DEPARTMENT OF PHYSICS

MAR IVANIOS COLLEGE (AUTONOMOUS), THIRUVANANTHAPURAM

(AFFILIATED TO THE UNIVERSITY OF KERALA)

SYLLABI FOR

FIRST DEGREE PROGRAMME IN PHYSICS (CORE)
WITH MATHEMATICS AND MACHINE LEARNING AS COMPLEMENTRY PAPERS

UNDER

CHOICE BASED-CREDIT & SEMESTER- SYSTEM (CBCSS)

(2020 admission onwards)

AIM AND OBJECTIVES OF THE PROGRAMME

In this programme, we aim to provide a solid foundation in all aspects of Physics and to show a broad spectrum of modern trends in physics and to develop experimental, computational and mathematical skills of students. The syllabi are framed in such a way that it bridges the gap between the plus two and post graduate levels of physics by providing more or less complete and logical framework in almost all areas of basic Physics.

The programme also aims to

(i) Provide education in physics of the highest quality at the undergraduate level and generate graduates of the calibre sought by industries and public service as well as academic teachers and researchers of the future.

(ii) Attract outstanding students from all backgrounds.

(iii) Provide an intellectually stimulating environment in which the students have the opportunity to develop their skills and enthusiasms to the best of their potential.

(iv) Maintain the highest academic standards in undergraduate teaching.

(v) Impart the skills required to gather information from resources and use them.

(vi) Equip the students in methodology related to Physics.

Objectives

By the end of the first year (2nd semester), the students should have,

(i) Attained a common level in basic mechanics and properties of matter and laid a secure foundation in mathematics for their future courses.

(ii) Developed their experimental and data analysis skills through a wide range of experiments in the practical laboratories.

By the end of the fourth semester, the students should have

i. Been introduced to powerful tools for tackling a wide range of topics in Thermodynamics, Electrodynamics, Classical Mechanics and Relativistic Mechanics.

ii. Become familiar with additional relevant mathematical techniques.

iii. Further developed their experimental skills through a series of experiments which also illustrate major themes of the lecture courses.

By the end of the sixth semester, the students should have

i. Covered a range of topics in almost all areas of physics including Quantum Physics, Solid State Physics, Computational Physics, Electronics etc.

ii. Had experience of independent work such as projects, seminars etc.

iii. Developed their understanding of core Physics.

Programme Specific Outcomes

PSO No.	Upon completion of B.Sc. Physics Degree programme, the graduates will be able to
PSO - 1	Conceptual understanding of Physics and its practical applications and scope in the present world.
PSO – 2	Analysing the theory part with practical experiments, interpretation of experimental results, finding out errors, suggestions to improve the errors.
PSO – 3	Develop and construct practical model systems from their conceptual knowledge.
PSO - 4	Distinguish Microscopic and Macroscopic Systems.
PSO - 5	Acquire conceptual understanding of Physics to General real-world situations.
PSO - 6	Integrate the Quantum Mechanics to understand the fundamentals of other branches of physics such as Vibrational Spectroscopy
PSO - 7	Understand possible atomic and molecular energy levels and transitions and predict the existence of new elements
PSO - 8	Develope an idea regarding x-rays resonance spectroscopic techniques
PSO - 9	Students will use the knowledge of electronics and communication to analyze the contemporary communication systems and to design the system.
PSO - 10	Apply the Langrangian and Hamiltonian formalisms to solve various dynamical problems which involve constraints.
PSO - 11	Students will use the knowledge of Mechanics to describe the motion of objects in different force fields.

I. General Structure for the First-Degree Programme in Physics

Sem. No.	Course title	Instructional hours/week L	P	Credit	University. Exam duration	Evaluation Internal	Uty. Exam	Total credit
I	EN1111 English Lang I	5		4	3 hours			
	1111 Addl Lang I	4		3	,,			
	EN1121 Foun Course I	4		2	,,	20%	80%	16
	PY1141 Core Course I	2		2	,,			
	Core pract. I	-	2	-	-			
	MM1131.1 Compl. Course I	2	2	3	3 hours			
	Compl. Course II (CH1131.1/ST1131.2/PCH1131.7/EL1131)	2	2	2	,,			
II	EN1211 Eng Lang. II	5		4	3 hours			
	EN1212 Eng Lang. III	4		3	,,			
	1211 Addl Lang. II	4		3	,,	20%	80%	17
	PY1241 Core Course II	2		2	,,			
	Core pract. I		2					
	MM1231.1 Compl. Course III	2	2-	3	,,			
	Compl. Course IV (CH1231.1/ST1231.2/ PCH1231.7/EL1231)	2	2	2	,,			
III	EN1311 Eng Lang. IV	5		4	3 hours			
	1311 Addl Lang. III	5		4	,,			
	PY1341 Core Course II	3	-	3	,,	20%	80%	18
	Core Pract I	-	2	-	-			
	MM1331.1 Compl. Course V	3	2	4	3 hours			
	Compl. Course VI (CH1331.1/ST1331.2/PCH1331.7/EL1331)	3	2	3	,,			

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II. Course structure:(1a). ***Core Courses (theory)***

Sem.	Title of paper	Number of hours per week	Number of credits	Total hours/ semester	UE Duration
1	PY1141 – Basic mechanics & Properties of matter	2	2	36	3 hrs
2	PY1241- Heat & Thermodynamics	2	2	36	3
3	PY1341– Electrodynamics	3	3	54	3
4	PY1441- Classical & Relativistic Mechanics	3	3	54	3
5	PY1541– Quantum Mechanics	4	4	72	3
	PY1542–Statistical Mechanics Research Methodology and Disaster Management	4	4	72	3
	PY1543–Electronics	4	4	72	3

(1b).COURSE STRUCTURE FOR PRACTICAL AND PROJECT WORK

	PY1544–Atomic & Molecular Physics	4	4	72	3
	PY1551– Open course	3	2	54	3
	PY1641-Solid State Physics	4	4	72	3
	PY1642–Nuclear & Particle Physics	4	4	72	3
6	PY1643- Classical & Modern Optics	4	4	72	3
	PY1644-Digital Electronics & Computer Science	4	3	72	3
	PY1661– Elective Course	3	2	54	3

FORTHECORE COURSE:

Sem	Title of Paper	Duration of Exam	Number Of Credits	Weightage IA	Weightage UE	Allotted hours	
						Per week	Per year
4	**PY1442- Basic Physics Lab 1**	3	3	1	3	S1---2 S2---2 S3---2 S4—2	144
6	**PY1645-Advanced Physics Lab 2**	3	2	1	3	S5---2 S6—2	72
6	**PY1646-Advanced Physics Lab 3**	3	3	1	3	S5---2 S6—2	72
6	PY-1647-Project	-	4	-	4	S5-2 S6-2	72

2(a). Complementary Courses (General structure)

Semester	Theory			Practical	
	Number of hours/week	Number of credits	Total hours/sem	number of hours/week	Number of credits
1	2	2	36	2	-
2	2	2	36	2	-
3	3	3	54	2	-
4	3	3	54	2	4

(2b). COMPLEMENTARY COURSES (Theory and Practical)

