio. 101 INTRODUCTORY ENTOMOLOGY (1) (1 cr. + 1 cr. Lab.)**

Offered in fall.

General considerations. External structure: Body wall. Head. Thorax. Abdomen. Internal structure and physiology: Digestive and excretory system. Respiratory system. Circulatory system. Nervous system. Reproductive system. Endocrine system. Insect growth and development: The egg. Fertilization. Early organization. Hatching. Larval and pupal forms. Metamorphosis.

**Bio. 102 INTRODUCTORY ENTOMOLOGY (2) (1 cr. + 1 cr. Lab.)**

Prerequisite: Bio101. Offered in spring.

Insect groups: Aperygotes. Exopterygotes. Endopterygotes. Terrestrial insects. Aquatic insects. Insect life cycle and seasonal cycle. Insect interactions in the community. Range of activity and distribution. Destructive and useful insects.

**Ent. 101 ENTOMOLOGY AND ENVIRONMENT-HEALTH (1) (2 cr. + 1 cr. Lab.)**

Offered in fall.

What an insect is? Insect science or "Entomology". Qualifications and abundance of insects. External and internal morphology and functions of a model insect (locust). Models of the insect life cycle. Environmental effects and seasonal cycle. Categories of insect interactions with the community. Important insect groups (Classificaion). Examples of beneficial insects to human, animals, and plants.

**Ent. 102 ENTOMOLOGY AND ENVIRONMENT-HEALTH (2) (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent 101. Offered in spring.

Insects attacking plants: Injury by feeding. Injury by oviposition. Disease transmission. Examples of insect pests to plants (Crop plants. Vegetables. Horticulture). Insect pests of stored products (Textiles. Food). Insects attacking man and animals. Insects and transmission of diseases. Examples of viral, rickettsial, and bacterial diseases, and role of insects in transmission.

**Ent. 211 CELL BIOLOGY (2 cr. + 1 cr. Lab.)**

Prerequisite: Z102. Offered in fall.

Ultrastructure of the cell. The macromolecules of the cell. Cells and organelles. Bioenergetics. Membranes: Their structure, function, and chemistry. Transport across membranes. Signal transduction mechanisms: 1. Electrical signals in nerve cells. 2. Messengers and receptors. Intracellular compartments: The endoplasmic reticulum, Golgi complex, endosomes, lysosomes, and peroxisomes. The structural basis of cellular information: DNA, chromosomes, and the nucleus. The cell cycle: DNA replication, mitosis, and cancer. Sexual reproduction, meiosis, and genetic recombination. Cytoskeletal systems. Cellular movement: motility and contractility.

**Ent. 212 INSECT ANATOMY AND HISTOLOGY (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent 101. Offered in fall.

Basic cell structure, ultrastructure, and organelles. Integument: Epidermis. Exocrine glands. Cuticular layers, Pore canals. Muscles: Musculature. Basic structure and variations. Innervation and tracheation. Alimentary canal: General structure and variations between insects. The different regions and parts. Salivary glands. Pulsatile organs of circulation and hemocoelic organs and tissues: Dorsal vessel and accessory pulsatile organs. Alary muscles, and dorsal and ventral diaphragms. Innervation of heart. Hemocytes. Phagocytic organs. Fat body. Connective tissues. Tracheal system: Tracheae. Tracheoles. Air sacs. Spiracles. Tracheal gills. Plastron. Spiracular gills. Hemoglobin–containing tracheal cells. Reperoductive system: Testes. Tubes. Ducts. Accessory glands and structures. Mature sperm. Spermatophore. Ovaries. Tubes. Ducts. Accessory glands and structures. Excretory organs: Malpighian tubules. Nephrocytes. Accessory excretory organs. Nervous and Endocrine systems: Neurones. Central, visceral, and peripheral nervous systems. Brain and ganglia. Connectives and nerves. Neurosecretory cells. Cropus cardiacum. Corpus allatum. Prothoracic gland. Histology of sensory receptors: Mechanorecoptors. Chemoreceptors.

Thermoreceptors. Hygroreceptors. Eyes.

**Ent. 213 INSECT MORPHOLOGY (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent 101. Offered in spring.

External features of body wall (Sutures. Apodemes. Articulations. External processes of body surface and sensory receptors). Body regions: Head (Areas. Sutures. Tentorium. Comparative morphology of the insect head, antennae, and mouthparts). Neck. Thorax (Pro-, and pterothoracic structure. Types of wings and legs, and articulation to thorax). Abdomen (Segmentation. Structure of abdominal segments. Abdominal appendages).

**Ent. 214 INSECT COLLECTIONS AND PRESERVATIONS**

Prerequeisite: - Offered in Foll

Collections of insects from different localities. Referring to orders. Mounting and preserving insects: Dry mounting- Preservation in fluids. Mounting on microscope slides using different mounting media.

**Ent. 215 INSECT EMBRYOLOGY, DEVELOPMENT, AND METAMORPHOSIS (2 cr.)**

Prerequisite: Ent 102. Offered in spring.

Embryogenesis: Histogenesis (Blastoderm formation. Germ band formation. Gastrulation. Envelopes). Organogeny (formation of organs and systems derived from ectoderm, mesoderm, and endoderm). Morphogenesis. Control of embryogenesis. Hatching (Stimuli of hatching. Mechanisms of hatching). Growth of immatures (Growth of body. Rate. Molting. Control). Development of adult (Hemi-, and holometabolus insects). Development of adult external features (Appendages. Epidermis). Development of internal adult organs. Control of matamorphosis. Adult emergence (Mechanism. Timing. Control). post-imaginal development.

**Ent. 216 INSECT INTERRELATIONS IN THE BIOSPHERE (2 cr.)**

Prerequisite: Ent 221. Offered in spring.

General considerations (The surrounding elements. Position of insects in food chains and webs of aquatic and terrestrial ecosystems. Feeding habits. Tolerance range). Forms of interactions in the community: Symbiosis (Commensalism. Mutualism. Parasitism). Allelopathy. Competition. Predation (Hiding adaptations. Defense adaptation). Insects, microbes, and helminthes. Entomophagous insects. Cooperative relationships between insects. Intra-specific behavioral interactions of insects. Interrelations between insects and vertebrate animals and vascular plants. Interactions and adaptations in soil and aquatic insects.

**Ent. 321 INSECT TAXONOMY AND CLASSIFICATION (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent 102. Offered in fall.

Introduction. Taxonomy: Linnean hierarchy. Species concept. Other kinds of species. Variety. Subspecies. Subgenus. Description. Lectotype designation. Taxonomic characters. Some latin abbreviations. Zoological nomenclature. Some rules of nomenclature. Classification: Arthropod diversity and morphological characteristics. Class Insecta. Subclass Apterygota (4 orders). Subclass Pterygota (Divison Exopterygota, 15 orders. Division Endopterygota, 8 orders).

**Ent. 251 PRINCIPLES OF INSECT PHYSIOLOGY (2 cr. + 1 cr. Lab.)**

Prerequisite: Bio 102. Offered in spring.

Molting and formation of new cuticle. Ecdysis. Sclerotization. Hormonal control. Functions of cuticle. Muscle excitation and activation. Visceral muscle physiology. Digestion. Hormonal control of midgut. Functions of peitrophic membrane. Absorption. Hemolymph circulation and functions. Heartbeats. Ventilation. Gas exchange in aquatic and endoparasitic insects. Respiratory pigments. Non-respiratory functions of the tracheal system. Nutrients and hormonal regulation of oogenesis. Vitellogenesis. Spermatogenesis. Urine formation. Selective reabsorption of hindgut. Role of excretory system in the internal environment homeostasis. Neurone responses to stimuli. Physiological basis for neuronal responses to stimuli. Conduction of the action potential. Excitatory and inhibibitory postsynaptic potentials. Acetylcholine mediated synapses. Physiology of neuromuscular junctions.

**Ent. 281 INSECT CONTROL**

Prerequisite: Ent 101, Ent 102. Offered in spring.

The importance of insect control operations. Different methods and ways of insect control:
Cultural control, resistant plant varieties, biological control (predators & parasitoids), Microbia control, Feeding deterrents, autocidal control (Radiations induced sterilization & chemosterilants), Semiochemicals (allomones, kairomons, pheromones), insect growth regulatiors and conventional chemical control.

**Ent. 311 PLANT PESTS AND TRANSMISSION OF DISEASES (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent 221. Offered in spring.

Assessement of pest injury: Types of plant injury (Injury by feeding: Chewing plant parts. Sap sucking. Mining and boring. Gall formation. Injury by oviposition. Injury by disease transmission). Major pests of small grains, corn, legumes, cotton, vegetables, fruit trees, and stored product. Pests of beneficial insects. Transmission of plant diseases: Definitions and terms. Classification of plant diseases. Susceptibility of plants to insect attack. Adaptations of insect vectors. Phytopathogens transmitted by insects: Nonmicrobial diseases. Microbial diseases (Bacterial diseases. Fungal diseases. Viral diseases).

**Ent. 331 INSECT ECOLOGY AND BEHAVIOR (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent 221. Offered in fall.

What is ecology. Individual insect ecology (Effect of abiotic conditions. Resource acquisition). Population ecology (Density. Distribution. Natality. Mortality. Dispersal). Community ecology (Diversity. Species interactions. Functional organization. Ecological succession). Ecosystem (Ecosystem structure. Energy flow. Biogeochemical cycling. Role of insects in ecosystems). Behavior and Orientation: Mechanisms of orientation (Kinesis. Taxes). Orientation by light, temperature, smell, and humidity. Rhythms. Locating food and initiating feeding. Locating mates, courtship, and copulation. Oviposition. Nesting and brood care. Migration. Competition. Protection (Autotomy. Reflex immobility. Reflex bleeding. Defensive secretion. Sonic devices). Revealing coloration. Mimicry. Co-ordinated behavior: Succession and inhibition of responses. Route finding by Hymenoptera.

**Ent. 341 MEDICAL AND VETERINARY ENTOMOLOGY, AND ACAROLOGY (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent 221. Offered in spring.

Arthropods as disease agents or vectors. Morphology, classification, biology and disease relationships of insects: Insects of minor medical importance (cockroaches, ants, beetles, moths). Insects of prominent medical importance: Blood sucking Hemiptera. Sucking lice. Chewing lice. Dipterans: Nematocera: Ceratopogonidae. Simulidae Culicidae. Brachycera: Tabanidae. Cyclorrhapha: Glossinidae, Muscide, Fanniidae, Callipharidae. Hippoboscidae. Siphonaptera. Morphology, classification, biology, and disease relationships of ticks and mites: Ixodidae, Agrasidae, Sarcoptidae, Psoroptidae, Dermanyssidae, Demodicidae, Acaridae, and Glycyphagidae.

**Ent. 371 PATHOGENS, EPIDEMIOLOGY, AND PARASITOLOGICAL DIAGNOSIS (2 cr. + 1 cr. Lab.)**

Offered in fall.

Groups of microbial pathogens to human, animals, and plants. Host-parasite relationshiphs. General properties of viruses. Arthropod-borne viruses. Bacterial cell characteristics. Major groups of bacteria. Mycoplasma, spirochetes, and rickettsia. Fungi structures and groups. Infection and epidemiology of selected pathogens causing indigenous diseases in Egypt. Cultivation of microorganisms. Laboratory diagnosis of microbial pathogens.

**Ent. 372 PARASITOLOGY, EPIDEMIOLOGY, AND PARASITIC DIAGNOSIS (2 cr. + 1 cr. Lab.)**

Offered in fall.

Parasites of human, animals, plants, and insects. Characteristics, biology, infection, and epidemiology of parasitic protozoans, worms and insects, of common occurrence in Egypt. Protozoa: Rhizopodea, Telosporea, Toxoplasmea, and Ciliatea. Platyhelminthes: Trematoda, and Cestoidea. Nematoda: Aphasmidia, and Phasmidia. Parasitic insects. Laboratory diagnosis of parasitic infections.

**Ent. 373 INSECT PATHOLOGY AND IMMUNOLOGY (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent.221, Ent.371. Offered in spring.

Basic techniques and procedures. Noninfectious diseases: Mechanical injuries. Injuries due to physical agents. Injuries due to poisons. Injuries due to parasitization or infestation by other insect or arthropod. Infectious dieases: Basic definitions and parameters. Insect immune system. Cell mediated immune response (Phagocytosis. Encapsulation. Nodule formation). Humoral reactions: Innate reactions (Lectins. Hemolins). Inducible reactions (Lysozymes. Cecropins. Attacin-like molecules). Prophenoloxidase activating systems. Suppression of the immune system. Anti-midgut vaccines.

**Ent. 374 INSECT MICROBIOLOGY AND IMMUNOLOGY (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent.221, Ent.371. Offered in spring.

Major groups of microorganisms pathogenic to insects. How infection and disease is produced. Epizootiology of insect diseases. Bacterial diseases. Fungal diseases. Viral diseases. Protozoal diseases. Nemtodal diseases. Insect immune system. Cell mediated immune response (Phagocytosis. Encapsulation. Nodule formation). Humoral reactions: Innate reactions (Lectins. Hemolins). Inducible reactions (Lysozymes. Cecropins. Attacin-like molecules). Prophenoloxidase activating systems. Suppression of the immune system. Anti-midgut vaccines.

**Ent. 451 INSECT PHYSIOLOGY (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent. 212. Offered in fall.

Molting and formation of new cuticle. Ecdysis. Sclerotization. Hormonal control. Functions of cuticle. Muscle excitation and activation. Visceral muscle physiology. Digestion. Hormonal control of midgut. Functions of peritrophic membrane. Absorption. Hemolymph circulation and functions. Heartbeats. Ventilation. Gas exchange in aquatic and endoparasitic insects. Role of respiratory pigments. Non-respiratory functions of the tracheal system. Nutrients and hormonal regulation of oogenesis. Vitellogenesis. Spermatogenesis. Urine formation. Selective reabsorption by hindgut. Role of excretory system in the internal environment homeostasis. Mechanoreception. Chemoreception. Photoreception. Thermo-, and hygroreception. Neurone responses to stimuli. Physiological basis of neuronal responses to stimuli. Conduction of the action potential. Excitatory and inhibibitory postsynaptic potentials. Acetylcholine mediated synapses. Physiology of neuromuscular junctions. Hormonal mode of action; and regulations to growth and development.

**Ent. 461 INSECT BIOCHEMISTRY (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent.212. Offered in fall.

Ultrastructure of a generalized cell and organelles. Biochemistry of the insect cuticle: Cuticular components. Biochemistry of hardening. Biosynthesis of cuticular components. Nutrition. Utilization of food. Digestive enzymes. Hemolymph composition. Control of pH. Ionic and osmotic regulation. Biochemistry of the contractile elements of muscles. Biological oxidations and energetics in mitochondria. Intermediary metabolism in the fat body. Insect-specific metabolic pathways for certain metabolites, e.g. $\alpha$-glycerophosphate, trehalose, tyrosine, glycerol, sorbitol, tryptophan, praline, vitellogenin, chitin, immunoproteins, o-dihydroxyphenols, xenobiotics… etc. Functional role of carbohydrates in insect life processes. Functional role of lipids in insects. Biosynthesis of specific insect proteins and its functional role. Formation of insect biochromes.