1. Physics for Mathematics B.Sc Programme

Semester	Title of the course	No. of hours/ week	No. of credits	Total credits	Total hours per sem.	UE duration
1	PY1131.1- Mechanics & properties of matter	2	2	2	36	3

	Practical	2			36	
2	PY1231.1- Thermal Physics and statistical mechanics	2	2	2	36	3
	Practical	2			36	
3	PY1331.1- Optics,magnetism & electricity	3	3	3	54	3
	Practical	2			36	
4	PY1431-Modern Physics & Electronics	3	3	7	54	3
	PY1432-Practical	2	4		36	

2. Physics for Chemistry B.Sc Programmes

Semester	Title of the course	No. of hours/ week	No. of credits	Total credits	Total hours per sem.	UE duration
1	PY1131.2- Rotational dynamics & properties of Matter	2	2	2	36	3
	Practical	2			36	
2	PY1231.2- Thermal Physics	2	2	2	36	3
	Practical	2			36	
3	PY1331.2 - Optics, Magnetism & Electricity	3	3	3	54	3
	Practical	2			36	
4	PY1431.2-Atomic physics, Quantum mechanics & Electronics	3	3	7	54	3
	PY1432- Practical	2	4		36	3

3. Physics for Statistics B.Sc Programme

Semester	Title of the course	No. of hours/ week	No. of credits	Total Credits	Total hours per sem.	UE duration
1	PY1131.3- Mechanics & properties of matter	2	2	2	36	3
	Practical	2			36	
2	PY1231.3 Physic - Thermal s & statistical mechanics	2	2	2	36	3
	Practical	2			36	
3	PY1331.3 - Optics, Magnetism& electricity	3	3	3	54	3
	Practical	2			36	
4	PY1431.3 - Modern physics & Electronics	3	3	7	54	3
	PY1432- Practical	2	4		36	3

4. Physics for Geology B.Sc Programme

Semester	Title of the course	No. of hours/ week	No. of credits	Total credits	Total hours per sem.	UE duration
1	PY1131.4 - Mechanics & properties of matter	2	2	2	36	3
	Practical	2			36	
2	PY1231.4 - Thermal Physics & Physics of the Earth	2	2	2	36	3
	Practical	2			36	
3	PY1331.4 - Optics and electrodynamics	3	3	3	54	3
	Practical	2			36	
4	PY1431.4 - Modern Physics, Electronics & crystallography	3	3	7	54	3
	PY1432- Practical	2	4		36	3

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5. Physics for Home Science B.Sc Programme

Semester	Title of the course	No. of hours/ week	No. of credits	Total credits	Total hours per sem.	UE duration
1	PY1131.5- Mechanics & properties of matter	2	2	2	36	3
	Practical	2			36	
2	PY1231.5- Thermal Physics	2	2	2	36	3
	Practical	2			36	
3	PY1331.5- Optics and electricity	3	3	3	54	3
	Practical	2			36	
4	PY1431.5- Atomic physics & Electronics	3	3	7	54	3
	PY1432- Practical	2	4		36	3

6. Electronics for Physics B.Sc Programme

Semester	Title of the course	No. of hours/ week	No. of credits	Total credits	Total hours per sem.	UE duration
1	EL1131- Electronics I	2	2	2	36	3
	Practical	2			36	
2	EL1231- Electronics II	2	2	2	36	3
	Practical	2			36	
3	EL1331- Electronics III	3	3	3	54	3
	Practical	2			36	
4	EL1431- Electronics IV	3	3	7	54	3
	EL1432- Practical	2	4		36	3

7. Physics for Polymer Chemistry B.Sc Programme

Semester	Title of the course	No. of hours/ week	No. of credits	Total credits	Total hours per sem.	UE duration
1	PY1131.7– Mechanics and Fluid dynamics	2	2	2	36	3
	Practical	2			36	
2	PY1231.7- Thermal Physics	2	2	2	36	3
	Practical	2			36	
3	PY1331.7- Modern Optics& Electricity	3	3	3	54	3
	Practical	2			36	
4	PY1431.7-Atomic Physics and Electronics	3	3	7	54	3
	PY1432- Practical	2	4		36	3

III. QUESTION PAPER PATTERN

For all semesters

1. The examination has duration of 3 hours
2. Each question paper has four parts A, B, C & D.
3. Part A contains 10 questions and the candidate has to answer all questions. Each question carries 1mark. The answer may be in the forms-one word/one sentence
4. Part B contains 12 short answer questions. Out of these 12 questions, the candidate has to answer 8 questions. Each question carries 2marks.
5. Part C contains 9 questions of which the candidate has to answer 6 of them. Each question carries 4 marks.
6. Part D contains 4 long answer questions (essays) of which the candidate has to answer 2 questions. Each question carries 15 marks.
7. The total weightage for the entire questions to be answered is 80 marks.

QUESTION PAPER PATTERN FOR TEST

Question No	Type of Question	Marks
Part A : 1-10	10 One word/One sentence	10
Part B : 11-22	8 out of 12; Short answer	16
Part C : 23-31	6 out of 9; Short essay/problem	24
Part D : 32-35	2 out of 4; Essay	30
		Total=80 marks

V. OPEN/ELECTIVE COURSES

During the programme the students have to undergo two open/elective courses. The students attached to the Physics department can opt one course from the Physics department (Elective course) and the other from any one of the other departments (Open course). The student has to do the open course during the fifth semester and the elective course during the sixth semester. As a beginning, the department will choose one open course for the fifth semester and one elective course for the sixth semester depending on the faculty and infrastructure available.

(a). Open Courses.

i) Bio-Physics ii) Astronomy & Astrophysics iii) Applied Physics
iv) Environmental Physics v) Energy Physics

(b). Elective Courses.

i) Photonics ii) Nano science iii) Computer hardware and networking iv) Instrumentation v) Space Science

VI. IMPLEMENTATION OF PROJECT WORK AND STUDY TOUR(RESEARCH INSTITUTE/SCIENCE MUSEUM VISIT)

As part of study the candidate has to do a project work. The aim of the project work is to bring out the talents of students and to introduce research methodology. The work may be chosen from any branch of Physics, which may be experimental, theoretical or computational. Emphasis should be given for originality of approach. The project shall be done individually or as a group of maximum 5 students. The projects are to be identified during the 4^{th} semester with the help of the supervising teacher. The report of the project (of about 30-40 pages) in duplicate shall be submitted to the department by the end of the 6^{th} semester well before the commencement of the examination. The reports are to be produced before the external examiners appointed by the University for valuation.

STUDY TOUR

Students are directed to visit one research institute /science museum preferably within the state of Kerala. Scientifically prepared hand-written study tour report must be submitted by each student for ESE on the day of the examination of project evaluation.

VII. CONTINUOUS EVALUATION

There will be continuous evaluation (CE) based on continuous assessment and end semester examination (ESE) for each course. CE carries 20 marks based on specific components such as attendance, tests, assignments, seminars etc. and ESE 80 marks. Out of the 20marks in internal assessment, 5marks shall be given to attendance, 10 marks to test papers, 5marks to seminar / assignments (minimum one test & one assignment). The components of the internal evaluation for theory and practical and their marks are given below.