**Ent. 462 INSECT METABOLISM (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent.212. Offered in fall.

General characteristics of enzymes: Biologic catalysts (Shared properties. Differences between enzymes and chemical catalysts). Measures of enzyme activity (Unit of enzyme activity. Specific activity). Enzyme nomenclature (Oxidoreductases. Transferases. Hydrolases. Lyases. Isomerases. Ligases. Trivial names). Mechanism of enzyme catalysis. Enzyme kinetics. Enzyme inhibition. General techniques for enzyme purification. Methods of studying metabolism (Use of radioactive isotopes as tracer atoms. Studies with purified enzyme systems. Inhibition of enzyme systems with poisons. Competitive analogue-metabolite inhibition. Tissue homogenate technique. Analysis of excretion. Respiratory exchange ….. etc.). biologic oxidation. Specialized metabolic pathways in insects.

**Ent. 465 TOXICOLOGY, AND POLLUTION (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent.461. Offered in spring.

Scope of toxicology. Classes and types of toxins. Chemistry of toxins. Mode of action of toxins(nerve poisons. Muscle poinsons Antimetabolites…etc.). Acute effects of poisons. Chronic effects of toxins (Mutagenic, carcinogenic, and teratogenic effects). Detoxification mechanisms: Oxidation. Reduction. Hydrolysis. Conjugation. Toxic residues and fate in the environment.

**Ent. 466 ENVIRONMENTAL RESIDUALS AND POLLUTANTS (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent. 462. Offered in spring.

Pollutants. Routes of the hazardous xenobiotics into, and fate in, living organisms and ecosystems. Metabolism and effect of hazardous xenobiotics on living organisms (Physiological effects. Biochemical effects. Interactive effects). Biomarkers. Effects of hazardous xenobiotics on populations and communities: Changes in population density. Evolution of resistance. Changes in communities and ecosystems. Biomarkers in populations.

**Ent. 481 INTEGRATED PEST MANAGEMENT (2 cr. + 1 cr. Lab.)**

Prerequisite: Ent. 311. Offered in spring.

Concepts of economic levels of injury. Dynamics of economic – injury levels. The concepts of pest management; strategies and tactics. Development of pest management programs. The theory of biological control. Agents of biological control. The practice of biological control. Augmentation. Common classes of insecticides. Concentration of compound, and timing of application. Chemicals used with insecticides. Insecticide formulations. Chemicals disrupting normal growth and development. Chemicals modifying behavior patterns. Tactics and techniques of genetic control. Uses of insect – resistant cultivars in pest management. Insect pest management programs.

**Ent.491MOLECULAR ANALYSIS, TISSUE CULTURE, and HISTOLOGICAL TECHNIQUES(3 cr.Lab.)**

Prerequisite: Ent. 461 Or Ent 462. Offered in fall.

Biological-specimen preparation: Cell lysis and extraction. Techniques for preparing biological material. Subcellular fractionation of cell components and organelles. Separation and purification of proteins, carbohydrates, and lipids. Centrifugation techniques: Separation methods in preparative ultracentrifuges. Applications of the analytical ultracentrifuge. Quantitative determination of biomolecules: Carbohydrates, amino acids, peptides, proteins, nucleotides, nucleic acids, and lipids. Electrophoretic techniques: Electrophoresis of proteins. Electrophoresis of nucleic acids. Chromatographic techniques: Low pressure column chromatography. High performance liquid chromatography. Ion-exchange chromatography. Exclusion (permeation) chromatography. Affinity chromatography. Gas-liquid chromatography. Thin-layer chromatogoaphy. Radioisotope techniques: Detection and measurement of radioactivity. Enzyme techniques: Enzyme assay techniques. Molecular biology techniques: Isolation of nucleic acids. Physical analysis of DNA. Enzymes used in genetic manipulation. Cloning vectors. Sequencing of DNA. Isolation of specific nucleic acid sequences (cDNA, gene libraries, colony hybridisation, PCR, oligonucleotide probes). Expression of genes. Histological techniques: Tissue preparation, mounting, cutting by ordinary, freezing and ultramicrotome. Staining, coating, and visualization of cells, chemical components, ultrastructure and organelles. Cell and tissue culture: Apparatus, sterility, and cleaning. Cell culture media. Microscopy of living cells. Basic cell culture technique and the maintenance of cell lines. Primary cultures and the establishment of cell lines. Specific cell types and their requirements. Uses of tissue and cell culture (In virology, biochemistry, immunology, parasitology and toxicology, physiology, and manufacture of biological substances).

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# ASTRONOMY AND METEOROLOGY

## First: Academic programs Offered by Astronomy and Meterology Department

**The Department offers courses for student of the following groups:**

1- Astronomy (A)
2- Physics/ Astronomy (Phys/A)
3- Mathematics/ Astronomy (Math/A)
4- Physics/ Meteorology (Phys/ Met)
5- Space Science (S)

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 1 | 1st | A 111 | Introduction to Astronomy and Space sciences (1) | - | A, Phys/A, Math/A, Phys/Met, S | - | 2 | - | 3 | 3 | 6 cr. Compuls. |
| | 2nd | A112 | Introduction to Astronomy and Space sciences (2) | A 111 | | | 2 | - | 3 | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 2 | 3rd | A201 | Solar Observations | A111 | A, A/Phys, A/Math | - | - | 6 | - | 2 | 18 cr. compuls. for Spical |
| | | A211 | Astrophysics (1) | A111 | | - | 2 | - | - | 2 | |
| | | A213 | Spherical Astronomy (1) | A111 | | - | 2 | - | 3 | 3 | |
| | | A215 | Celectial Mechanics | A111 | | - | 2 | - | - | 2 | |
| | | Math211 | Linear Algebra And Geometry (1) | Math110 | A, S | - | 2 | - | 3 | 3 | |
| | | Phys221 | Classical Mechanics (1) | Math131 | | - | 2 | - | - | 2 | |
| | | Math231 | Calculus And Analytical Geometry (3) | Math132 | | - | 2 | - | - | 2 | |
| | | Phys201 | Practical Physics | - | | - | - | 6 | - | 2 | |
| | | S201 | Observations | A112 | S | - | - | 6 | - | 2 | |
| | | S211 | Principles of space physics | A112 | | - | 2 | - | - | 2 | |
| | | S213 | Geographic and celestial coordinates | A112 | | - | 2 | - | 3 | 3 | |
| | | Met216 | Atmospheric Physics (1) | A112 | | - | 2 | 3 | - | 3 | |
| | | Met201 | Weather Analysis | A112 | Met/Phys | - | - | 3 | - | 1 | 9 cr. compuls. for dual |
| | | Met203 | Application on Atmospheric | A112 | | - | - | - | 3 | 1 | |
| | | Met205 | Physical Meteorology Laboratory | A112 | | - | - | 3 | - | 1 | |
| | | Met211 | General Meteology | A112 | | - | 2 | - | - | 1 | |
| | | Met213 | Introductory Dynamical Meteorology | A112 | | - | 2 | - | - | 1 | |
| | | Met215 | Introductory Physical Meteorlogy | A112 | | - | 2 | - | - | 1 | |
| | 4th | A202 | Stellar Observations | A201 | A, A/Phys, A/Math | - | - | 6 | - | 2 | 9 cr. compuls. for dual |
| | | A212 | Astrophysics (2) | A211 | | - | 2 | - | - | 2 | |
| | | A214 | Spherical Astronomy (2) | A213 | | - | 2 | - | 3 | 3 | |
| | | A216 | Astronomical Equipments and Observational Analysis | A215 | | - | 2 | - | - | 2 | |
| | | Math241 | Ordinary Differential Equations | Math231 | A, S | - | 2 | - | 3 | 3 | 19 cr. compuls. for spicial |
| | | Phys261 | Modern Physics | Phys221 | | - | 2 | - | - | 2 | |
| | | Phys241 | Mathematical Physics (1) | Phys231 | | - | 2 | - | 3 | 3 | |
| | | Phys202 | Practical physics | - | | - | - | 6 | - | 2 | |
| | | A202 | Stellar Observations | A112 | S | - | - | 6 | - | 2 | |
| | | A211 | Astrophysics (1) | A111 | | - | 2 | - | - | 2 | |
| | | S214 | Orbital mechanics | S213 | | - | 2 | - | 3 | 3 | |
| | | Met214 | Atmospheric Dynamics (1) | Met216 | | - | 2 | - | - | 2 | |
| | | Met212 | General Climatology | Met211 | Met/Phys | - | 2 | - | - | 2 | 9 cr. compuls. for Met/Phys |
| | | Met214 | Atmospheric Dynamics (1) | Met213, Met203 | | - | 2 | - | - | 2 | |
| | | Met216 | Atmospheric Physics (1) | Met215, Met205 | | - | 2 | - | - | 2 | |
| | | Met202 | Synoptic (1) | Met201 | | - | - | 3 | - | 1 | |
| | | Met206 | Synoptic (2) | Met201 | | - | - | 3 | - | 1 | |
| | | Met204 | Applications on Atmospheric Physics and Dynamics (1) | Met213, Met215 | | - | - | - | 3 | 1 | |
| | | Met218 | Climate & applied Meteorology for non meteorologists | - | - | Chem/Z | 2 | 3 | - | 3 | Z |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 3 | 5th | A301 | Astronomical Calculations | A214 | A, A/Phys, A/Math | - | - | - | 3 | 1 | 18 cr. Compuls. for A, 19 cr. compuls. for S., 8 cr. compuls. for dual |
| | | A303 | Orbital Calaulations | A215 | | - | - | 3 | - | 1 | |
| | | A311 | Solar Physics | A212 | | - | 2 | - | - | 2 | |
| | | A313 | Radiative Transfer | A212 | | - | 2 | - | - | 2 | |
| | | A315 | Celectial Mechanics | A215 | | - | 2 | - | 3 | 3 | |
| | | Phys342 | Mathematical physics (2) | Phys241 | A, S | - | 2 | - | 3 | 3 | |
| | | Phys351 | Statistical physics (1) | Phys221 | | - | 2 | - | - | 2 | |
| | | Phys301 | Spectrescopy lab. | - | A | - | - | 6 | - | 2 | |
| | | Phys424 | Fluied Dynamics | Phys221 | | - | 2 | - | - | 2 | |
| | | S301 | Analytical Computations (1) | - | S | - | - | 3 | - | 1 | |
| | | S303 | Orbital Calaculations (1) | S212 | | - | - | 3 | - | 1 | |
| | | S305 | Solar spectra | - | | - | - | 3 | - | 1 | |
| | | S307 | Analytical Computations (2) | - | | - | - | 3 | - | 1 | |
| | | S311 | Space Dynamics | S212 | | - | 2 | - | 3 | 3 | |
| | | S313 | Space Physics | A211 | | - | 2 | - | - | 2 | |
| | | S315 | Solar Physics and Energy | A211 | | - | 2 | - | - | 2 | |
| | | A318 | General Relativity | A211 | | - | 2 | - | 3 | 3 | |
| | | Met301 | Synoptic (1) | Met202 | Met/Phys | - | - | 3 | - | 1 | 9 cr. compuls. |
| | | Met305 | Applications on Atmospheric Physics and Dynamics (2) | Met204 | | - | - | - | 3 | 1 | |
| | | Met302 | Synoptic (1) | Met301 | | - | - | 3 | - | 1 | |
| | | Met311 | Atmospheric Dynamics (2) | Met214 | | - | 2 | - | - | 2 | |
| | | Met313 | Atmospheric Physics (2) | Met216 | | - | 2 | - | - | 2 | |
| | | Met315 | Synoptic (1) | Met212 | | - | 2 | - | - | 2 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 3 | 6th | A302 | Analysis and Computer | - | A, A/Phys, A/Math | - | - | - | 3 | 1 | 14 cr. compuls. + 4 cr. elective for A, 7 cr. compuls. + 2 cr. elective for A dual |
| | | A304 | Astrophysics | - | | - | - | 6 | - | 2 | |
| | | A312 | Stellar Structure and Evolution | A212 or A313 | | - | 2 | - | - | 2 | |
| | | A322 | Planetary Physics | A212 | A/Math, A/Phys, S | A | 2 | - | - | 2 | |
| | | A306 | Astronomical Applications on the Conputer (1) | - | A | - | - | 3 | - | 1 | |
| | | A314 | Interstellar Matter | A212 | - | A, A/Phys, A/Math | 2 | - | - | 2 | |
| | | A316 | Stellar Dynamics | A312 | - | | 2 | - | - | 2 | |
| | | A320 | Statistical Astronomy | A312 | - | | 2 | - | - | 2 | |
| | | A318 | General Relativity | A212, A313 | A | A/Phys, A/Math | 2 | - | 3 | 3 | |
| | | Phys352 | Statistical physics (2) | Phys351 | A, S | - | 2 | - | - | 2 | |
| | | Phys362 | Quantum mechanics (1) | Phys261 | | - | 2 | - | - | 2 | |
| | | Met413 | Physics of upper atmosphere | Met216 | S | - | 2 | - | - | 2 | 14 cr. compuls, + 4 cr. elective |
| | | S302 | Analytical Computations (2) | - | | - | - | 3 | - | 1 | |
| | | S304 | Orbital Calculations (2) | S212 | | - | - | 3 | - | 1 | |
| | | S306 | Space Physics (1) | - | | - | - | 3 | - | 1 | |
| | | S308 | Space Physics (2) | - | | - | - | 3 | - | 1 | |
| | | S310 | Computational Analysis (4) | - | | - | 2 | - | - | 2 | |
| | | S312 | Space Mission Analysis and Design | S111 | - | S | 2 | - | - | 2 | |
| | | S313 | Space Physics | A211 | - | | 2 | - | - | 2 | |
| | | S314 | Space Chemistry | Met413 | - | | 2 | - | - | 2 | |
| | | S316 | Astronautics | S313 | - | | 2 | - | - | 2 | |
| | | S318 | Remote Sensing | - | - | | 2 | - | - | 2 | |
| | | A417 | Dynamical Systems | S311 | - | | 2 | - | - | 2 | |
| | | Met303 | Synoptic (3) | Met206 | - | Met/Phys | - | 3 | - | 1 | 9 cr. elective |
| | | Met304 | Synoptic (4) | Met303 | - | | - | 3 | - | 1 | |
| | | Met312 | Boundary Layer Dynamics | Met311 | - | | 2 | - | - | 2 | |
| | | Met316 | Synoptic (2) | Met315 | - | | 2 | - | - | 2 | |
| | | Met322 | Climatology and Climate Change | Met315 | - | | 2 | - | - | 2 | |
| | | Met318 | Radiation and Satellite Metorology | Met313 | - | | 2 | - | 3 | 3 | |
| | | Met320 | Energy and Environment | Met313, Met311 | - | | 2 | - | 3 | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 7th | A411 | Galactic Structure and Dynamics | A316 or A320 | - | A, A/Phys, A/Meth | 2 | - | - | 2 | 18 cr. elective foe spicial , 9 cr. elective for dual |
| | | A413 | Advanced Astrophysics | A212 | - | | 2 | - | - | 2 | |
| | | A425 | Compact Objects | A312 or A318 | - | | 2 | - | - | 2 | |
| | | A415 | Radio Astronomy | - | - | | 2 | - | - | 2 | |
| | | A423 | Special Course | - | - | A | 2 | - | - | 2 | |
| | | A421 | Field Theories | A318 | - | A, A/Phys, A/Meth | 2 | - | - | 2 | |
| | | A417 | Dynamic Systems | A315 | - | | 2 | - | - | 2 | |
| | | A419 | Dynamics of Star Clusters | A320 | - | | 2 | - | - | 2 | |
| | | A401 | Astronomical Applications on the Computer (2) | A306 | - | | - | 3 | - | 1 | |
| | | A403 | Astronomy Lab (1) | - | - | A | - | 3 | - | 1 | |
| | | A409 | Astrophysics Lab (1) | A304 | - | A, A/Phys, A/Meth | - | 3 | - | 1 | |
| | | A405 | Observatory (1) | - | - | | - | 6 | - | 2 | |
| | | A407 | Astronomical Training (1) | - | - | | - | - | 3 | 1 | |
| | | S401 | Analysis of Satellite pictures (1) | - | - | S | - | 3 | - | 1 | 18 cr. elective for S, 9 cr. elective for dual |
| | | S403 | Satellite Observations (1) | - | - | | - | 6 | - | 2 | |
| | | S405 | Orbital Calculations (1) | S304 | - | | - | 3 | - | 1 | |
| | | S407 | Analysis of Satellite pictures (2) | - | - | | - | 3 | - | 1 | |
| | | S409 | Space Calculations (1) | - | - | | - | 3 | - | 1 | |
| | | S411 | Space Environment (1) | - | - | | 2 | - | - | 2 | |
| | | S413 | Space Physics (1) | S313 | - | | 2 | - | - | 2 | |
| | | S415 | Artifical Satellite Theory (1) | S311, S303 | - | | 2 | - | - | 2 | |
| | | S417 | Satellite Geodesy | S303, S304 | - | | 2 | - | - | 2 | |
| | | S419 | Propulsion Systems | - | - | | 2 | - | - | 2 | |
| | | S418 | Optimal Trajectories | S413 | - | | 2 | - | - | 2 | |
| | | S425 | Attitude Dynamics and Control | - | - | | 2 | - | - | 2 | |
| | | S427 | Special Course (1) | - | - | | 2 | - | - | 2 | |
| | | Met401 | Meteorological Application and Techniques by Computers (1) | - | - | Met/Phys | - | 3 | - | 1 | 9 cr. elective |
| | | Met403 | Applications in Air Pollution | Met312 | - | | - | - | 3 | 1 | |
| | | Met405 | Meteorological Application and Techniques by Computers (2) | - | - | | - | 3 | - | 1 | |
| | | Met411 | Numerical Weather prediction (1) | Met311 | - | | 2 | - | - | 2 | |
| | | Met413 | Physics of the upper Atmosphere | Met316 or Met318 | - | | 2 | - | - | 2 | |
| | | Met415 | Tropical Meteorology | Met322 | - | | 2 | - | - | 2 | |
| | | Met417 | Physical Climatology | Met322 | - | | 2 | - | - | 2 | |
| | | Met419 | Selected topics in Meteorology | Met322 or Met318 or Met312 | - | | 2 | - | - | 2 | |
| | | Met421 | Air Pollution | Met312 | - | | 2 | - | - | 2 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 8th | A412 | Stellar Atmosphere | A313 | - | A, A/Phys, A/Math | 2 | - | - | 2 | 18 cr. elective for A, 9 cr. elective for dual |
| | | A418 | Astrochemistry | A314 | - | | 2 | - | - | 2 | |
| | | A416 | The Sun-Earth Connections | A311 | - | | 2 | - | - | 2 | |
| | | A414 | Perturbation Methods | A315 or A417 | - | | 2 | - | - | 2 | |
| | | A420 | Radiation and Gravitational | A313 | - | | 2 | - | - | 2 | |
| | | A424 | Csmology | A318 | - | | 2 | - | - | 2 | |
| | | A402 | Astronomical Applications on the Computer (3) | A401 | - | | - | - | 3 | 1 | |
| | | A406 | Observatory (2) | A405 | - | | - | - | 6 | 2 | |
| | | A426 | Astronomy of Short Waves | - | - | A | 2 | - | - | 2 | |
| | | A428 | Special Course (2) | - | - | | 2 | - | - | 2 | |
| | | A422 | Study of Extra Galaxies | A314 or A320 | - | | 2 | - | - | 2 | |
| | | A408 | Astronomical training (2) | - | - | | - | - | 3 | 1 | |
| | | S402 | Analysis of Artificial satellite Pictures (1) | - | - | S | - | 6 | - | 2 | 18 cr. elective for S, 9 cr. elective for dual |
| | | S404 | Artificial Satellite Observations (2) | - | - | | - | 6 | - | 2 | |
| | | S406 | Examinations From Space (1) | - | - | | - | 3 | - | 1 | |
| | | S408 | Examinations from Space (2) | - | - | | - | 3 | - | 1 | |
| | | S410 | Space Calculations (2) | S409 | - | | - | 3 | - | 1 | |
| | | S412 | Space Environment (2) | S411 | - | | 2 | - | - | 2 | |
| | | S414 | Space Physics (2) | S413 | - | | 2 | - | - | 2 | |
| | | S416 | Artifical Satellite Theory (2) | S415 | - | | 2 | - | - | 2 | |
| | | A416 | The Sun-Earth Connections | S405 | - | | 2 | - | - | 2 | |
| | | S418 | Optical tragictories | - | - | | 2 | - | - | 2 | |
| | | S420 | Astronautics | S316 | - | | 2 | - | - | 2 | |
| | | S422 | Space Communications | - | - | | 2 | - | - | 2 | |
| | | S424 | Microgravity and Biodynamics | - | - | | 2 | - | - | 2 | |
| | | S428 | Special course (2) | - | - | | 2 | - | - | 2 | |
| | | S430 | Hydrodynamics | - | - | | 2 | - | - | 2 | |
| | | Met402 | Atmospheric Modeling (1) | Met411 | - | Met/Phys | - | - | 3 | 1 | 9 cr. elective |
| | | Met404 | Statistical Application in Meterology | Met316 | - | | - | - | 3 | 1 | |
| | | Met406 | Atmospheric Modeling (2) | Met411 | - | | - | 3 | - | 1 | |
| | | Met412 | Numerical Weather prediction | Met411 | - | | 2 | - | - | 2 | |
| | | Met414 | Atmospheric chemistry | Met421 | - | | 2 | - | - | 2 | |
| | | Met416 | Statistical Clematology | Met322 | - | | 2 | - | - | 2 | |
| | | Met418 | Aviation Meterology | - | - | | 2 | - | - | 2 | |
| | | Met420 | Agrometeorology | Met312 | - | | 2 | - | - | 2 | |
| | | Met422 | Essay in Advanced Topics in Meteorology | - | - | | 2 | - | - | 2 | |

# Second: Courses Offered by Astronomy and Meteorology Department

## ASTRONOMY

**A. 111 INTRODUCTION TO ASTRONOMY AND SPACE SCIENCES (1) (2 cr. + 1 cr. Lab).**

Offered in fall.

Astronomy & history apparent, naked eye view, units & astronomical coordinates solar system (general), some astronomical phenomena, motion of stars & planets, stars and their types, clusters, interstellar matter, galaxies, story of the universe.

**Practical:** Intro. To coordinates, naked eye sky, star charts, constellations, the plants.

**A. 112 INTRODUCTION TO ASTRONOMY AND SPACE SCIENCES (2) (2 cr. + 1 cr. Lab).**

Prerequisite: A 111. Offered in spring.

Space sciences, satellites and spacecrafts, types of satellites, principles of orbital motions, life in space, space missions, space physics, atmospheric structure, air movements, heat budget, atmospheric optics, electricity in the atmosphere.

**A. 201 SOLAR OBSERVATIONS (2 cr. Lab.).**

Prerequisite: A 111. Offered in fall.

Angular diam, of the sun, solar rotation, solar cycles, diff. wavelighnth observations, azimath of the mark-time.

**A. 202 STELLAR OBSERVATIONS (2 cr. Lab.)**

Prerequisite: A 212. Offered in spring.

Adjustment of telescope, determination of latitude, obs othe lunar craters obs, of cluster of stars and galaxies, photographic obs.

**A. 211 ASTROPHYSICS (1) (2 cr.).**

Prerequisite: A 111. Offered in fall.

Historical introduction, light, stellar distances, stellar motions, analyzing starlight, H-R diagram, stellar properties: luminosity, radii and densities, stellar masses, stellar spectra, telescopes.

**A. 212 ASTROPHYSICS (2) (2 cr.).**

Prerequisite: A 211. Offered in spring.

Gas and dust in space, basic properties of the planetary system, chemistry of the planetary system, planetary atmospheres, earth as a planet, modeling the atmospheres of Venus and mars.

**A. 213 SPHERICAL ASTRONOMY (1) (2cr. + 1 cr. tut).**

Prerequisite: A 111. Offered in fall.

Spherical trigonometry, celestial sphere, time, refraction, parallax

**A. 214 SPHERICAL ASTRONOMY (2) (2cr. + 1 cr. tut).**

Prerequisite: A 213. Offered in spring.

Planetary phenomena and heliographic coordinates, aberration, precession and nutation, occultation and eclipses, binary systems.

**A. 215 CELECTIAL MECHANICS (2 cr.).**

Prerequisite: A 111. Offered in fall.

Noninertial reference systems, rigid body dynamics, Lagrangian mechanics, the dynamics of oscillations, classical mechanics, the special theory of relativity.

**A. 216 ASTRONOMICAL EQUIPMENTS AND OBSERVATIONAL ANALYSIS (2 cr.).**

Prerequisite: A 201. Offered in spring.

Optical telescopes, radio telescope, detectors, photometers, IR and X-ray telescopes, space observatories.

**A. 301 ASTRONOMICAL CALCULATIONS (1 cr. Lab.).**

Prerequisites: A 213 & A 214. Offered in fall.

Astronomical tab., rising and setting of the sun, twilight at diff. Latitudes, beginning of lunar month.

**A. 302 ANALYSIS AND COMPUTER (1 cr. Lab.).**

Prerequisites: A 215 & A 315. Offered in fall.

Intro to computer, numerical analysis of diff. and intg. Equations, interpolation, fitting of data.

**A. 303 ORBITAL CALCULATIONS (1 cr. Lab.).**

Offered in spring.

Two-body problem, methods of orbit determination, station coordinates, station flyover problem, Ballistic missile, Eclipse of artificial satellites in the Earth's shadow, Artificial satellite tracks .

**A. 304 ASTROPHYSICS (2 cr. Lab.).**

Offered in spring.

Eclipses , planet, asteroids, comets, stellar motion and distances

**A. 306 ASTRONOMICAL APPLICATIONS ON THE COMPUTER (1) (1 cr. Lab.).**

Offered in spring.

Analysis of astronomical data using computer

**A. 311 SOLAR PHYSICS (2 cr.).**

Prerequisite: A 212. Offered in fall.

Introduction, the Solar Interior, the magnetic solar Atmosphere, the explosive sun, predicting explosions on the sun, the solar wind, sun Earth connection

**A. 312 STELLAR STRUCTURE AND EVOLUTION (2 cr.).**

Prerequisites: A 212 & A 313. Offered in spring.

Birth of stars, series of nuclear reactions, stellar evolution, star clusters, red giant, white dwarfs, evolution of massive stars, supernovae, pulsars, black holes, variable stars, stellar structure: basic equations, models.

**A. 313 RADIATIVE TRANSFER (2 cr.).**

Prerequisite: A 212. Offered in fall.

stellar spectra, stellar magnitudes and stellar colors, temperature estimates for stars, basics about radiative transfer, radiative transfer in stellar atmospheres, the depth dependence of the source function, the continuous absorption coefficient, the pressure stratification, theory of line formation, spectrum analysis, basics about non-local thermodynamic equilibrium.

**A. 314 INTERSTELLAR MATTER (2 cr.).**

Prerequisite: A 212 . Offered in spring.

Interstellar medium, interstellar observations, models of interstellar clouds, interstellar dust, observations of star formation, theory of star formation, interstellar reddening, chemistry in Interstellar matter.

**A. 315 CELESTIAL MECHANICS (2 cr. +1 cr. tut).**

Prerequisite: A 215 . Offered in fall.

The problem of two bodies, the body problem, fundamentals of the perturbation theory, perturbation in the elements, the disturbing function.

**A. 316 STELLAR DYNAMICS (2 cr.).**

Prerequisite: A 312 . Offered in spring.

Equation of motion of isolated star cluster, dispersion velocity, time of relaxation, mean free path, dsintegration of cluster by the escape of stars, effect of galactic rotation on star dynamic, the stability of cluster.

**A. 318 GENERAL RELATIVITY (3 cr.).**

Prerequisites: A 212 or A 313 . Offered in spring.

Tensor algebra-Riemannian space and Foundations of Riemannian geometry-Einstein field equations-The Schwarzschild solution-Classical tests-The Schwarzschild singularity -Gravitational collapse and black holes-The Schwarzschild solution in other coordinate systems-The Kerr solution - Other solutions.

**A. 320 STATISTICAL ASTRONOMY (2 cr.).**

Prerequisite: A 312 . Offered in spring.

Elements of statistical theory, statistical discriptioin of galactic system, stellar motion in the vicinity of the sun, luminosity spectral type distribution, space distribution of stars.

**A. 322 PLANETARY PHYSICS (2 cr.).**

Prerequisite: A 212 . Offered in spring.

Planetary properties, planetary atmosphere: thermal structure, atmospheric composition, cloud's, photochemistry, ionosphere, atmospheric evolution, interplanetary medium, solar wind, plasma, magnetospheres of individual bodies, waves in the magnetospheres. Solar interior and activities, models of the planetary atmospheres: thermal structure, atmospheric composition, cloud's, photochemistry, ionosphere, atmospheric evolution, internal structure, planetary magnetospheres, rings, satellites, asteroids, comets, meteors, meteoroids, meteorites, interplanetary dust.

**A. 401 ASTRONOMICAL APPLICATIONS ON THE COMPUTER (2) (1 cr.)**

Prerequisite: A 306 . Offered in fall.

Determination and analysis of spectral type on computer.

**A. 402 ASTRONOMICAL APPLICATIONS ON THE COMPUTER (3) (1 cr.)**

Prerequisite: A 401 . Offered in spring.

Analysis and calculations of image of galaxies

**A. 403 ASTRONOMY LAB(1), (1 cr. Lab.).**

Prerequisite: A 304 . Offered in fall.

Stellar measurements of in optical range, stellar spectra, binaries

**A. 404 ASTRONOMY LAB (2), (1 cr. Lab.).**

Prerequisite: A 403 . Offered in spring.

Analysis and evolution of stars, analysis of ISM., analysis of galaxies

**A. 405 OBSERVATORY (1) (2 cr. Lab.).**

Offered in fall.

Obs, of moon and plants, Obs of some stars, photometric obs.

**A. 406 OBSERVATORY (2) (2 cr. Lab.).**

Prerequisite: A 405 . Offered in spring.

Obs and analysis of some galaxies, obs. Of spectra, obs, of magnetic field

**A. 407 ASTRONOMICAL TRAINING (1) (1 cr. tut).**

Offered in fall.

Training on cluster dyn, training on dynamical systems.