(a). Theory

No	Component	marks
1	Attendance	5
2	Assignment	5
3	Test paper	10
	Total	20

The continuous evaluation (CE) shall be based on periodic written tests, assignments, viva/ seminar and attendance in respect of theory courses. **Written Tests**: Each test paper may have duration of minimum 3 hours. For each course there shall be a minimum of one written test during a semester. **Assignments**: Each

student is required to submit one assignment for a theory course. Seminar / Viva: For each theory course, performance of a student shall also be assessed by conducting a viva – voce examination or seminar presentation based on topics in that course.

(b). Continuous Evaluation CE (Practical)

No	Component	Marks
1	Attendance	5
2	Skill & Punctuality	5
3	Laboratory record	5
4	Test (internal exam)	5
Total		20

Lab skill is to be assessed based on the performance of the student in practical classes. Minimum one practical test paper and an internal viva – voce examination based on the experiments done in the lab are to be conducted in each practical course. The laboratory record should contain an index and a certificate page. Separate records are to be used for each practical course. **A candidate shall be permitted to attend an end semester practical examination only if he / she submit a certified record with a minimum of 10 experiments**. This is to be endorsed by the examiners.

The **evaluation of certified record** shall be according to the scheme given below.

No of experiments recorded	Marks
18	10
16	9
14	8
12	7
10	6

(c) The allotment of marks for attendance shall be as follows.

	% of attendance	Marks
Attendance	Attendance less than 50%	0
	51%-60%	1
	61%-70%	2
	71%-80%	3
	81%-90%	4
	91%-100%	5

(d) Tests, Assignments and Seminars

For each course there shall be at least two class tests during a semester. Marks for the test in continuous evaluation shall be awarded on the basis of the markssecured for the better of the two tests. Valued answer scripts shall be made available to the students for perusal within 10 working days from the date of the test.

Each student shall be required to do one assignment and one seminar for each course. Valued assignments shall be returned to the students. The seminars shall be organized by the teacher in charge and the same shall be assessed by a group of teachers including the teacher in charge of that course.

VIII. END SEMESTER EXAMINATION (ESE)

The external theory examinations of all semesters shall be conducted by the University. There will be no supplementary examinations. For reappearance/ improvement, as per university rules, the students can appear along with the next batch.

IX. EVALUATION OF PROJECT AND TOUR REPORT

The evaluation of the project shall be done by two external examiners according to the scheme given above. Each candidate shall be evaluated separately. There shall be a maximum of 12 candidates per session with two sessions per day. However, there shall be no continuous evaluation for the project.

The **evaluation of project** shall be according to the scheme given below.

Component	Marks
Originality of approach	15
Relevance of the topic	10
Involvement	10
Viva-voce	15
Presentation of report	20
Research Institute/Science museum visit and Report	**30**

Evaluation of Tour report

The evaluation of tour report shall be according to the scheme given below

Component	**Marks**
Presentation of the report	10
Certified report	20

X. EVALUATION OF PRACTICAL EXAMINATION

The practical examinations for the core subject shall be conducted by the University at the end of semesters 4 and 6 with a common time table and questions set by the University. Similarly, the practical examination for the complementary course shall be conducted by the University at the end of the 4th semester. The examiners shall be selected from a panel of experts prepared by the University.

For each examination centre there shall be two external examiners and one internal examiner who is not in charge of the practical at that centre. The mark sheet duly certified by the head of the institution should be sent to the University

before the commencement of the end semester examinations.
The evaluation scheme for the end semester practical examinations shall be as follows.

Component	Marks
Formula, circuit,graph, brief procedure	20
Setting and experimental skill	15
Observations and tabulations	15
Substitution, calculation, result with correct unit	20
Certified record with 18 experiments	10
Total	80

For electronics experiments, the scheme shall be as follows.

Component	Marks
Formula, circuit,graph, brief procedure	20
Observations, skill and tabulations	25
Substitution, calculation, result with correct unit	25
Certified record with 18 experiments	10
Total	80

For computer experiments, the following scheme shall be followed.

Component	Marks
Writing the programme	30
Execution of the programme	20

Output/Result	20
Certified record with 18 experiments	10
Total	80

PY1141:BASIC MECHANICS & PROPERTIES OF MATTER

(36 HOURS-2 CREDITS)

MECHANICS (22 hrs)

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO –1	Correlate the knowledge gathered to the immediate experimental curriculum	PSO-1	Apply
CO –2	Distinguish the dynamics of rigid bodies of different shapes	PSO-1	Understand
CO –3	Explain the implications of conservation laws	PSO-1	Understand
CO –4	Interpret the flavour of classical fields from oscillations and waves	PSO-1	Understand
CO –5	Handle the known problems in elasticity, surface tension and viscosity in a more mathematically rigorous way	PSO -2	Apply

Unit 1- Dynamics of Rigid Bodies (7 hrs)

Equations of motion for rotating rigid bodies- angular momentum and M.I- Theorems on MI.- calculation of MI. of bodies of regular shapes- uniform rod, ring, disc, annular ring, solid cylinder, hollow cylinder and solid sphere- KE of rotating and rolling bodies- torque- Determination of MI. of a fly wheel (theory, experiment and applications).

Unit 2- Conservation of energy (3 hrs) Energy Conservation law- Work – power- Kinetic Energy – Work Energy theorem- Conservative Forces - potential energy- Conservation of energy for a particle– energy function- .

Unit 3-Oscillations (12 hrs)

Simple harmonic motion – Energy of harmonic oscillators-simple pendulum-mass on a spring-oscillation of two particles connected by a spring- compound bar pendulum - interchange ability of suspension and oscillation-four points collinear with C.G about which the time period is the same-conditions for maximum and minimum periods - Determination of g using symmetric bar pendulum.Mechanical and electromagnetic wave motion- General equation of a wave motion-expression for a plane progressive harmonic wave- energy density for a plane progressive wave.

PROPERTIES OF MATTER (14hrs)

Unit 4- Elasticity (8 hrs)

Modulus of elasticity (revision)Relations connecting the three elastic moduli-Poisson's ratio- bending of beams- bending moment-cantilever-centrally loaded beams and uniformly bent beams-I section girders-torsion of a cylinder-expression for torsional couple -work done in twisting a wire-torsion pendulum-.

Unit 5– Surface Tension (3 hrs)

Surface tension-molecular explanation of ST.-angle of contact(revision)shapes of drops -expression for excess of pressure on a curved liquid surface -variation of ST. with temperature.

Unit 6 – Fluid Dynamics (3 hrs)

Streamline and turbulent flow-equation of continuity-Bernoulli's theorem-venturimeter-viscosity-Newton's law- Stoke's formula.