**A. 408 ASTRONOMICAL TRAINING (2) (1 cr. tut.).**

Prerequisite: A 407 . Offered in spring.

Training on perturbations or short wave astronomy or stellar atmosphere

**A. 409 ASTROPHYSICS LAB (1) (1 cr. Lab.).**

Prerequisite: A 304 . Offered in fall.

Variables, H.R analysis of stars

**A. 410 ASTROPHYSICS LAB (2) (1 cr. Lab.).**

Prerequisite: A 409 . Offered in spring.

Super nova obs, pulsars obs

**A. 411 GALACTIC STRUCTURE AND DYNAMICS (2 cr.).**

Prerequisite: A 316 & A 360 . Offered in fall.

Observation of the galaxy, properties of galaxies, masses of galaxies, ISM in galaxies, the chemical evolution of galaxies, galaxies in the universe, quasars, galaxy interactions, super clusters, formation and evolution of galaxies**.**

**A. 412 STELLAR ATMOSPHERE (2 cr.).**

Prerequisite: A 313 . Offered in spring.

Temperature estimates for stars, radiative transfer in stellar atmospheres, the source function, absorption processes, hydrostatic equilibrium, theory of line formation, spectrum analysis, non local thermodynamic equilibrium, stellar: chromosphere, transition, corona and winds.

**A. 413 ADVANCED ASTROPHYSICS (2 cr.).**

Prerequisite: A 212 . Offered in fall.

Brief history of stellar spectrometry. Basic radiative transfer. Local Thermodynamic equilibrium LTE - Non-Local Thermodynamic equilibrium NLTE. Bound-Bound and Bound-Free Transitions, analytical Radiative Transfer, numerical Radiative Transfer. Polarized Radiative Transfer. Model Atmospheres.

**A. 414 PERTURBATION METHODS (2 cr.).**

Prerequisites: A 315 or A 417 . Offered in spring.

Straightforward expansion, Multiple scales, Linstidt-Poincre technique, Averaging principle, Lie series and approach – Lie-Kamel – KAM method.

**A. 415 RADIO ASTRONOMY (2 cr.).**

Offered in fall.

Introduction, radio telescopes, signal detection and noise, galactic continuum radiation, interstellar matter, galactic dynamics, stars, pulsars, radio galaxies and quasars, cosmic microwaves, gravitational lensing.

**A. 416 THE SUN-EARTH CONNECTIONS (2 cr.).**

Prerequisite: A 311 . Offered in spring.

The Earth's magnetic influence. Geomagnetic storms and terrestrial auroras, danger blowing in the wind, the varying sun and its effect on the earth's atmosphere, the sun's role in warming and cooling the earth, open topics.

**A. 417 DYNAMIC SYSTEMS (2 cr.).**

Prerequisite: A 315 . Offered in fall.

Phase space analysis, diffeomorphisms and flames, stability, bifurcations, area preserving maps

**A. 418 ASTROCHEMISTRY (2 cr.).**

Prerequisite: A 314 . Offered in spring.

Chemistry in: diffuse clouds ,translucent clouds, dense clouds, shocked regions, photo dominated regions, hot cores, planetary nebula, gas phase, grain: structure, physics, chemistry. Interstellar molecules, chemical models, star forming regions.

**A. 419 DYNAMICS OF STAR CLUSTERS (2 cr.).**

Prerequisite: A 320. Offered in fall.

Equation of motion of isolated star cluster, dispersion velocity, time of relaxation, mean free path, dsintegration of cluster by the escape of stars, effect of galactic rotation on star dynamic, the stability of cluster.

**A. 420 RADIATION AND GRAVITATIONAL (2 cr.).**

Prerequisite: A 313 . Offered in spring.

Maxwell theory. Radiation. Gravitational Radiation, the equation of state of matter, cold matter, the equilibrium and stability of stars. Relativistic equations of stellar equilibrium. Cold white dwarfs, neutron stars and stability, equilibrium of a supermassive star, critical states of stars with intermediate mass.

**A. 421 FIELD THEORIES (2 cr.).**

Prerequisite: A 318 . Offered in fall.

Geometrical field Theories-Riemannian theories-Non, Riemannian theories, Quantum field theory, quantum electrodynamics, Feynman diagrams, Renormalization, Path integrals, Gauge symmetries, The weak interaction, Non-Abelian gauge symmetries, Spontaneous symmetry breaking. The electroweak model, Quantum chromodynamics, Quantum gravity, Kaluza-Klein models, Supersymmetry.

**A. 422 STUDY OF EXTRA GALAXIES (2 cr.).**

Prerequisites: A 314 or A 320 . Offered in spring.

Seyfert galaxies, radio galaxies, quasars, interacting galaxies, cluster of galaxies, expansion of the universe, models of galaxies, radiation in the universe. Galaxies: formation, masses, angular momentum, properties, dark matter, galaxies and the universe, the chemical evolution of galaxies.

**A. 423 SPECIAL COURSE (1) (2 cr.).**

Offered in fall.

To be proposed by the dept.

**A. 424 COSMOLOGY (2 cr.).**

Prerequisite: A 318. Offered in spring.

Concepts of general relativity, classical cosmology and models, early universe, the hot big bang, inflationary cosmology and models, observational cosmology and dark matter, background radiation, galaxies and their evolution and counts, active galaxies, galaxy formation and clustering, nonlinear models and fractal. The sequence of galaxy formation, cosmic background fluctuations, Observations of CMB anisotropies, dark matter.

**A. 425 COMPACT OBJECTS (2 cr.).**

Prerequisites: A 312 & A 318. Offered in fall.

Star deaths, the formation of compact objects, equation of states, white dwarfs degeneracy, polytropes, clandrasekhar's white dwarf models, cooling of white dwarfs, equilibrium and stability of fluid configurations, magnetic white dwarfs rotating configurations, stability criteria for rotating stars, cold equation of state above neutron drip, neutron stars: history of the idea and discovery, observations of neutron star masses, black holes, kerr black holes, accretion in binary systems and binary pulsar, supermassive stars and black holes: properties, stability, evolution, stellar collapse and supernova explosions.

**A. 426 ASTRONOMY OF SHORT WAVES (2 cr.).**

Offered in spring.

X-ray astronomy, gamma ray astronomy, uv and euv astronomy, optical and ir astronomy from space.

**A. 428 SPECIAL COURSE (2) (2 cr.).**

Offered in spring.

To be proposed by the Dept.

## SPACE SCIENCE

**S. 201 OBSERVATIONS (2 cr.)**

Offered in fall.

Satellite identification, obs of Al, Az , eq and geocentric sys of satellite**.**

**S. 211 PRINCIPLES OF SPACE PHYSICS (2 cr.).**

Prerequisite: A 112 . Offered in fall.

Introduction to space physics, spacecrafts and their types, the space environment near earth, e.m. waves, the Earth's magnetosphere, the upper atmosphere, Artificial Satellites and their uses, Possible satellite orbits, Interplanetary probes and space shuttles.

**S. 214 Orbital mechanics (2 cr. + 1 cr. tut.).**

Prerequisite: S213 . Offered in spring.

Noninertial reference systems, rigid body dynamics, Lagrangian mechanics, the dynamics of oscillations, classical mechanics, the special theory of relativity

**S. 213 GEOGRAPHIC AND CELESTIAL COORDINATES (3 cr.).**

Prerequisite: A 111 . Offered in fall.

Spherical trigonometry, geocentric, geodetic, and astronomical coordinates, the celestial sphere and celestial coordinate systems, topocentric coordinates, station coordinates, time systems.

**S. 301 ANALYTICAL COMPUTATIONS (1) (1 cr. Lab).**

Offered in fall.

Space applications on computer, applications on magnetic field of the earth

**S. 302 ANALYTICAL COMPUTATIONS (2) ( 1 cr. Lab.).**

Prerequisite: S301 . Offered in spring.

Space applications on computer, applications on magnetic field of the earth

**S. 303 ORBITAL CALCULATIONS (1) (1 cr. Lab).**

Prerequisite: S212 . Offered in fall.

Two-body problem, methods of orbit determination, station coordinates, station flyover problem.

**S. 304 ORBITAL CALCULATIONS (2) (1cr. Lab.)**

Prerequisite: S303 . Offered in spring.

Ballistic missile, eclipse of artificial satellites in the earth's shadow, artificial satellite tracks, coverage.

**S. 305 SOLAR SPECTRA (1 cr. Lab).**

Offered in fall.

Spectra by spectrograph, line optical and statistical measurements

**S. 306 SPACE PHYSICS (1) ( 1 cr. Lab.).**

Offered in spring.

Photographic observations of stellar objects, photoelectric measurements, light curves, photometric measurements of galaxies

**S. 307 ANALYTICAL COMPUTATIONS (2) (1 cr. Lab).**

Offered in fall.

Space applications on computer, applications on solar radiations in diff. Waves.

**S. 308 SPACE PHYSICS (2) ( 1 cr. Lab.).**

Offered in spring.

Ccd photometry, ccd spectroscopy, extended objects spectroscopy, slitless spectroscopy.

**S. 310 COMPUTATIONAL ANALYSIS (4) ( 1 cr. Lab.).**

Offered in spring.

Space applications on computer, applications on solar radiations.

**S. 311 SPACE DYNAMICS (2 cr. + 1 cr. Tut.).**

Prerequisite: S 212 . Offered in fall.

The problem of two bodies, the n body problem, fundamentals of the perturbation theory, perturbation in the elements, the disturbing function

**S. 312 SPACE MISSION ANALYSIS AND DESIGN (2 cr.).**

Prerequisite: S 311 . Offered in spring.

The process, characterization, evaluation, requirements, definition, geometry, orbit and constellation design, environmental considerations.

**S. 313 SPACE PHYSICS (2 cr.).**

Prerequisite: A 211 . Offered in fall.

Electromagnetic radiation, spectroscopy-earth: atmosphere, geology, magnetosphere: structure, waves in the magnetosphere, space weather, interplanetary medium, plasma in the magnetosphere, radio emissions, generation of magnetic field.

**S. 314 SPACE CHEMISTRY (2 cr.).**

Prerequisite: A 413. Offered in spring.

The atmosphere of the earth, atmospheric chemistry, chemistry of the ionosphere, plasma in the magnetosphere, outgasing of artificial satellites, solar radiation effects on materials and life, e.m. radiation, solid matter, solar radiation, Aledo, aurora, the solar wind and interplanetary magnetic field, Satellites: surface charging, erosion, interaction, radiation belt.

**S. 315 SOLAR PHYSICS AND ENERGY (2 cr.).**

Prerequisite: A 211 . Offered in fall.

Solar: interior, atmosphere, active region, cycles and radiation, Sun-earth connection, thermal radiation, solar irradiance, solar energy applications.

**S. 316 ASTRONAUTICS (2 cr.).**

Prerequisite: S 313 . Offered in spring.

Time and reference systems, transfer and maneuvers,Two body boundary-value problem, value problem, ballistics missile trajectories, Lunar and interplanetary trajectories, rendezvous, impulsive maneuvers, satellite tracking and orbit determination. Orbital systems (types-windows-tracks), coverage and constellation design, reentry and landing, particular topics(solar sails, planet-assisted trajectories, tethers), space debris.

**S. 318 REMOTE SENSING (2 cr.).**

Offered in spring.

Ranging systems, scattering techniques, platforms (aircraft, satellites, orbits, and coverage), data processing.

**S. 401 ANALYSIS OF SATELLITE PICTURES (1) (1 cr. Lab.).**

Offered in fall.

Space mission analysis on computer using diff. programs (earth sat.)

**S. 402 ANALYSIS OF ARTIFICIAL SATELLITE PICTURES (1) (1 cr. Lab).**

Offered in spring.

Data analysis by the missions software.

**S. 403 SATELLITE OBSERVATIONS (1) (2 cr. Lab.).**

Offered in fall.

Transformations from geocentric to topocentric systems and reverse, determination of orbits using two positions

**S. 404 ARTIFICIAL SATELLITE OBSERVATIONS (2) (2 cr. Lab).**

Prerequisite: S 403 . Offered in spring.

determination of orbit by three observation (azimuth, elevation, time), Rising and setting, the shadow

**S. 405 ORBITAL CALCULATIONS (1) (1 cr. Lab).**

Prerequisites: S 303, S 304. Offered in fall.

The coverage, tracking, station coordinates, station visibility

**S. 406 EXAMINATIONS FROM SPACE (1) (1 cr. Lab).**

Offered in spring.

Simulation for microgravity experiment, natural debris

**S. 407 ANALYSIS OF SATELLITE PICTURES (2) (1 cr. Lab.).**

Offered in fall.

Space mission analysis on computer using diff. programs (Planets mission)

**S. 408 EXAMINATIONS FROM SPACE (2) (1 cr. Lab).**

Offered in spring.

Determination of physical parameters by using data fro satellite. Manufactured debris

**S. 409 SPACE CLCULATIONS (1) (1 cr. Lab).**

Offered in fall.

Perturbations due to drag. Calculations for life time

**S. 410 SPACE CLCULATIONS (2) (1 cr. Lab).**

Offered in spring.

Computation of perturbations due to solar radiation (direct and indirect), method of calculation of satellite visibility.

**S. 411 SPACE ENVIRONMENT (1) (2 cr.).**

Offered in fall.

Space weather, Earth's magnetosphere, advances on the ionosphere, meteoroids and space debris, satellites: anomalous, contamination, surface charging

**S. 412 SPACE ENVIRONMENT (2) (2 cr.).**

Prerequisite: S 411 . Offered in spring.

Space weather, Earth's magnetosphere, advances on the ionosphere, fields, corpuscular radiation, the radiation belt-e.m. radiation, the solar wind-high energetic particles.

**S. 413 SPACE PHYSICS (1) (2 cr.).**

Prerequisite: S 313 . Offered in fall.

Introduction to space weather, Earth's magnetic field, physics of the upper polar atmosphere, meteoroids and space debris, comets, Asteroids, physics of the space near Earth.

**S. 414 SPACE PHYSICS (2) (2 cr.).**

Prerequisite: S 413 . Offered in spring.

Modeling the upper atmosphere, horizon sensing, modeling the earth's magnetosphere and gravitational fields, solar radiation and solar winds.

**S. 415 ARTIFICAL SATELLITE THEORY (1) (2 cr.).**

Prerequisites: S 303 & S 311 . Offered in fall.

Numerical integration of orbits, observability (rising and setting, visibility zone Shadow, brightness), the critical inclination, resonant orbits, Intermediaries, frozen orbits.

**S. 416 ARTIFICAL SATELLITE THEORY (2) (2 cr.).**

Prerequisite: S 415. Offered in spring.

Numerical integration of orbits, observability (rising and setting, visibility zone, shadow, brightness), the critical inclination, resonant orbits, intermediaries, frozen orbits.

**S. 417 SATELLITE GEODESY (2 cr.).**

Prerequisites: S 303 & S304 . Offered in fall.

Reference coordinate systems, geometry of satellite observations, satellites and data analysis, gravity field recovering from satellite tracking data, satellite altimetry.

**S. 418 OPTIMAL TRAJECTORIES (2 cr.).**

Prerequisite: S 405. Offered in spring.

Modelling of propulsion systems, parametric optimization, the contensou, pontryagin maximum principle, optimal transfer in a uniform and in a general gravitational field, optimal orbit corrections. time free and time fixed orbital transfer, interplanetary rendezvous.