Books for Study:

1. Mechanics: Hans H. S. and Puri S. P,TMH, 2nd Edn.

2. Mechanics: J.C. Upadhyaya and,Ram Prasad S. Chand Publications, 2017

3. Elements of Properties of Matter: D.S. Mathur, S. Chand Publications,2008

4. Fundamentals of Physics: Halliday and Resnick, Wiley India Pvt. Ltd.,2006

Books for Reference:

1. Properties of matter: Brijlal and Subramaniam, S.Chand & Co.,2004

2. Principles of Physics: P.V.Naik, PHI,2010

Topics for assignments /discussion in the tutorial session (sample)

1. Physics-The fundamental science-historical development of mechanics-some implications of the principle of mechanics-The scope of mechanics.

2. Life of eminent physicists- Newton, Einstein, C.V.Raman, Edison.

3. Study of Young's modulus for different types of wood.

4. Study of variation of surface tension for different detergents.

5. Study of viscosity of different types of ink and to arrive at knowledge of its fluidity.

6. Wide applications of Bernoulli's equation.

7. Variation of surface tension with temperature by Jaeger's method

PY1241 –HEAT AND THERMODYNAMICS

(36 HRS-2 CREDITS)

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO –1	Compare thermal conductivity of various types of conductors.	PSO -1,2	Analyse
CO –2	Differentiate between various thermodynamic processes.	PSO - 1	Analyse
CO –3	Judge the efficiency of engines by comparing the performance of various vehicles	PSO - 1	Evaluate
CO –4	Associate entropy and available energy in various thermodynamic processes	PSO - 1	Understand
CO –5	Differentiate between various phase transitions	PSO -1,2	Analyse

Unit 1- Transference of heat (8 hrs)

Thermal conductivity - determination by Lee's Disc method for bad conductor radial flow of heat, cylindrical flow,thermal conductivity of rubber, Weidman-Franz law. Radiation of heat, Stefan's law, determination of Stefan's constant, solar constant, determination of solar temperature

Unit 2- Thermodynamics (18 hrs)

Zeroth Law & First law of Thermodynamics, differential form-Thermodynamic Processes-Expression for work done in isothermal and adiabatic processes. Application of first law to specific heat and latent heat.Reversible and irreversible processes.Second law of thermodynamics- Clausius and Kelvin statements-Carnot engine- Principle of refrigerator- working and efficiency, Otto engine and Diesel engine – working and efficiency.

Unit 3- Entropy (10 hrs.)

Definition of entropy, change of entropy in reversible and irreversible cycle, Clausius inequality and second law of thermodynamics, entropy and available energy,Entropy, probability and disorder.Nernst theorem and third law of thermodynamics.phase transition, phase diagram,first order and second order phase transition (qualitative idea) Clausius-Clepeyron Equation

Books for Study:

1. Thermal and Statistical Mechanics: S.K. Roy, NewAge International
2. Heat and Thermodynamics: D. S. Mathur, S. Chand &Co
3. Heat and Thermodynamics: Brijlal &Subramaniam, S. Chand &Co
4. Thermal Physics, Statistical Physics and SolidState Physics: C. J. Babu, Calicut University Press
5. Engineering Thermodynamics:P. K. Nag, McGraw-Hill,5thEdn.

Books for Reference:

1. Heat and Thermodynamics: Zemansky, McGraw-Hill
2. Heat and Thermodynamics: Rose C McCarthy, The Rosen Publishing Group, Inc.NY,2005
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics: F. W. Sears and G. L. Salinger, Addison-Wesley Publishing Company, 3rdEdn.

PY 1341 ELECTRODYNAMICS

(54 Hours-3Credits).

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO –1	Coulombs law, Application of Gauss law ,Work and energy in electrostatics.	PSO-1	Apply
CO –2	have a unified surveillance of electromagnetic phenomena and be engaged to draw qualitative conclusions about them by managing a small number of physical concepts and laws	PSO-1	Understand
CO –3	Apply the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density.	PSO-1	Understand
CO –4	To impart knowledge on the concepts of Faraday‘s law, induced emf and Maxwell‘s equation	PSO-1	Understand

Unit 1-Electrostatic Field (10hrs)

Electric field: introduction, Coulomb's law,Electric field, continuous distribution(Revision) , Divergence and curl of electrostatic fields; Field lines,flux applications of gauss's law,Curl of E, Electric potential: Introduction to potential, Comments on potential, Poisson's and Laplace's equations,potential of a localized charge distribution, Electrostatic boundary , Work and Energy in Electrostatics: The work done to move a charge, the energy of a point charge distribution, The energy of a continuous charge distribution.

Unit 2-Electrostatic fields in matter (10 hrs)

Polarization: Dielectrics,induced dipoles, Polarization, The field of a polarized object: Bound charges, physical interpretation of bound charges and the field inside a dielectric Electric displacement: Gauss's law in the presence dielectrics, Boundary conditions.

Unit 3-Magnetostatics (7hrs)

IntroductionThe Biot- Savart law,Ampere's force law (revision), Magnetic torque, Magnetic flux and gauss's law for magnetic fields, magnetic vector potential, Magnetic intensity and Ampere's circuital law, magnetic materials.

Unit 4-Electromagnetic Induction (7hrs)

Electromotive force: Ohm's law Electromagnetic Induction Faraday's law,the induced electric field, Maxwell's equations, Magnetic charge,

Unit 5-Electromagnetic waves (6hrs)

Waves in one dimension: The wave equation Electromagnetic waves in vacuum: The

wave equation for E and B, Monochromatic plane waves, Energy and momentum in electromagnetic waves.

Unit 6-Transient currents(7hrs)

Growth and decay of current in LR and CR Circuits-Measurement of high resistance by leakage-Charging and discharging of a capacitor through LCR circuit.

Unit 7-Alternating current (7 hrs)

AC through series LCR (acceptor circuit) and parallel LCR circuit (rejecter circuit)- Q- factor, Power in AC-power factor.

Books for Study:

1. Electrodynamics: David J Griffith, PHI, 3rdEdn.
2. Electricity and Magnetism:Murugesan, S.Chand & Co.
3. Electricity and Magnetism: K.K.Tiwari, S.Chand & Co.
4. Principles of electromagnetics: Matthew N.O. Sadiku and S. V. Kulkarni, Oxford University Press, 6thEdn.

Books for Reference:

1. Electricity and Magnetism: Muneer H. Nayfeh & Norton K. Bressel, John Wiley & Sons
2. Electricity and Magnetism: E.M. Purcell, Berkley Physics course, Vol.2, MGH
3. Electricity and Magnetism: J.H. Fewkes & John Yarwood, University Tutorial Press
4. Classical Electrodynamics: Walter Greiner, Springer International Edn.
5. Electromagnetic waves and radiating systems: Jordan & Balmain, PHI
6. Electromagnetics: B.B.Laud, Wiley Eastern Ltd., 2ndEdn.
7. Introduction to electrodynamics: Reitz&Milford Addison Wesley
8. Electromagnetic theory fundamentals: Bhag Guru and Huseyin Hizirogulu, Cambridge University Press, 2ndEdn.
9. Electricity and Magnetism: D.C.Tayal, Himalaya Publishing Co.