**S. 419 PROPULSION SYSTEMS (2 cr.).**

Offered in fall.

Classification, different types of propulsion, launch vehicle performance, launch phases and mission planning, examples of some launch vehicles (ariane, space shuttle,…), launch system selection process, costs , atmospheric re-entry, the optimization of rocket trajectories.

**S. 420 ASTRONAUTICS (2 cr.).**

Prerequisite: S 316 . Offered in spring.

Orbital systems (types, windows, tracks), coverage and cnstellation design, reentry and landing, particular topics (solar sails, planet assisted trajectories, tethers), space debris.

**S. 422 SPACE COMMUNICATIONS (2 cr.).**

Offered in spring.

Overview, strtion and satellite visibility, radio wave propagation, polarization, antennas, earth and spase segments, station keeping, attitude and orbit control. Signal types, interference, space link, satellite access, satellite services, relativity, future trends.

**S. 424 MICROGRAVITY AND BIODYNAMICS (2 cr.).**

Offered in spring.

**S. 425 ALTITUDE DYNAMICS AND CONTROL (2 cr.).**

Offered in fall.

Altitude geometry, rotetional kinematics, altitude dynamics, control of altitude in space.

**S. 428 SPECIAL COURSE (2) (2 cr.).**

Offered in spring.

To be proposed by the dept.

**S. 427 SPECIAL COURSE (1) (2 cr.).**

Offered in fall.

To be proposed by the Dept.

**S. 430 HYDRODYNAMICS (2 cr.).**

Equations of motion, circulation, Vortex motion, Irrotational motion, Uniplanar motion, wave motion, tides, sound waves, drag and lift.

## METOROLOGY

**Met. 201 WEATHER ANALYSIS (1 cr. Lab.).**
Prerequisite: A 112 . Offered in fall.
Analysis of scalar and vector fields, atmospheric structure.

**Met. 202 SYNOPTIC (I) (1 cr. Lab.).**
Prerequisites: Met. 201, Met. 211 . Offered in spring.
Synoptic calculations, Analysis of weather system, thermodynamic diagrams.

**Met. 203 APPLICATION ON ATMOSPHERIC DYNAMICS (1 cr. Lab.).**
Prerequisite: A 112 . Offered in fall.
Atmospheric applications, dynamical Calculations.

**Met. 204 APPLICATIONS ON ATMOSPHERIC PHYSICS AND DYNAMICS (I) (1 cr. Lab.).**
Prerequisites: Met. 213, Met. 215. Offered in spring.
Problems and selected applications.

**Met. 205 PHYSICAL METEOROLOGY LABORATORY (1 cr. Lab.).**
Prerequisite: A 112 . Offered in fall.
Measurements of meteorological parameters.

**Met. 206 SYNOPTIC (2) (1 cr. Lab.).**
Prerequisites: Met. 201, Met. 211. Offered in spring.
Synoptic calculations, Analysis of weather system, thermodynamic diagrams.

**Met. 211 GENERAL METEOROLOGY (2 cr.).**
Prerequisite: A 112 . Offered in fall.
Atmospheric structure and composition; weather and circulation systems; physics of atmospheric processes.

**Met. 212 GENERAL CLIMATOLOGY (2 cr.).**
Prerequisite: Met. 211. Offered in spring.
Global distribution of principal climatic elements with emphasis on physical causes.

**Met. 213 INTRODUCTORY DYNAMICAL METEOROLOGY (2 cr.).**
Prerequisite: A 112 . Offered in fall.
Kinematics; acceleration in rotating curvilinear coordinates; equation of motion; scale analysis; geostrophic, gradient, and thermal winds, generalized vertical coordinates.

**Met. 214 ATMOSPHERIC DYNAMICS (I) (2 cr.).**
Prerequisites: Met. 213, Met. 203. Offered in spring.
Fronts, Circulation theorem, vorticity and divergence equation; mechanism of pressure changes, inertial instability, Rossby waves, baroclinic instability, energy equations and transformations.

**Met. 215 INTRODUCTORY PHYSICAL METEOROLOGY (2 cr.).**
Prerequisite: A 112 . Offered in fall.
Kinematics and thermodynamics of atmospheric systems (Equation of state, first and second laws of thermodynamics, atmospheric applications, … etc).

**Met. 216 ATMOSPHERIC PHYSICS (1) (2 cr.).**
Prerequisites: Met. 215, Met. 205. Offered in spring.
Thermodynamics of moist air, thermodynamic diagrams; hydrostatics and stability, formation of cloud droplets and precipitation elements.

**Met. 218 climate and applied Meterology for non meterologists (2 cr. + 1 cr. Lab.).**
Offered in spring.
Introduction to atmospher, physical processes in the atmosphere, general climate classification, some applications.

**Met. 301 SYNOPTIC (1) (1 cr. Lab.).**
Prerequisite: Met. 202. Offered in fall.
Atmospheric structure, forecasting techniques.

**Met. 302 SYNOPTIC (1) (1 cr. Lab.).**

Prerequisite: Met. 301. Offered in spring.

Analysis of air mass and front, cyclonic formation and evolution of pressure systems, chart analysis. Basic of forecasting techniques.

**Met. 303 SYNOPTIC (3) (1 cr. Lab.).**

Prerequisite: Met. 206. Offered in fall.

Atmospheric structure, forecasting techniques.

**Met. 304 SYNOPTIC (4) (1 cr. Lab.).**

Prerequisite: Met. 303. Offered in spring.

Analysis of air mass and front, cyclonic formation and evolution of pressure systems, chart analysis. Basic of forecasting techniques.

**Met. 305 APPLICATIONS ON ATMOSPHERIC PHYSICS AND DYNAMICS (2) (1 cr. Lab.).**

Prerequisite: Met. 204. Offered in fall.

Problems and selected applications. Calculations of some meteorological fields from the data of the weather charts.

**Met. 311 ATMOSPHERIC DYNAMICS (2) (2 cr.).**

Prerequisite: Met. 214. Offered in fall.

Turbulence, numerical prediction, general circulation, treatment of specialized equations, fluctuations and perturbation theory, stability analysis.

**Met. 312 BOUNDARY LAYER DYNAMICS (2 cr.).**

Prerequisite: Met. 311. Offered in spring.

Boundary layer theory, scale analysis, physics of the Air-sea boundary layer (Flux of momentum, heat, and water); study of air-sea interaction mechanism of exchange and budgets, energy dissipation, diffusion theory.

**Met. 313 ATMOSPHERIC PHYSICS (2) (2 cr.).**

Prerequisite: Met. 216. Offered in fall.

Atmospheric electricity, rainbow and halo, microphysics of clouds and precipitation, solar radiation, temperature structure of planetary atmosphere.

**Met. 315 SYNOPTIC (I) (2 cr.).**

Prerequisite: Met. 212 . Offered in fall.

General circulation, baroclincity and jet stream, air masses, fronts, and cyclones, monsoons and tropical cyclones.

**Met. 316 SYNOPTIC (2) (1 cr.).**

Prerequisite: Met. 315. Offered in spring.

Cyclones and anticyclones in mid-latitudes, movement of the pressure systems, regeneration of cyclones and anticyclones, the general principals and method of forecasting synoptic situations. Forecast of formation, development, and movement of synoptic situations.

**Met. 318 RADIATION AND SATELLITE METEOROLOGY (2 cr. + 1 cr. Tut.).**

Prerequisite: Met. 313 . Offered in spring.

Basic definitions, radiative heating, topics in skylight polarization ; atmospheric optics and visual range, satellite application in meteorology, physics of clouds and precipitation.

**Met. 320 ENERGY AND ENVIRONMENT (2 cr. + 1 cr. Tut.).**

Prerequisites: Met. 313, Met. 311. Offered in spring.

Air and water pollution mechanisms, population growth, solar energy, wind and Renewal energy, Environmental Laws.

**Met. 322 CLIMATOLOGY AND CLIMATE CHANGE (2 cr.).**

Prerequisite: Met. 315. Offered in spring.

Climate classification. Climate factors, concept of climate change, feedbacks, simple climate model, concept of GCM.

**Met. 401 METEOROLOGICAL APPLICATION AND TECHNIQUES BY COMPUTERS (1) (1 cr. Lab.).**

Offered in fall.

Numerical integration, advection methods, solving DE, analytical and numerical solutions, stability analysis, objective analysis, simple barotropic model.

**Met. 402 ATMOSPHERIC MODELING (1) (1 cr. Lab.).**

Prerequisite: Met. 411. Offered in spring.

Data assimilation, operational NWP, primitive equations, lateral B.C in numerical models, space discretization methods, sub-grid processes data quality control ensemble forecasting, quality control of observations

**Met. 403 APPLICATIONS IN AIR POLLUTION (1 cr. Lab.).**

Prerequisite: Met. 312 . Offered in fall.

Objectives of stack design, Dispersion models, turbulence and mixing process and receptors, model outputs.

**Met. 404 STATISTICAL APPLICATION IN METEOROLOGY (1 cr. Lab.).**

Prerequisite: Met. 316 . Offered in spring.

Extended forecast, Long range forecast basics.

**Met.405 METEOROLOGICAL APPLICATION AND TECHNIQUES BY COMPUTERS (2) (1 cr.).**

Offered in fall.

Numerical integration, advection methods, solving DE, analytical and numerical solutions, stability analysis, objective analysis, simple baroclinic model.

**Met. 406 ATMOSPHERIC MODELING (2) (1 cr. Lab.).**

Prerequisite: Met. 411 . Offered in spring.

Data assimilation, operational NWP, primitive equations, lateral B.C in numerical models, space discretization methods, sub-grid processes data quality control ensemble forecasting, quality control of observations

**Met. 411 NUMERICAL WEATHER PREDICTION (1) (2 cr.).**

Prerequisite: Met. 311. Offered in fall.

Introduction to N.W.P. numerical solutions of partial differential equations, basics of modeling theory.

**Met. 412 NUMERICAL WEATHER PREDICTION (2) (2 cr.).**

Prerequisite: Met. 411. Offered in spring.

Modern meteorological prediction techniques with emphasis on numerical weather prediction, lee wave, circulation in forced and non-forced flow.

**Met. 413 PHYSICS OF THE UPPER ATMOSPHERE (2 cr.).**

Prerequisites: Met. 316 or Met. 318 . Offered in fall and spring.

Temperature, circulation, and composition of the upper atmosphere, ionosphere, electron density measurements, atmospheric signal phenomena.

**Met. 414 ATMOSPHERIC CHEMISTRY (2 cr.).**

Prerequisite: Met. 421 . Offered in spring.

Gas phase chemistry, aerosols, chemistry of aqueous systems, sources of pollution , gas emission, interaction of organic and non organic matter.

**Met. 415 TROPICAL METEOROLOGY (2 cr.).**

Prerequisite: Met. 316 . Offered in fall.

Pressure, wind, temperature, and rain fall distribution in the tropics; convection, tropical cyclones, models at tropical area, tropical disturbances.

**Met. 416 STATISTICAL CLIMATOLOGY (2 cr.).**

Prerequisite: Met. 316 . Offered in spring.

Multiple regression , tests of significance, random variables stochastic forecast, ARIM 1,2.

**Met. 417 PHYSICAL CLIMATOLOGY (2 cr.).**

Prerequisite: Met. 322 . Offered in fall.

Evaporation, climate at elevated areas, ENSO, returning flow, Internal mixing, growth of photochemistry, Ozone circulation and Ozone hole.

**Met. 418 AVIATION METEOLOGY (2 cr.).**

Offered in spring.

**Met. 419 SELECTED TOPICS IN METEOROLOGY (2 cr.).**

Offered in fall.

**Met. 420 AGROMETEOROLOGY (2 cr.).**

Prerequisite: Met. 312 . Offered in spring.

Hydrolitical cycles, water sources, time of agrometeorlogy.

**Met. 421 AIR POLLUTION (2 cr.).**

Prerequisite: Met. 312 . Offered in fall.

Physics of air pollution, artifficial pollution, models of air pollution, control of air pollution.

**Met. 422 ESSAY IN ADVANCED TOPICS METEOROLOGY (2 cr.).**

Offered in spring.

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# BIOPHYSICS

## First: Academic programs Offered by Biophysics Department

**The Department offers courses for student of the following groups:**

1- Biophysics (Biophys)
2-Mathematics/ Biophysics (Math/Biophys)

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 1 | 1st | Biophys 111 | General Biophysics (1) | - | Biophys., Biophys./Math. | Other groups | 2 | 2 | - | 3 | 6 cr Compul. |
| | 2nd | Biophys 112 | General Biophysics (2) | Biophys 111 | | | 2 | 2 | - | 3 | |
| 2 | 3rd | Biophys 211 | General Biophysics | Biophys 112 | Biophys., Biophys./Math. | - | 2 | - | - | 2 | 10 cr Compul. |
| | | Z.213 | Cell Biology & Genetics | - | | - | 2 | 2 | - | 3 | |
| | | Biophys 221 | Electronics and Electricity in Biological Systems | Biophys 112 | | - | 2 | - | - | 2 | |
| | | Biophys 231 | Wave Biophysics | - | | - | 2 | - | - | 2 | |
| | | Biophys 241 | Exp. Biophysics | - | | - | - | 2 | - | 1 | |
| | | B. 210 | General Microbiology | - | Biophys. | - | 2 | 3 | - | 3 | 9 cr |
| | | Chem.242 | Basic Organic Chemistry (2) | Chem.102 | | - | 2 | 3 | - | 3 | |
| | | Math.239 | Multiple Integrals and Ordinary Differential Equations | - | | - | 2 | - | 2 | 3 | |
| | 4th | Biophys 212 | Quantum Mechanics and its Biological Applications | Math.239 | Biophys., Biophys./Math. | - | 2 | - | - | 2 | 9 cr Compul.. |
| | | Biophys 222 | Atomic Spectra | - | | - | 2 | - | - | 2 | |
| | | Biophys 232 | Environmental Biophysics | Biophys 211 | | - | 2 | - | - | 2 | |
| | | Biophys 242 | Thermodynamics For Biological Systems | Phys.111 Phys.112 | | - | 2 | - | - | 2 | |
| | | Biophys 252 | Exp. Biophysics | - | Biophys. | - | - | 2 | - | 1 | 9 cr Compul. |
| | | Z.202 | Immunology & Molecular Biology | - | | - | 2 | 3 | - | 3 | |
| | | Chem.251 | Biochemistry (1) | - | | - | 2 | 3 | - | 3 | |
| | | Chem.252 | Biochemistry (2) | - | | - | 2 | 3 | - | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 3 | 5th | Biophys 311 | Radiation Biophysics | Biophys 221 | Biophys., Biophys./Math. | - | 2 | - | - | 2 | 19 Credit Compul.. for Biophys. 9 Credit Compul.. for Dual. |
| | | Biophys 321 | Molecular Biophysics | Biophys 212, 252 | | - | 2 | 3 | - | 3 | |
| | | Biophys 331 | Neurobiophysics | Biophys 221,Z.213 | | - | 2 | - | - | 2 | |
| | | Biophys 341 | Bioenergetics | - | | - | 2 | - | - | 2 | |
| | | Biophys 351 | Exp. Biophysics | - | Biophys./Math. | - | - | 3 | - | 1 | |
| | | Biochem.352 | Metabolism of Amino Acids and Proteins | - | Biophys. | - | 2 | 3 | - | 3 | |
| | | Stat. 321 | Introduction to Probability and Mathematical Statistics for Non Mathematicians | - | | - | 2 | - | 2 | 3 | |
| | | Z.353 | Human Physiology | - | | - | 2 | 3 | - | 3 | |
| | | Biophys 361 | Exp. Biophysics | - | | - | - | 6 | - | 2 | |
| | 6th | Biophys 312 | Health Biophysics | Biophys 311 | Biophys., Biophys./Math. | - | 2 | 3 | - | 3 | 8 Credit Compul. |
| | | Biophys 322 | Molecular Spectroscopy | Biophys 222 | | - | 2 | - | - | 2 | |
| | | Med.312 | Human Anatomy | - | | - | 2 | 3 | - | 3 | |
| | | Biophys 362 | Exp. Biophysics | - | Biophys./Math. | - | - | 3 | - | 1 | |
| | | Biophys 342 | Neurobiophysics | - | - | Biophys., Biophys./ Chem. Biophys./ Biochem Biophys./ Math. | 2 | - | - | 2 | 2 cr Elective |
| | | Biophys 352 | Bioelectronics | Biophys 221 | - | | 2 | - | - | 2 | |
| | | Biophys 382 | Laser & its applications | - | Biophys. | - | 2 | 3 | - | 3 | 10 Credit Compul. |
| | | Biophys 332 | Electronic Simulation for Biological Systems | Biophys 221 | | - | 2 | 3 | - | 3 | |
| | | Stat. 322 | Biostatistics and Difference Equations | - | | - | 2 | - | 2 | 3 | |
| | | Biophys 372 | Exp. Biophysics | - | | - | - | 6 | - | 2 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 7th | Biophys 411 | Nuclear Reactor Safety | - | Biophys., Biophys./Math. | - | 2 | - | - | 2 | 6 cr Compul. |
| | | Biophys 421 | Radiation Treatment Planning | Biophys 311 | | - | 2 | - | - | 2 | |
| | | Biophys 431 | Exp. Biophysics | - | Biophys., | - | 2 | - | - | 2 | 2 cr Compul. |
| | | Biophys 471 | Exp. Biophysics | - | Biophys./Math. | - | - | 6 | - | 2 | |
| | | Biophys 441 | Biomaterials | - | Biophys. | - | 2 | - | - | 2 | 12 cr Compul.. for Biophys. |
| | | Biophys 451 | Molecular Spectroscopy | Biophys 322 | | - | 2 | - | - | 2 | |
| | | Biophys 461 | Article (1) | - | | - | 2 | - | - | 2 | |
| | | Biophys 481 | Exp. Biophysics | - | | - | - | 8 | - | 3 | |
| | | Biophys 491 | Technology of Nucleic Acids | - | | - | 2 | 2 | - | 3 | |
| | 8th | Biophys 412 | Biophysics of Medical Imaging | Biophys 311 | Biophys., Biophys./Math. | - | 2 | - | - | 2 | 16 Credit Compul. for Biophys. 10 Credit Compul.. for Dual. |
| | | Biophys 432 | Biophysical Measurements | Biophys 321 | | - | 2 | - | - | 2 | |
| | | Biophys 492 | Exp. Biophysics | - | Biophys., Biophys./Math. | - | - | 6 | - | 2 | |
| | | Biochem 456 | Clinical Biochemistry | - | Biophys. | - | 2 | - | - | 2 | |
| | | Biophys 442 | Molecular Biophysics | Biophys 321 | | Biophys. /Chem. Biophys. /Biochem Biophys. /Math. | 2 | - | - | 2 | |
| | | Biophys 452 | Computational Biophysics | - | | | 2 | - | - | 2 | |
| | | Biophys 462 | Article (2) | - | | - | 2 | - | - | 2 | |
| | | Biophys 494 | Exp. Biophysics | - | | - | - | 8 | - | 3 | |
| | | Biophys 472 | Communication and Control Biophysics | Biophys 231, 332 | - | Biophys. | 2 | - | - | 2 | |
| | | Biophys 482 | Biophysics of Cell Communication | Biophys 332 | - | | 2 | - | - | 2 | |

# Second: Courses Offered by Biophysics Department

**Biophys 111 GENERAL BIOPHYSICS (1) (2 cr. + 1 cr. Lab).**

Offered in Fall

**Electricity within the body:** The nervous system and the neurons, electrical potential of the nerves, the electromyogram (EMG), the electrocardiogram (ECG), the electroencephalogram (EEG), electroretinogram (ERG), electrooculogram (EOG). **Physics of diagnostic X-rays:** Production of X-rays, absorption of X-rays, X-rays imaging. **Radionuclides in medicine:** Characteristics and units of radioactivity, sources of radioactivity for nuclear medicine, statistical aspects of nuclear medicine. **Basic nuclear instrumentation and its clinical applications:** Geiger-Mueller (GM) counter, the photomultiplier tube (PMT) and the pulse height analyzer (PHA), the gamma camera, radiation doses in nuclear medicine. **Radiation protection in medicine:** Sources of natural and artificial ionizing radiation, biological effects of ionizing radiation, radiation protection units and limits in nuclear medicine. **Heat and cold in medicine:** Heat therapy using conductive methods, infrared (IR) radiation, radiowave heating (diathermy), microwave and ultrasonic diathermy, cryogenics, cryobiology, preservation of organs, blood preservation and cryosurgery. **Light in medicine:** General properties of light, measurements of light and its units, applications of visible light in medicine, flexible fiber optics, endoscopes, application of UV and IR in medicine, IR imaging, Laser and its clinical applications, microscopes.

**Biophys 112 GENERAL BIOPHYSICS (2) (2 cr. + 1 cr. Lab).**

Prerequisite: Biophys111. Offered in spring.

**Energy, work and power of the body:** Conservation of body energy. Changes of energy within the body. Work and power. The maim mechanism of heat loss from the body. **Physics of eyes and vision:** The sense of vision components and the special optical features. Focusing elements of the eye. The retina the light detector of the eye and the general type of photoreceptor. Defective vision and its correction. Contact lenses. The visual acuity. **Sound in medicine:** General properties of sound, Reflection of sound waves, the stethoscope, Ultrasound picture of the body, the A-scan method, the b-scan method, the M-scan method to measure motion. The Doppler effect, physics of the ear and hearing, sensitivity of the ears, testing of hearing, deafness and hearing aids. **Biophysics of skeletal muscle**: Elastance and Compliance, effect of load on skeletal muscle contraction, active-passive tension of the muscle. **Hemodynamics**: hydraulic filctering and cardiac work, cardiac output and blood pressure, fahraeus lindquist effect, poiseuille and bernoulli equation in high blood tension, **biomechanics of the lung**: surface tension and the lung, effect of surfactant on breathing, relationship between flow, pressure and resistance during a breathing cycle.

**Biophys 211 GENERAL BIOPHYSICS (2 cr.).**

Prerequisite: B. Ph. 112. Offered in fall.

**Some manipulative experiments on living cells:** elasticity of living cells, viscosity of elemental protoplasm, surface energy of cells. **Biological effects of some fields:** light: energetics of light quanta, transmission and absorption, physical basis of photobiological process. Biological effects; therapeutic and clinical, electromagnetic waves, (non-ionizing) spectrum and range, biological impedance measurements, attenuation, low frequency effects, microwave radiation, laser irradiation, ultraviolet radiation. **Acoustical phenomena of biophysical interest:** units and scale in acoustics measurements, acoustic transducers, physical consequence of absorption of acoustic beam.

**Biophys 212 QUANTUM MECHANICS AND ITS BIOLOGICAL APPLICATIONS (2 cr.).**

Prerequisite: Math. 235. Offered in spring.

Heisenberg uncertainty relation, schrodinger equation, solution of schrodinger equation for one dimensional problems, solution of schrodinger equation for the hydrogen atom, calculation of the electronic energy levels for diatomic molecule, calculation of vibrational energy levels for diatomic molecule, calculation of rotational energy levels for diatomic molecule, tunnel effect in quantum mechanics and its application in biology.

**Biophys 221 ELECTRONICS AND ELECTRICITY IN BIOLOGICAL SYSTEMS (2 cr.).**

Prerequisite: Biophys112. Offered in fall.

Some basic theories: Maximum power transfer and thevenin's theorem, Rc. Circuit and filters, voltage and current divider, equivalent circuit for biological membranes, Ac sources, analyses, RLC circuit and resonance conditions, dielectric loss, applications to biological systems. P.N. junction characteristics, rectifier, filters, limiter clippers and clampers. Ionic conductors Uses of rectified impulses in medicine. Transistors characteristics, amplifiers, stabilization.

**Biophys 222 ATOMIC SPECTRA (2 cr.).**

Offered in spring.

Quantized energy levels, Wave mechanics, The hydrogen atom, The energy levels and spectra of atoms, The effects of magnetic and electric fields, Hyperfine structure

**Biophys 231 WAVE BIOPHYSICS (2 cr.).**

Offered in fall.

Mechanical waves: Nature of mechanical waves, properties of propagation medium, propagation of sound waves in phantoms, interaction of sound waves with biological tissues (reflection, scattering, refraction, diffraction, interference, absorption, attenuation), intensity of sound in tissues, determination of echo intensity, application of ultrasound in imaging, image formation.

Light waves: Nature and sources of light, endoscopy in medicine, dispersion, polarization and polarizing filters, optical instrumentation in medicine and biology, Laser optics and its applications in medicine, uncertainty principle in studying the motion of micro particles, interference, diffraction and refraction, Young's double slit experiment, Huygen's principle, Frunhover diffraction from single slit, Light scattering and turbidity, Determination of particle size distribution by the turbidity technique, Optical activity, Photodynamic therapty.

**Biophys 232 ENVIRONMENTAL BIOPHYSICS (2 cr.).**

Prerequisite: Biophys 211. Offered in spring.

Definition of pollution to the environment, types of pollutants (chemical, radiation), pollution areas (air, land, surface contamination, water), Environmental Pollution by radiation: Types of radiation sources, (ionizing, non-ionizing), Pollution from nuclear reactor chimney, radioactive materials (NORM), radiation risks in mines and from petroleum oil production, Non-ionizing radiation, types: classification according to wavelength, sources of electromagnetic radiation in environment, transmission antennas, broadcast, television, telecommunication, mobile phones power stations, high voltage power lines, electric wiring indoors, electric appliances, computer…etc, Aerosols: definition, size distribution function, properties of size distribution function, Atmospheric aerosols, visibility degradation, components of the extinction coefficient in atmosphere, scattering of light, absorption of light, Dynamics of single aerosol particles transport properties of gases, as mean free path phenomena, Mass and heat transfer to single aerosol particles, mean path, diffusion.

**Biophys 241 Exp. BIOPHYSICS (1 cr.)**

Offered in fall.

**Biophys 242 THERMODYNAMICS FOR BIOLOGICAL SYSTEMS (2 cr.).**

Prerequisites: Phys 111, Phys 112. Offered in spring.

**The first law of thermodynamics applied to biological system:** Internal energy, Work, The first law in operation, Enthalpy, Standard state, Application on macromolecules, Heat capacity, Energy conservation in living organisms. **The second law of thermodynamics:** Entropy, Heat energy, Isothermal systems, Protein denaturation, The third law and biology, Irreversibility and life. **Gibbs free energy:** Equilibrium states, Reversible process, Phase transition, Chemical potential, Ionic solutions, Standard state of macromolecules, Effect of temperature on the equilibrium constant Keq, Chemical coupling of biomolecules. **Application to Gibbs free energy:** Photosynthesis and glycolysis, ATP hydrolysis, Osmosis and dialysis, Donan equilibrium, Membrane transport, Enzyme-substrate interaction, Protein solubility, stability and dynamics.

**Biophys 252 Exp. BIOPHYSICS (1 cr.)**

Offered in spring.

**Biophys 311 RADIATION BIOPHYSICS (2 cr.).**

Prerequisite: Biophys 221. Offered in fall.

Atoms and nuclei, isotopes, atomic mass unit, elemental. Particles used in radiology, natural radioactivity and radioactive series, radioactive decay, laws and total emitted radiation, different modes of nuclear disintegrations. Energy absorbed by the patient from radioactive isotopes. Growth of radioactive daughter (equilibrium) and isotopt generators, activation of isotopes, saturation activity, interaction of radiation with body tissues, range energy relationships for charged particles, gamma ray absorption and interaction mechanisms, Ionizing radiation detection.

**Biophys 312 HEALTH BIOPHYSICS (2 cr.).**

Prerequisite: Biophys 311. Offered in spring.

**Ionizing radiation,** International organization that set ionizing radiation. Dosimetry standards Exposure Dose measurement. standard free air chamber, absorbed dose measurement, Bragg-Gray principle, Kerma, specific gamma ray emission, principle. Kerma specific gamma ray emission. Dosimetry of internally deposited radioisotopes, dosimetry of Beta, type and gamma, type radiations.

Basic ionizing radiation safety criteria , exposure of individuals in the general public and radiation workers. Dose measuring instruments. Pocket dosimters. Film badges, Thermoluminescent dosimeter.

**Non – ionizing radiation**, Basic laser physics, laser tissue interaction, types of laser, laser safety and hazards, biological effects of laser radiation, laser measurements, protective standards, laser beam hazard evaluation and classification, laser in medicine, chemical and biological sciences.

**Biophys 321 MOLECULAR BIOPHYSICS (2 cr.).**

Prerequisites: Biophys212, Biophys252. Offered in fall.

**Energetics and statistical relations in the living cell:** Statistical thermodynamics and biology, Theory of absolute reaction rates, The entropy transfer of living organisms, Information theory, Information content of biological systems, Information content of a bacterial cell. **Physical methods of determining the sizes and sahpes of molecules:** Random motion and Diffusion, Measurement of diffusion constants, Sedimentation, Sedimentation-equilibrium method, Sedimentation-velocity method, Rotational diffusion and birefringence, X-ray diffraction. **Intramolecular and intermolecular forces:** Strong interactions, Weak interactions, Dipole-dipole interaction, Permanent dipole-Induced dipole interaction, Transient dipole-Induced dipole interaction, The hydrogen bond interaction, Debye-Huckel theory, Antigen-antibody interaction as examples of short range interaction. **Enzymes:** Temperature dependence of enzyme kinetics, Enzyme specificity, Mechanism of enzyme action, Minimum size of an enzyme. **Action spectra and quantum yields:** Definition of action spectra, Action spectra theory, Inactivation of proteins and nucleic acids, Light action on respiratory pigments, Cooperative events in light action, Photoreversal. The physics of cellular processes: The speed of diffusion in the cell, Electrical events in diffusion, Specificity of transport, Random diffusion and specific selection in DNA synthesis.

**Biophys 322 MOLECULAR SPECTROSCOPY (2 cr.).**

Prerequisite: Biophys222 . Offered in spring.