Topics for discussion in Tutorial session/Assignments (sample)

1. Comment on how electrostatic energy is stored in a field

2. Discuss the electrostatic properties of conductors

3. What is meant by electrostatic shielding? In what way it helps us?

4. Discuss the peculiarities of electric displacement D and electric field E. How they are incorporated in Maxwell's Equations

5. Discuss the properties of linear dielectrics. What differentiates adielectric to be linear or not?

6. Discuss applications of Ampere's circuital law

7. Compare electrostatics and magnetostatics

8. Why magnetic forces cannot do work

9. Discuss about cyclotron motion & cycloid motion

10. Discuss whether there exists any stand-off between ohm's law and Newton'ssecond law

11. A battery has an *emf*. Can this *emf*. be a 'force'? How will you interpret electromotive force?

12. Discuss the role of motional *emf* in power generation

13. Discuss the orthogonality of E, B and propagation vector k

14. A wave function can have a sinusoidal representation. Solve the wave equation for this function and discuss the various terms related to a wave such as amplitude, frequency, phase, wave number.

15. Complex representation of wave function has good advantage. Why? Discuss the linearity of wave function. (use complex notation)

16. Discuss AC through LC, LR and CR circuits

17. Show that sharpness of resonance is equal to Q- factor

18. What is a choke coil? Discuss the advantage of using a choke coil instead of a resistor

PY1441CLASSICAL AND RELATIVISTIC MECHANICS (54 Hours-3Credits).

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO –1	Handle the mechanics of a single and a system of particles(both charged and uncharged) under different force fields	PSO - 10	Understand
CO –2	Explain the importance of symmetry transformation and conservation of momentum and energy.	PSO - 11	Apply
CO –3	Describe the motion of particles in central force field including planetary motion	PSO - 1	Remember
CO –4	Solve different mechanical problems in classical mechanics using Lagrangian formalism	PSO - 10	Apply
CO –5	Generalize Hamiltonian mechanics to solve various problems in classical mechanics	PSO - 10	Apply

Unit 1 - Particle Dynamics (5 hrs)

Mechanics of a particle – equation of motion of a particle – Motion of a charged particle in electromagnetic field – mechanics of a system of particles.

Unit 2-Conservation laws (6 hrs)

linear uniformities of space and conservation of linear momentum – rotational invariance of space and law of conservation of angular momentum – homogeneity of flow of time and conservation of energy.

Unit 3- Motion in central force field (10 hrs)

Equivalent one body problem – motion in central force field – general features of motion – motion in an inverse square law force field – equation of the orbit – Kepler's laws of planetary motion and their deduction.

Unit 4 - Collisions (6 hrs)

Conservation laws- Conservation of momentum- laboratory and centre of mass systems-kinetic energies in thelab and CM systems-Cross-section of elastic scattering

Unit 5. Lagrangian Dynamics(9hrs)

Constraints-generalized coordinates- principle of virtual work-D' Alembert's principle, Lagrange's equation from D'Alembert's principle-applications of Lagrange's equation in simple pendulum,Atwood's machine and compound pendulum, Comparison of Lagrangian approach with Newtonian approach.

Unit 6. Hamiltonian Dynamics(5hrs)

Generalized momentum and cyclic coordinates- Hamiltonian function H-conservation of energy- Hamilton's equation - examples of Hamiltonian dynamics-one dimensional harmonic oscillator

Unit 7. Frames of Reference, Galilean transformation and Special theory of relativity(13hrs)

Inertial frames of reference- Galilean transformation- non- inertial frames

Origin and significance of special theory of relativity-search for universal frame of reference-Michelson-Morley experiment- postulates of special theory of relativity-consequences-Lorentz transformation equations- kinematical consequences of Lorentz transformations-length contraction-time dilation-twin paradox-transformation of velocity- variation of mass with velocity- mass energy equivalence

Books for Study:

1. Classical Mechanics: J. C. Upadhyaya, Himalaya Publishing
2. Mechanics: H.S.Hans and S.P.Puri, Tata-McGraw Hill
3. Classical Mechanics: G. Aruldhas, PHI Learning Pvt Ltd., 2008
4. Introduction to classical mechanics: R.G.Thakwale and P.S.Puranik, Tata-McGraw Hill.
5. Classical Mechanics: Vimal Kumar Jain, ,Ane Books Pvt. Ltd., 2009

Books for Reference:

1.Classical Mechanics: Goldstein.

2.Modern Physics:Ronald Gautreau, Shaum's outlines series,1999

3.Classical Mechanics-Systems of Particles & Hamiltonian Dynamics:Walter Greiner, Springer,2nd Edn.

4.Classical Mechanics: N.C Rana and P.S.Joag, TMH Education Pvt. Ltd., 2015

PY1541- QUANTUM MECHANICS

(72 HRS-4 CREDITS)

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO –1	Review and Compare the concepts of Classical Mechanics and Quantum Mechanics	PSO 1 PSO2	Knowledge Remember
CO –2	Discriminate between Particle and Wave nature	PSO - 4 PSO - 5	Knowledge Remember
CO –3	Underline the postulates of Quantum Mechanics	PSO - 4 PSO - 5	Knowledge Remember
CO –4	Verify the concepts of Quantum Mechanics with examples and introduce Schrodinger equation	PSO - 2	Application
CO –5	Visualize the wave function	PSO - 2	Application
CO –6	Mathematical formulation of observables and wavefunctions	PSO - 2	Synthesis
CO –7	Apply Schrodinger equation in various physical systems (LHO,Particle in a box etc)	PSO - 2 PSO - 6	Analysis

CO-8	Justify the phenomena of Specific Heat of Solids,Tunneling Effect, Photoelectric Effect	PSO - 2 PSO - 6	Creation

Unit 1 – The Emergence of Quantum Mechanics (18 hrs)

Limitations of classical physics, Black body radiation curve-Optical spectra –- photoelectric effect -specific heat of solids -Plank's quantum hypothesis, Einstein's theory of photoelectric effect -Compton effect- Quantum theory of specific heat of solids, -Bohr model- hydrogen atom- Bohr postulates-The correspondence principle.

Unit 2-Wave Mechanics (22 hrs)

Wave nature of particles-electron diffraction- standing wave of electron in the orbit uncertainty principle -uncertainty relation among canonically conjugate pairs-application- non-existence of electrons in the nucleus-ground state energy of hydrogen atom- width of spectral lines-Properties of wave function-Conditions for Physical Acceptability of Wave Function, Normalization and orthogonality condition. Superposition Principle-wave packets, relation between - Particle velocity- group velocity and phase velocity- Probability Interpretation of Wave Function -Statistical Interpretation of Wave function -probability current density in one dimension-Expectation value- Time dependent Schrodinger equation,-Time independent Schrodinger equation - stationary states.

Unit 3-One Dimensional Energy Eigen Value Problems (14hrs)

Free particle Schrodinger equation–square-well potential with infinite walls- Square well potential with finite walls, square potential barrier– The Harmonic oscillator-(Schrodinger method)-

Unit 4- General Formalism of Quantum Mechanics (18hrs)

Linear vector space, Linear operator, Eigen values and Eigen functions-, Hermitian operator, Postulates of Quantum Mechanics-Equation of motion-Schrodinger representation- Momentum representation

Books for Study:

1. Quantum Mechanics: G. Aruldhas, PHI, 2nd Edn., 2002
2. A Text book of Quantum Mechanics: P.M. Mathews & K. Venkatesan-McGraw Hill, 2nd Edn., 2010
3. Quantum Mechanics: Robert Eisberg and Robert Resnick, Wiley, 2nd Edn. 2002

4. Quantum Mechanics: Leonard I. Schiff, TMH, 3rd Edn., 2010

5. Concepts of Modern Physics: Arthur Beiser, TMH, 6th Edn.

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Books for Reference:

1. Quantum Mechanics:Eugen Merzbacher, John Wiley and Sons Inc.,2004
2. Introduction to Quantum Mechanics: David J. Griffith, Pearson Education, 2nd Ed. 2005
3. Quantum Mechanics: Walter Greiner, Springer,4thEdn., 2001
4. Quantum Mechanics: Bruce Cameron Reed, Jones and Bartlett, 2008.
5. Quantum Mechanics for Scientists & Engineers: D.A. B. Miller, Cambridge University Press, 2008
6. Shaum's outline series

PY1542: STATISTICAL PHYSICS, RESEARCH METHODOLOGY AND DISASTER MANAGEMENT
(72 HRS- 4 CREDITS)

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	Able to define phase space, microstate, macrostate and ensemble Learn to distinguish different statistical distributions and judge which distribution applies to a given system		Define Distinguish Judge
CO –2	Able to solve problems based on the principles of		Solve

	statistical mechanics		
CO –3	Understand the objectives , motivation and significance of research		Understand
CO–4	Identify the key elements and prepare a research design		Identify
CO 5	Able to write a review of literature		
CO –6	Understand the different steps in research process		Understand
CO –7	Able to select a good research question based on the criteria of good research		
CO -8	Understand the components of thesis and able to write a thesis/report		Understand
CO-9	Understand the basic ideas of error measurement		Understand
CO-10	Define and distinguish various types of errors		Define, distinguish
CO-11	Able to estimate uncertainty in measurements and judge whether our measurements are consistent with standard values		Estimate
CO-12	Familiar with natural hazards and disasters		Familiar
CO-13	Understand the impact of climate change on natural disasters		Understand
CO-14	Understand the primary steps in pre disaster and post disaster activity		Understand
CO-15	Familiar with research innovations for disaster risk reduction		Familiar

CO-16	Able to manage public health during disasters		Manage
CO-17	Able to know the management of radiation emergency		Know

Unit 1- Statistical Physics (18 hrs)

Statistical probability, Macro and Micro states, Phase space, Statistical ensemble, Postulate of equal probability, Maxwell Boltzmann distribution, Velocity distribution. Indistinguishability of identical particles, Bose Einstein and Fermi Dirac distribution function, comparison of three statistics

Unit 2 Research Methodology (18 hrs)

Research - Objectives and motivation in research – different types of research- research approaches- Significance of research- Research methods and methodology – Research and scientific method- Various steps in a research process- importance of literature survey- criteria of good research.

Thesis/ Report writing - preliminary section (Title page, declaration of author, certificate of supervisor, table of contents, list of tables and figures, preface acknowledgement), Main Text (abstract, introduction, experimental section, results and discussion), Conclusions, references, scope for future study.

Unit 3 Error Analysis (12 hrs)

Significant figures- Basic ideas of error measurement, uncertainties of measurement, importance of estimating errors, dominant errors, random errors, systematic errors, rejection of spurious measurements.

Estimating and reporting of errors, errors with reading scales, absolute and relative errors, and standard deviation, Variance in measurements, error bars and graphical representation.

Unit 4 – Disaster Management (24hrs)

Global natural disasters: Natural hazards and natural disasters, Recent major disasters and their relief efforts, Impact of global climate change and major natural disasters, Human adaptability of natural disasters, Fragile natural eco-environment, Disaster reduction activity, achievements, challenges and future development

Earth quake disaster and their and their effects, Advancement in research of earthquake disaster, earthquake and tsunami warnings, earthquake disaster prevention, earthquake disaster mitigation

Health emergencies and diseases: environmental health and diseases, disasters and emergencies, steps in disaster management, pre-disaster activity, role of water

supply, need for protecting large scale water supply schemes, assessment of damaged and available and water resources, water quality testing- Personal hygiene, control of communicable diseases and prevention of epidemics, measures for controlling communicable diseases and epidemics.
Radiation emergencies, health consequence of radiation, measures to prevent sudden health emergencies due to radiation

Books for Study:

1. Thermal and Statistical Mechanics: S.K. Roy –New Age International-2001
2. Elements of Statistical Mechanics: Kamal Singh and S. P. Singh- S. Chand & Co,1999
3. Thermal Physics, Statistical Physics and Solid State Physics: C. J. Babu, Calicut University Press
4. Introduction to Statistical Mechanics: S. K. Sinha, Alpha Science International Ltd. 2005
5. Statistical Mechanics: B. K. Agarwal- New Age International 2007
6. Research Methodology: C. R. Kothari, New Age International Publishers.
7. Natural disaster mitigation – a scientific and practical approach: Science Press, Beijing, 2009
8. Environmental health in emergencies and disasters: A practical guide, B.Wisner & J.Adams (Eds.), WHO, Geneva, 2002 ISBN 92-4 154541-0.
9. Introduction to Disaster Management: SatishModh, Macmillan, 2010

Books for Reference:

1. Statistical Mechanics: S. Rajagopal
2. Introduction to Statistical Physics: Kerson Huang -CRC Press, 2001
3. Statistical Mechanics: Norman Davison, Courier Corporation, 2013
4. Disaster Management: Harsh K Gupta, Universities Press, 2003

PY1543-ELECTRONICS
(72 HOURS-4 CREDITS)

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO – 1	Describe semiconductor properties in different diodes.	PSO - 9	Remember

CO – 2	Explain the applications of different junction diodes	PSO – 2,9	Apply
CO – 3	Distinguish different feedback networks	PSO - 9	Understand
CO – 4	Design single stage transistor amplifiers, oscillators and operational amplifiers.	PSO – 2,9	Analyze
CO – 5	Explain the working of special devices, FET, MOSFET, UJT	PSO - 9	Understand
CO – 6	Understand the concept of modulation	PSO - 9	Understand
CO – 7	Distinguish power amplifiers from small signal amplifiers	PSO - 9	Understand

Unit 1. Circuit Theory (4 hours)

Kirchhoff's law- Ideal voltage and current sources- Thevenin's and Norton'stheorem, Maximum power transfer theorem

Unit 2. Diode Circuits(14 hours)

Extrinsic semiconductors-n- type and – p-type semiconductors-PN junction-PN junction under forward and reverse biased conditions-r m s value and peakinverse voltage- diode characteristics-ac and dc resistances- half wave and full wave rectifiers- (average dc value of current, ripple factor and efficiency)- different types of filters(shunt capacitor, LC and RC)- break down mechanism in diodes-Zener diode- voltage regulator-

Unit 3.Transistors(16 hours)

Theory of BJT operation- CB,CE and CC characteristics-alpha , beta and gamma – relation between transistorcurrents- biasing circuits(CE configuration)- stability factors-selection of operating point-ac and dc load lines-Q point-collector feedback; base resistor and potential divider methods- BJT amplifiers- input and outputimpedances-graphical analysis of CE amplifier(frequency response,band width and gain in dB)- emitter follower.