**Proton Magnetic Resonance spectra:** Introduction and theory, NMR spectrometer and sample handling, shielding and deshielding mechanisms, types of protons, chemical shift and structural enviroments, spin-spin coupling, vicinal and geminal coupling, spin-spin decoupling, Nuclear overhauser effect, application and structure elucidation, NMR in medicine and NMR imaging. **Infrared Spectra:** Introduction and theory, Instrumentation and sample handling, Characteristic functional group frequencies, structure and stretching frequencies, interpretation of the spectra and elucidation of molecular structure. **Electronic Absorption spectra:** Introduction and theory, Types of electronic transitions, Lambert-Beer's law, Quantitativce analysis, bathochromic and

hypsochromic shifts, correlation between structure and wavelength of maximum absorption, woodward rule, intrepretation of UV and visible spectra.

**Biophys 331 NEUROBIOPHYSICS (2 cr.).**

Prerequisites: Biophys221, Z.213 . Offered in fall.

**Introduction, Structure and Function of the Nervous System**, **Biophysics of Neuron:** Membrane Potential, Chemical-to-Electrical transduction, Signal Summation, Action Potential, Electrical-to-Chemical Transduction. **Biophysics of ionic channels:** Types of ionic channels, Methods of measuring channels activity. **Neural Systems:** Overview, Sensory Systems, Neural Networks, Volume Transmission, Learning and Memory. **Instrumentation for measuring bioelectric activity from the neurons:** Extracellular recordings, Intracellular recordings, Signal conditioning, Transducers, Noise in measurements, Methods of Data Analysis.

**Biophys 332 ELECTRONIC SIMULATION FOR BIOLOGICAL SYSTEMS (2 cr.).**

Prerequisite: Biophys221. Offered in spring.

**Operational amplifiers: Single-input circuits:** Voltage summer, current-to-voltage converter, integrator and differentiator circuits, integration with summing and summing differentiator. **Differential mode circuits:** Subtracting circuits, difference integrator and voltage follower, Nonlinear circuits, Comparator, Rectifiers, Operational amplifier in simulation, Spring and weight system, Analog computation, Differential equations. Electrocardiogram simuulator, Electrocardiogram amplifier, Notch filter, Audiometer, Pacemaker nerve simulator, Galvanic skin resistance detector.

**Biophys 341 BIOTECHNOLOGY (2 cr.).**

Offered in fall.

Biophysical topics pertinent to biotechnology include: Chemical context of life, The thermodynamic aspects of the organization of amino acids, nucleotides, lipids, and sugars into higher-order structures, such as proteins, nucleic acids, and membranes. The use of mechanistic and kinetic information in enzyme characterization and drug discovery. Methods of protein purification and characterization. Biophysical and biochemical analysis of recombinant proteins and recombinant DNA and its application in genetic engineering. Liposomes and nanoparticles drug delivery system. Gene therapy. Potential use of intelligent biological materials in data processing in what is called “optical computer”. Potential use of biological photochromic materials in holography and optical devices. ATP generation in bioreactors. Desalination of seawater, Conversion of sunlight into electricity via protein, Artificial retinas, Spatial light modulators, Biosensors.

**Biophys 342 BIOENERGETICS (2 cr.).**

Offered in spring.

The flow of energy in the biological world, Free energy change of chemical reactions under non-standard conditions, The adenosine triphosphate system (ATP) and the transfer of energy, Generation of ATP in cells, The mitochondrion, Respiration and oxidative phosphorylation, The chloroplast , Photosynthesis and photophosphorylation, The ATP synthase, Chemiosmotic principle and proton circuit, Energetics of photosynthetic bacteria, The chemical work of biosynthesis, Biosynthesis of DNA, RNA and proteins, The assembly of cell structure.

**Biophys 351 EXP. BIOPHYSICS (1 cr.).**

Offered in fall.

**Biophys 352 BIOELECTRONICS (2 cr.).**

Prerequisite: Biophys221. Offered in spring.

Electron and proton transport in natural and artificial systems, Structure of electron carriers, Proton movement associated with electron transfers, Hydration studies, Protein fluctuations, Types of polarization, permanent dipole and orientational polarization ,Maxwell-Wagner polarization,rotational relaxation, Dielectric studies of biological molecules and systems, Dielectric studies of ionic and protonic conductions in proteins, Dielectric and conduction properties of proteins, amino acids, DNA, liposomes and cell suspensions, and tissues.

**Biophys361 EXP. BIOPHYSICS (2 cr.).**

Offered in fall.

**Biophys 362 EXP. BIOPHYSICS (1 cr.).**

Offered in spring.

**Biophys 372 EXP. BIOPHYSICS (2 cr.).**

Offered in spring.

**Biophys 411 NUCLEAR REACTOR SAFETY (2 cr. + 1 cr. Lab).**

Offered in fall.

Transuranium elements and radioactive equilibrium, nuclear forces and nuclear bindings, coulomb barrier height, q value of a reaction and threshold energy, energy states of a nucleus, liquid drop model, neutron reactions, cross section, attenuation 1\v low, nuclear fission, energy and mass distribution of fission products, prompt and delayed neutrons, slowing down of neutrons, angular and energy distribution, average logarithmic energy decrement, slowing down power, neutron shielding, dose assessment, radiation monitors neutron dose measurement, biological effects of neutrons.

**Biophys 412 BIOPHYSICS OF MEDICAL IMAGING (2 cr.).**

Prerequisite: Biophys311. Offered in spring.

Introduction: This course deals with the important aspects of medical imaging. It discusses the fundamental imaging physics in addition to a variety of imaging modalities. The aim is to gain essential knowledge for a biophysicist to carry research and become able to work in the field of medical imaging.

Main Topics: Screen-film radiography (conventional imaging), Mammography (x-ray imaging of the breast), Fluoroscopy (x-ray life images of the body including angiography), Image quality (the procedures for evaluating the quality of an image), Digital radiography (the use of digital detectors and image processing), Computed Tomography (CT), tomographic imaging using x-rays, Magnetic Resonance Imaging (MRI), medical imaging using the principle of the NMR.

**Biophys 421 RADIATION TREATMENT PLANNING (2 cr. + 1 cr. Lab).**

Prerequisite: Biophys311. Offered in fall.

CGS and SI radiation units. Exposure-to-absorbed dose conversion factor. Factors affecting isodose curve patterns in tissue-equivalent phantom. Types of tissue equivalent materials. Equivalent square and circles for rectangular fields. Percentage Depth Dose. Backscatter or Peakscatter factor. Tissue-Air ratio. Tissue-Phantom ratio. Alteration of isodose curves by patient skin contour shape. Bolus and compensating filters. Dose correction for tissue inhomogeneities. Wedge filters. Integral dose. Multiple-field isodose curve.0 pattern. Isodose curve notation. Two-field plans. Three-field plans. Beam direction devices. Manual addition of isodose curves. Constant SSD/FSD treatment dose calculation using Percentage Depth Dose. Patient dose prescription chart. Constant SAD treatment doses calculation using Tissue-Air ratio (TAR). Tissue-Maximum ratio (TMR) and Tissue-Phantom ratio (TPR).

**Biophys 422 CELL AND MEMBRANE BIOPHYSICS (2 cr.).**

Prerequisite: Biophys213. Offered in spring.

The importance of biological membrane: Cell protection, Selective communication with the exterior, Compartmentalization, Transfer system, Electrochemical gradient, Membrane recognition. The molecular structure of biological membrane: Fluid-mosaic model, The dynamic model of biomembrane. The different artificial model of biomembrane: Lipid monolayer at air-water interface, Black lipid membrane, Liposomes. Membrane permeability and transport: Effect of temperature and membrane content of cholesterol, Effect of action potential. Ion conducting channels in membrane, Liposomes as a drug and gene targeting systems.

**Biophys 431 BIOMECHANICS (2 cr.).**

Biomechanics of bone, the meaning of constitutive equation,Elasticity of solid body . viscosity of liquids.viscoelasticity of biological materials, different models of Viscoelasticity, the definition of stress relaxation, creep and hysterics, testing the mechanical properties of biological materials .The

flow properties of blood, the viscosity of blood as function of shear rates, The flow property from large tubes (arterial) to very small capillaries.

**Biophys 432 BIOPHYSICAL MEASUREMENTS (2 cr. + 1 cr. Lab).**

Prerequisite: Biophys321. Offered in spring.

Separation methods: Chromatography (column chromatography, HPLC, adsorption, ion-exchange, permeation, gas-liquid and thin-layer chromatography), Electrophoresis (protein separation: SDS-PAGE, gradients gels, isoelectric focusing, Western blotting, DNA separation [southern blotting]: Agarose gel, sequencing gel, pulsed-field gel, RNA separation [northern blotting), Diffusion and sedimentation methods. Principles of: x-ray diffraction from biological samples, Nuclear Magnetic Resonance (NMR), mass spectroscopy and dielectric technique (dielectric constant, relaxation time and dipole moment).

**Biophys 441 BIOMATERIALS (2 cr.).**

Offered in fall.

Materials used in bioequivalent materials: Metals, Ceramics, Polymers, Chemical structur and Basic concepts. Electrical properties of bioequivalent materials: Biomaterials in static fields: Electrostatic relations, Molecular polarisability, Local field, The clausius – Mosotti relation, Dielectric constant and molecular weight theory. Dielectric Relaxation: General theory of relaxation. Different techniques for the measurements of dielectric properties. Measurement of resistivity: Surface and Volume resistivity measurements. Mechanical properties of Biomaterials: Basic materials properties, Tensile properties, Fracture, The hardness test, Fatigue, Corrosion fatigue, Material used in total joint replacement, General considerations, Static mechanical properties. The Tissue response to total joint replacement prostheses: The reaction of bone to an implant, The morphology of the normal bone cement interface, The cause of bone cement death. Metals as implant materials: Introduction, Metallic corrosion, Metallic implant fractute. Tissue Reactions: Metals, Polymers, Ceramics.

**Biophys 442 MOLECULAR BIOPHYSICS (2 cr.).**

Prerequisite: Biophys321. Offered in spring.

Binding of small molecules by a macromolecule: a Identical and independent sites model-examples. b.Nearest-neighbor interaction model-examples, Random walk theory and the average dimesion of a flexible biopolymer, Molecular distribution and the most probable one, Enzyme kinetics, Biopolymers as polyelectrolytes, Dielectric properties of biopolymers.

**Biophys 451 MOLECULAR SPECTROSCOPY (2 cr.).**

Prerequisite: Biophys322. Offered in fall.

Introduction of spectroscopy, Microwave spectroscopy, Infrared spectroscopy, Electronic spectroscopy of atoms, Electronic spectroscopy of molecules.

**Biophys 452 COMPUTATIONAL BIOPHYSICS (2 cr.).**

Offered in spring.

Study of the different types of models, one-compartment model, two-compartment model, models based on the differential equations, models based on difference equation enzyme kinetic models, population models, fitting different models to a data, Monte Carlo simulation and its applications in biophysics.

**Biophys 461 Article (1) (2 cr.).**

Offered in fall.

**Biophys 462 Article (2) (2 cr.).**

Offered in spring.

**Biophys 471 EXP. BIOPHYSICS (2 cr.).**

Offered in fall.

**Biophys 472 COMMUNICATION AND CONTROL BIOPHYSICS (2 cr.).**

Prerequisites: Biophys231, 332 . Offered in spring.

Passive electric properties of tissues and cells, Physical bases for bioelectric potentials: Resting potential, Cell responses to tissues excitation, Microelectrodes and their uses and applications

**Biophys 481 EXP. BIOPHYSICS (3 cr.).**

Offered in fall.

**Biophys 482 BIOPHYSICS OF CELL COMMUNICATION (2 cr.).**

Prerequisite: Biophys332 . Offered in spring.

An Overview of Cell Signaling, Cell signaling evolved early in the history of life, Communicating cells may be close together or far apart, The 3 stages of cell signaling, Reception, Transduction, Response, Signal Reception and the Initiation of Transduction, A chemical signal binds to a receptor protein, causing the protein to change shape, Most signal receptors are plasma-membrane proteins, Signal Transduction Pathways, pathways relay signals from receptors to cellular responses, Protein phosphorylation, a common mode of regulation in cells, is a major mechanism of signal transduction, Certain small molecules and ions are key components of signaling pathways (2nd messengers), Cellular Responses to Signals, In response to a signal, a cell may regulate activities in the cytoplasm or transcription in the nucleus, Elaborate pathways amplify and specify the cell's responses to signal.

**Biophys 492 EXP. BIOPHYSICS (2 cr.).**

Offered in spring.

**Biophys 494 EXP. BIOPHYSICS (3 cr.).**

Offered in spring.

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# GEOPHYSICS

## First: Academic programs Offered by Geophysics Department

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 1 | 1st | Geophys 101 | Introduction to Geophys sics (1) | - | Geophys | - | 2 | 2 | - | 3 | 6 cr. compuls. |
| | 2nd | Geophys 102 | Introduction to Geophys sics (2) | Geophys101 | | - | 2 | 2 | - | 3 | |
| 2 | 3rd | Geophys 201 | Seismic Waves and Velocities | Geophys102 | Geophys | - | 2 | 2 | - | 3 | 18 cr. compuls. |
| | | Geophys 202 | Gravity Methods | Geophys102 | | - | 2 | 2 | - | 3 | |
| | | Geophys 203 | Magnetic Methods | Geophys102 | | - | 2 | 2 | - | 3 | |
| | | Geophys 204 | Electrical Methods | Geophys102 | | - | 2 | 2 | - | 3 | |
| | | Geophys 205 | Seismic Methods | Geophys102 | | - | 2 | 2 | - | 3 | |
| | | Geophys 206 | Geothermal and Radiation Methods | Geophys102 | | - | 2 | 2 | - | 3 | |
| | 4th | Geophys 207 | An Introduction in Well Logging | - | Geophys | - | 2 | 2 | - | 3 | 18 cr. compuls. |
| | | Geophys 208 | Petrophysics | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 209 | Seismic Field Techniques | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 210 | Paleomagnetism | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 211 | Potential Field Data Acquistion | - | | - | 2 | 2 | - | 3 | |
| | | G 224 | Minerals and Rocks | - | | | 2 | 2 | - | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 3 | 5th | Geophys 301 | Earthquakes Seismology | Geophys 102 | Geophys | - | 2 | 2 | - | 3 | 12 cr. compuls., 6 cr. elective |
| | | Geophys 302 | Electromagnetic Methods | Geophys203, Geophys204 | | - | 2 | 2 | - | 3 | |
| | | Geophys 303 | Potential Field Data Processing | Geophys211 | | - | 2 | 2 | - | 3 | |
| | | G 323 | Structural and Field Geology & Surverying | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 304 | Petroleum Economics and Assessment | - | - | Geophys | 2 | 2 | - | 3 | |
| | | Phys 424 | Fluid Mechanics | - | - | | 2 | 2 | - | 3 | |
| | | Math 353 | Numerical Analysis And Computer (1) | - | - | | 2 | 2 | - | 3 | |
| | 6th | Geophys 305 | Seismic Data Processing | Geophys209 | Geophys | - | 2 | 2 | - | 3 | 12 cr. compuls., 6 cr. elective |
| | | Geophys 306 | Computer Applications in Geophys sics | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 307 | Well Logging | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 308 | Geotectonics | - | | - | 2 | 2 | - | 3 | |
| | | G 324 | Sedimentary Layers | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 309 | Radar in Geophys sics | - | - | Geophys | 2 | 2 | - | 3 | |
| | | Phys 391 | Instrumentation & Electronics | - | - | | 2 | 2 | - | 3 | |

| LEVEL | SEMESTER | SUBJECT No. | SUBJECT NAME | PRE-REQUISITE | SUBJECT CASE | | HOURS | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Compulsory | Elective | Lectures | Practical | Tutorial | Credit | |
| 4 | 7th | Geophys 401 | Seismic Interpretation | - | Geophys | - | 2 | 2 | - | 3 | 12 cr. compuls., 6 cr. elective |
| | | Geophys 402 | Interpretation of Potential Field Data | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 403 | Seismic Stratigraphy | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 404 | Engineering and Environmental Geophys sics | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 405 | Marine Geophys sics | Geophys308 | - | Geophys | 2 | 2 | - | 3 | |
| | | Geophys 406 | Reservoir Engineering | - | - | | 2 | 2 | - | 3 | |
| | | Geophys 407 | Reservoir Simulation and Productivity | - | - | | 2 | 2 | - | 3 | |
| | 8th | Geophys 408 | Mining Geophys sics | Geophys302 | Geophys | - | 2 | 2 | - | 3 | 15 cr. compuls., 3 cr. elective |
| | | Geophys 409 | Integration of Geophys sical Data | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 410 | Project | - | | - | 2 | 2 | - | 3 | |
| | | G 432 | Petroleum and Subsurface Geology | - | | - | 2 | 2 | - | 3 | |
| | | G 434 | Geology of Egypt and Economic Ore Deposits | - | | - | 2 | 2 | - | 3 | |
| | | Geophys 411 | Remote Sensing | - | - | Geophys | 2 | 2 | - | 3 | |
| | | G 436 | Hydrogeology | - | - | | 2 | 2 | - | 3 | |

## Second: Courses Offered by Geophysics Department

**Geophys 101 GEOPHYSICS (1) (2cr. + 1cr. Lab.)**

Offered in fall.