Unit 4. Power amplifiers: (5 hours)

Amplifier classes and efficiency - class A operation - transformer coupled class A amplifier - class B amplifier - push pull amplifier - basic ideas of class C operation - distortion in amplifiers.

Unit 5. Feedback & Oscillator circuits (8 hours)

Feedback principles – negative feedback - advantages of negative feedback - positive feedback - principle of sinusoidal feedback- oscillation - Barkhausen criterion for oscillations - RC phase shift, Hartley Oscillator, Colpitt's, Oscillator (derivations not required).

Unit 6. Modulation (5 hours)

Fundamentals of modulation - AM, FM - frequency spectrum of AM - power in AM - demodulation of AM signal - frequency spectrum for FM

Unit 7. Special devices: (8 hours)

JFET- Basic construction - Theory of operation - Static characteristics - Drain characteristics- Advantages - MOSFET – Depletion enhancement MOSFET – Construction – Static characteristics. Uni-junction Transistor - Construction-operation.

Unit 8. Operational amplifiers (IC741)(12 hours)

Introduction – Schematic symbol and pin configuration - circuit configuration and block diagram representation – differential amplifier-ideal OP amp. - CMRR – differential mode and common mode – virtual ground principle – parameters of OP amp. - inverting amplifier – non-inverting amplifier –summing- differentiator-integrator amplifiers.

Books for Study:

1. Basic electronics: Devices, circuits and IT fundamentals: Santiram Kal, PHI, 2009

2. Basic Electronics-Solid State: B. L. Theraja, S. Chand Ltd., 2005

3. Principles of Electronics: V. K. Mehta, S. Chand Ltd.,2005

4. A first course in Electronics: Anwar A. Khan, Kanchan K. Dey,PHI, 2006

5. Communication Electronics:Jose Robin and Ubald Raj, Indira Publications, 2002

Books for Reference:

5. Electronic Devices and Circuits: Theodore F. Bogart Jr., Universal book stall

6. Electronic devices and Circuit theory: Robert Boylestad & Louis Nashelski,PHI,5th Edn.

7. Electronic fundamentals & applications: John D Ryder, PHI, 4thEdn.

8. Electronic Communications: Dennis Roddy, John Coolen,Pearson, 4thEdn.

Topics for assignments/discussion in the tutorial session (sample)

1. Electronic projects using flip flops.

2. Electronic projects using logic gates.

3. Electronic projects using IC 741 OP amp.

4. Electronic projects using timer 555.

5. Electronic projects using IC 311.

6. Constant voltage power supplies.

7. Constant current sources.

8. Oscillators of different frequencies.

9. Low range frequency generators.

10. High range frequency generators.

11. Voltage regulated dc power supplies with variable output.

12. Voltage regulated dual power supplies with variable output.

13. Instrument for the measurement of capacitance.

14. Instrument for the measurement of dielectric constant of a liquid/ solid.

15. Effect of temperature on electronic components.

PY1544-ATOMIC & MOLECULAR PHYSICS

(72 HOURS-4 CREDITS)

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO –1	Recall the basics of atom model and draw the energy level diagram of hydrogen spectrum and correlate Classical and Quantum mechanics through Bohr's correspondance principl	PSO - 7	Know, Remember
CO –2	Visualise the spin orbit interaction through coupling schemes	PSO - 7	Apply

CO –3	Predict and explain the atomic configuration of atoms using Pauli's exclusion principle	PSO - 7	Analysis /synthesis /creation
CO –4	Sketch the allowed optical and hyperfine spectra and understand the effect of external fields on the spectra of atoms	PSO - 7	Apply
CO –5	Develope ideas regarding production, properties classification and importance of x-rays and explore structure and elemental composition using x-rays	PSO - 8	Analysis /synthesis /creation
CO –6	Understand and sketch the possible energy levels and transition of molecules and relate the molecular energy spectrum with the symmetry of the molecule	PSO - 7	Apply
CO –7	Elucidate the relation of allowed energy levels and chemical environment and it's spectrum of atoms through resonance spectroscopic technique	PSO - 8	Analysis /synthesis /creation

Unit 1- Vector Atom Model (10hrs)

Bohr's theory, correspondence principle Somerfield's atom modeland explanation of fine structureof H line inBalmer series of hydrogen atom.Limitationof Sommerfeld atommodel.Vector atommodel-Various quantum numbers associated with vector atom model-, L.S and j.j couplings –application of spatial quantization-Pauli's exclusion principle - magnetic dipole moment of electron due to orbital and spin motion - Spin-Orbit coupling.

Unit 2- Atomic Spectra (14hrs)

Optical spectra-Spectral terms and notations - selection rules - intensity rule and interval rule - fine structure of sodium D lines – hyperfine structure-alkali spectra - Zeeman effect - Larmor's theorem – quantum mechanical explanation of normal Zeeman effect. Anomalous Zeeman effect –Paschen-Back effect-Stark effect.

Unit 3- X-ray Diffraction (8 hrs)

X-rays- Discovery- properties -scattering -Measurement of X-ray wavelengths by ruled gratings-X-ray Spectra- continuous and characteristics X- ray spectrum-Origin of continuous Spectrum -Origin of characteristic X-rays-X-ray energy level diagram.

-Absorption of X-rays-Applications of X-rays

Unit 4- Molecular spectra (28 hrs)

Electromagnetic spectra-molecular energies-classification of molecules-rotational spectra of diatomic molecules-rotational energy levels-selection rules-rotational spectrum-isotope effect- bond length and atomic mass.

Diatomic vibrational spectra-vibrational energy levels-selection rule-vibrational transitions-Rotation-Vibration transitions-IR spectrometer

Raman scattering- classical description of Raman scattering, quantum theory of Raman scattering- -vibrational Raman spectra-diatomic molecules-polyatomic molecules-rotational Raman spectra Raman spectrometer.

Electronic spectra sequences and progressions-Frank-Condon principle-

Unit 5- Resonance Spectroscopy (12 hrs)

NMR principle-Resonance condition-NMR spectrometer-chemical shift-indirect spin-spinInteraction- applications of NMR spectroscopy-

ESR principle- Resonance condition –ESRspectrometer-hyperfineinteraction – applicationsofESRspectroscopy.

Mossbauerspectroscopy- principle -isomer shift.

Books for Study:

1. Modern Physics: G.Aruldas and P.Rajagopal, PHI, New Delhi, 2005
2. Modern Physics: R.Murugesan, S.Chand& Co., Reprint, 2008
3. Atomic and Nuclear Physics: N.Subramaniam&Brijlal, S.Chand& Co.
4. Atomic Physics: J.B.Rajam, S.Chand&Co.
5. Concepts of Modern Physics: A. Beiser, TMH, New Delhi, 6thEdn.