General introduction to geophysics, Basic principals of gravity method, Basic principals of magnetic method.

**Geophys 102 GEOPHYSICS (2) (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 101. Offered in spring.

General introduction to Seismic methods, Basic principals of Seismic reflection method, Basic principals of Seismic refraction method, Basic principals of Electric methods.

**Geophys 201 SEISMIC WAVES AND VELOCITIES (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 102. Offered in fall.

Theory of elasticity, Wave equation and its solutions, Field techniques, Wave characteristics on field record.

**Geophys 202 GRAVITY METHODS (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 102. Offered in fall.

Gravimetry and its purpose. The main purpose of Gravimetry, Fundamental Relations, Gauss' Law, r – Function, Laplace's Equation, Direct and Inverse Gravimetric Problems for Spherical Bodies, Initial Formula for Gravimetric Interpretation, Gravitating Bodies of Irregular Shapes, Inverse Problem of Gravitating Bodies of Irregular Shapes, Variation of Gravity with Latitude, Gravity Formulas.

**Geophys 203 MAGNETIC METHODS (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 102. Offered in fall.

Basic fundamentals of the magnetic method in geophysics, lines of force, magnetic fields (b and h fields), intensity of magnetisation, magnetic susceptibility and permeability, diamagnetism, paramagnetism and ferromagnetism, magnetic hysteresis, common magnetic minerals, the earth's magnetic field, the geomagnetic elements, geomagnetic poles, the non-dipole field, variations in the geomagnetic field (diurnal and secular), origin of the earth's magnetic field, surveying techniques, terrestrial magnetic surveying, grid station requirements, base station options, data corrections, airborne magnetic surveying, flight-line pattern, flight-line orientation, positioning, elevation, data corrections, marine magnetic surveying.

**Geophys 204 ELECTRIC METHODS (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 102. Offered in fall.

Fundamental principles, Point and dipole sources on a uniform earth, Electrical fields in 1-D earth structures, Electrical field in 2-D earth structures, Apparent and true resistivities, Factor affecting resistivity, Fundamental equation of resistivity, Resistivity survey types, Resistivity arrays, Types of resistivity curves, Qualitative inversion of resistivity curves.

**Geophys 205 SEISMIC METHODS (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 102. Offered in fall.

Theory of elasticity, stress, strain, hook's law, elastic constants, wave motion, wave equation, plane wave solution, spherical wave solutions, harmonic waves, p- waves and s- waves, surface waves, energy density (intensity), absorption, dispersion, seismic velocity, types of seismic wave velocities, factors affecting velocities, measurement of velocity.

**Geophys 206 GEOTHERMAL AND RADIATION METHODS (2cr. + 1cr. Lab.)**

Offered in fall.

Introduction, the earth's heat and internal temperatures, observed heat flow (q), implications of the observed heat flow (q), heat flow provinces, thermal models of the crust and upper mantle, internal temperatures, convection cells and plate tectonics, geothermal exploration, geothermal reservoirs, world distribution of hydrothermal systems, first stage surveys, second stage surveys, third stage surveys, fourth stage surveys, general criteria for the sitting of deep exploration holes, nuclear exploration geophysics, theory of nuclear radiation, gamma ray, transport phenomena, gamma ray scattering with matter (photoelectric effect, compton scattering, pair production), cosmic rays, sources of background radiation, detector radioactivity, radiological instruments, graound radioelement concentration units, uranium deposits.

**Geophys 207 AN INTRODUCTION IN WELL LOGGING (2cr. + 1cr. Lab.)**

Offered in spring.

Introduction to borehole geophysics, basic concepts, borehole environment, invasion process & resistivity profiles, modern logging tools, log interpretation, archie equation, ratio method, bulk volume water, quick-look methods, pickett and hingle crossplots, permeability from logs, shaly sand analysis.

**Geophys 208 PETROPHYSICS (2cr. + 1cr. Lab.)**

Offered in spring.

Introduction, mineralogical and petrographical principles of rock physic, physical properties of rocks and factors determining them, mechanical properties of rocks, acoustics of rock, themodynamics of rocks, electromagnetic properties of rocks, radiation properties of rocks, inter-relation between properties and physical phenomena in rocks.

**Geophys 209 SEISMIC FIELD TECHNIQUES (2cr. + 1cr. Lab.)**

Offered in spring.

Fundamental principles & applications, seismic refraction & reflection methods, field layout, survey equipment and field conditions, data acquisition and reduction, seismic data processing and interpretation, borehole seismic surveys, seismic tomography survey.

**Geophys 210 PALEOMAGNETISM (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 203. Offered in spring.

Introducing the Natural Remanent Magnetisation (NRM) acquired by rocks, Isothermal remanent magnetization (IRM), Viscous remanent magnetization (VRM), Thermoremanent magnetization (TRM), Self-reversed magnetization (SRM), Depositional remanent magnetization (DRM), Chemical remanent magnetization (CRM), Piezo-remanent magnetization (PRM), The Königsberger ratio, Magnetic character of continents and oceans, Applications of palaeomagnetism.

**Geophys 211 POTENTIAL FIELD DATA ACQUISITION (2cr. + 1cr. Lab.)**

Prerequisites: Geophys 202, Geophys 203. Offered in spring.

Relative gravity measurements, pendulum instruments, gravimeters, calibration of gravimeter, drift correction, field operation, reduction of gravity data, free air correction, bouguer correction, topographic correction, isostatic correction, reduction of combined land and water station, construction of the bouguer anomaly map, magnetic measurements, magnetometers, magnetic land, arial and sea surveying, normal corrections, diurnal corrections.

**Geophys 301 EARTHQUAKE SEISMOLOGY (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 201. Offered in fall.

Review-theory of elasticity, review-seismic waves, introduction: seismicity of the world and plate tectonics, earthquake types, interpolate versus intra-plate earthquakes, tectonic earthquakes versus volcanic earthquakes, artificial seismicity versus earthquake tremors, seaquakes (tsunamis), instrumentation for earthquake recordings, reading earthquake records, identification of earthquake phases and structure of the earth's interior, determination of earthquake parameters, origin time, magnitude, focal mechanism, epicenter location and focal depth, earthquake intensity scale, earthquake hazards, earthquake induced processes, rupture, soil failure, ground shaking, introduction to seismicity of Egypt.

**Geophys 302 ELECTROMAGNETIC METHODS (2cr. + 1cr. Lab.)**

Prerequisites: Geophys 203, Geophys 204. Offered in fall.

Background and applications, type of EM systems, principles of EM surveying, factors affecting terrain conductivity, airborne and sea EM surveying, borehole EM surveying, continuous and pulse-transient EM systems, telluric and Magneto-telluric methods, applications and case histories.

**Geophys 303 POTENTIAL FIELD DATA PROCESSING (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 211. Offered in fall.

Regional-residual separation techniques, Arithmatic mean method, Smoothing Methods, Profiling Method, Running Average Profiling Method, Griffin's Method, Least-Squares Method, Second Derivative Methods, Downward and Upward Continuation Methods.

**Geophys 304 PETROLEUM ECONOMICS AND ASSESSMENT (2cr. + 1cr. Lab.)**

Offered in fall.

Introduction, Planning and Exploration, Development, Production and Marketing.

**Geophys 305 SEISMIC DATA PROCESSING (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 209. Offered in spring.

Overview : the need for processing seismic data, The definitions of the seismic signal and the seismic noise, The Fourier analysis, Principal operations for data processing, Demultiplexing, Normal move out (NMO), common depth point gathers and stacking velocity, Static correction, Velocity analysis; overview, Filtering, Convolution, Correlation, Deconvolution, Migration, Processes to improve S/N ratio, Processes to reposition the data, Other data processing techniques.

**Geophys 306 COMPUTER APPLICATIONS IN GEOPHYSICS (2cr. + 1cr. Lab.)**

Offered in spring.

Fortran language, number systems, priority rules for performing orders on computer, presentation of data, types of variable names, fortran coding sheet, flow charts, types of format, types of if-statement, logical gates, if then else statement, types of do loops, one dimension arrays, two dimension arrays.

**Geophys 307 WELL LOGGING (2cr. + 1cr. Lab.)**

Offered in spring.

Review on: The basic concepts of log analysis, Modern logging tools, Formation evaluation overview, Interpretation, "Quick-look" interpretation, crossplots & overlays, Petrophysical parameter determination, Log evaluation in shaly sands, Porosity determination, Saturation determination, Evaluation of complex lithology, Wireline formation tester, Drillstem testing.

**Geophys 308 GEOTECTONICS (2cr. + 1cr. Lab.)**

Offered in spring.

Introduction: Historical background Development of the theory, The plate tectonic theory: evidences of plate motion, sea floor spreading and types of plate boundaries. Mid oceanic ridge, subduction zone and transform faults, Global distribution of seismicity and volcanicity. Types of earthquakes, seismic belts, volcanic chains. Mantle convection, The driving mechanisms of plate tectonics and continental drift, The Red Sea – Gulf of Suez – Gulf of Aqaba Rift system. Origin of the Red Sea.

**Geophys 309 RADAR IN GEOPHYSICS (2cr. + 1cr. Lab.)**

Offered in spring.

Introduction, nature of GPR waves, antenna types & frequencies, horizontal & vertical resolutions, behavior of GPR with different types of rock and fluids, data processing (GPR time and frequency domain filters), applications, engineering applications, geological application, environmental application, archeological applications.

**Geoph 401 SEISMIC INTERPRETATION (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 305. Offered in fall.

Introduction: basic geologic concepts, introduction to seismic field techniques, geophysical interpretation of seismic data, seismic cross sections, picking seismic horizons, fault criteria. typing seismic sections, typing sections to well data, time maps, evidences for geologic features, structural interpretation of seismic data, stratigraphic interpretation of seismic data, seismic modeling, synthetic seismograms, direct hydrocarbon indicators, overview: vertical seismic profiling.

**Geophys 402 INTERPRETATION OF POTENTIAL FIELD DATA (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 303. Offered in fall.

Characteristic points and distance approaches, nomograms, standard curves, least-squares method, correlation factors, window curves method, transform techniques, werner deconvolution method, euler deconvolution method.

**Geophys 403 SEISMIC STRATIGRAPHY (2cr. + 1cr. Lab.)**

Offered in fall.

Introduction, Seismic Stratigraphy and Global changes of sea level, Interpretation procedure of seismic stratigraphy, Seismic sequence analysis, Seismic facies analysis, Analysis of relative changes of sea level, Example of seismic stratigraphy interpretation from the Gulf of Suez, Egypt.

**Geophys 404 ENGINEERING & ENVIRONMENTAL GEOPHYSICS (2cr. + 1cr. Lab.)**

Offered in fall.

Introduction to ground geophysical techniques Applied in engineering Geophysics, Gravity surveying, Magnetic surveying, Seismic surveys, Resistivity surveys, Ground penetrating radar, Application of ground geophysics to foundation engineering, Depth to bed-rock, Physical properties

of bedrocks, Fracture characteristics of bedrock, Application of ground geophysics to water location, Water supply (volume and quality), Sewage disposal, Application of ground geophysics to cave detection, Application of ground geophysics to buried objects delineation, Application of ground geophysics to Archaeological prospecting.

**Geophys 405 MARINE GEOPHYSICS (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 308. Offered in fall.

Introduction, Basic seismic Theory of wave propagation in fluid medium, Marine seismic sources and receivers, Positioning of seismic sources and receivers, Noise types affecting seismic data, Design of seismic survey, Survey types in marine recording and application, Multi-component seismic: Acquisition and applications, New technologies in marine seismic, Other Geophysical methods applied in marine Geophysics.

**Geophys 406 RESERVOIR ENGINEERING (2cr. + 1cr. Lab.)**

Offered in fall.

Definition, characteristics, and types of hydrocarbon reservoir, 2D and 3D geophysical techniques used to assess hydrocarbon reservoir, Reservoir potentialities as delineated from various geophysical tools, Reservoir maturity and flow, Reservoir lifetime and extensions, Integration of geophysical and engineering tools for reservoir maintenance and development.

**Geophys 407 RESERVOIR SIMULATION AND PRODUCTIVITY (2cr. + 1cr. Lab.)**

Offered in fall.

Introduction to Reservoir Simulation, What is Reservoir Simulation?, Types of Reservoir Simulation Models (Analog, Physical, Mathematical, Numerical, and Computer models), When you should use Reservoir Simulation?, Application of Reservoir Simulation, Simplified Approach to Understanding Reservoir Simulation, Difference between Simulators, Steps in a Reservoir Simulation Study, Data needed for a typical simulation study.

**Geophys 408 MINING GEOPHYSICS (2cr. + 1cr. Lab.)**

Prerequisite: Geophys 302. Offered in spring.

Use of geophysical methods (Magnetic, SP, IP, Electromagnetic, Gravity) in Mining geophysics, Field examples.

**Geophys 409 INTEGRATION OF GEOPHYSICAL DATA (2cr. + 1cr. Lab.)**

Offered in spring, case Histories.

**Geophys 410 PROJECT (2cr. + 1cr. Lab.)**

Offered in spring.

Special problems, Preparation of final manuscript (Bsc Thesis).

**Geophys 411 REMOTE SENSING (2cr. + 1cr. Lab.)**

Offered in spring.

Current role of remote sensing in exploration, Characteristics of ore deposits, Physical phenomena and measurement techniques, Spectral reflectance and emittance, Thermal images, Slide looking radar system, Remote sensing systems, Image analysis, Application of remote sensing systems, Image analysis, Economic considerations.

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