Books for Reference:

1. Fundamentals of Molecular Spectroscopy: Banwell, TMH
2. Spectroscopy: Walker & Straw, Chapman & Hill.
3. Molecular Spectroscopy: G.Aruldhas, PHI, 2004
4. Atomic and Nuclear Physics: Dr.V.W.Kulkarni-Himalaya Publishing House

PY 1551-OPEN COURSES
(54 HOURS-2CREDITS) FOR EACH COURSE

PY1551.1. BIO PHYSICS (54 HOURS)

Unit 1 (18 hrs)

Bio mechanics- biophysics and fluid flow—Gas transport—physics of audition

Physics of vision (chapter 1 to 5 of Reference 3)

Unit 2 Cellular – Molecular biophysics (18 hrs)

Cell -components-proteins-nucleic acids—physics of bio-membranes - Thermodynamics of bio systems (Chapter 6 to 9 of reference 3)

Unit 3 (18 hrs)

Radiation biophysics

Bio –electronics and Bio Instrumentation (chapter 17 of reference 1) Bio – informatics - (chapter 6 of reference 1) Demonstration of biophysics experiments (reference 3)

Booksfor Study

1. Essentials of Biophysics: P. Narayanan, 2nd Edn. New Age publishers

2. A text book of biophysics: R.N.Roy, New central book agency Kolkata.

3. Elementary bio physics,P.K.Srivastava,Narosa publishing house ,New Delhi
4. Introduction to Biophysics ,Pranab kumar banerjee,S.Chand& co ,New Delhi

5.Biological science ,Green,Stout,&Taylor, Cambridge university press

Reference

PY 1551.2 ASTRONOMY AND ASTROPHYSICS

(54 Hours)

Unit 1: Introduction to Astronomy (10 hours)

What is Astronomy – Branches of Astronomy - The celestial sphere and stellar magnitudes: constellations, stellar magnitudes, apparent magnitudes – The celestial coordinate system – Precession of Earth's axis.

Unit 2: History of Modern Astronomy (14 hours)

Ptolemy's model of Universe – Copernican and Galilean contributions – Laws of planetary motion: Tycho Brahe's observations, Kepler's laws – Newton and his law of Universal law of Gravity – Einstein's special and general theories of relativity (*topics in this unit are intended as brief qualitative introductions only*)

Unit 3: The Solar system (15 hours)

Formation of solar system: Nebular hypothesis – The Sun: Physical properties – Internal structure – Solar atmosphere - Sun spots – Solar wind, prominences and flares – Physical characteristics of planets in solar system – Earth's motion and Seasons - Lunar and Solar eclipses – Brief familiarisation of solar system objects: Satellites, Asteroid belt, Kuiper belt, Comets and Meteorites.

Unit 5: Outer Universe (15 hours)

Properties of stars: luminosity, colour and surface temperature – Spectral types of stars – Hertzsprung-Russel diagram – Evolution of a Sun-like star – Fate of high-mass stars: Supernova, Neutron stars and Black holes (*qualitative description only*) – Brief familiarization of Milky Way galaxy, Types of galaxies according to shape.

Sources for Study:

1. https://www.space.com/16014-astronomy.html
2. Introduction to Astronomy and Cosmology – Ian Morison (Wiley)
3. https://theplanets.org/solar-system/

Additional Reference:

1. Planet Earth, Cesare Emiliani, (Cambridge University Press)
2. Astrophysics - K. D. Abhayankar (University Press)
3. Introduction to Astrophysics – Baidyanadh Basu

PY 1551.3- APPLIED PHYSICS(54HOURS)

UNIT-1.ELECTRIC AND ELECTRONIC EQUIPMENTS (14 hrs)

Electric motor-principles of working, Microwave oven-principle-technical specifications-applications-advantages, public address system-Block diagram representation- function of each unit-CD player and drives-DVD player and drives-Telephonic communication(Cable and cellular)-principles (qualitative study using block diagram) -Cell phone-SIM card-technical specifications-Radio –History of radio revolution-different types of radios-Television-working(qualitative)-Touch screens & ATM (Automatic Telling machine)

UNIT-2- X-RAY AND ITS APPLICATIONS (11 hrs)

Discovery of X-rays, Gas filled tube, Coolidge X-ray tube, Properties of X-ray, X-ray spectra-continues and characteristic spectra, C T Scan-basic principle-applications and advantages –MRI Scan-Principle, applications and advantages.

UNIT-3- LASERS (13 hrs)

Introduction-Interaction of light with matter, Absorption, spontaneous emission, stimulated emission, Light amplification, population inversion, metastable states-Components of Laser-Principal pumping Schemes-Role of resonant cavity- Ruby laser, He-Ne Laser-Applications.

UNIT-4- HOLOGRAPHY(6 hrs)

Introduction, principle of holography, Recording of the hologram, Reconstruction of the image-applications.

UNIT-5-FIBRE OPTIC COMMUNICATION (10 hrs)

Introduction, optical fibre, Necessity of cladding, optical fibre system, Total internal reflection, propagation of light through an optical fibre, critical angle of propagation , Modes of propagation- Types of rays-classification of optical fibres-Applications

References

1. Audio and Video Systems. R.G.Gupta, Technical Education Series.
2. Mobile Satellite Communication Network (ch 1 &2),Ray E Sherrif &Y. Funttu,Wiley India Edu.
3. Television Engineering & Video System, R.g.Gupta,TMH.
4. Electrical Technology (Vol 1& 2),B.L.Theraja
5. A Text book of Optics by DR. N. Subrahmanyam Brijlal,Dr MN Avadhanulu-S.Chand & Company Pvt Ltd
6. Modern Physics by R.Murugesan & Kiruthiga Siva Prasath S.Chand & Company Pvt Ltd
7. Atomic and Nuclear Physics By Dr.V.W.Kulkarni-Himalaya Publishing House

PY1551.4. ENVIRONMENTAL PHYSICS
(54 HOURS)

Unit 1 Essentials of Environmental physics (18 hrs)

Structure and thermodynamics of the atmosphere; composition of air; Greenhouse effect; Transport of matter; energy and momentum in nature; Stratification and stability of the atmosphere; Laws of motion; Hydrostatic equilibrium; General circulation of the tropics; Elements of weather and climate in India.

Unit 2 Environmental pollution and Degradation(18 hrs)

Factors governing air, water and noise pollution; Air and water quality standards;Waste disposal; Heat island effect; Land and sea breeze; Puffs and Plumes; Gaseous and particulate matter; Wet and dry deposition; Dispersal mechanism of air and water pollutants; Mixing height and turbulence; Gaussian plume models; Dispersion models; Environmental degradation; Thermal and radioactive pollution; Nuclear radiation; Health hazards and safety.

Unit 3 Environmental Changes and remote sensing (18 hrs)

Energy sources and combustion processes; Renewable sources of energy; Solar energy, Wind energy, Bio energy, hydro power; fuel cells; and nuclear energy;Forestry and bio-energy; Deforestation; Degradation of soils; Agriculture and land use changes; Changing composition of local and global environment; Remote sensing techniques.

Books for Study:

1. The Physics of Monsoon:R.N.Kesavamoorthy andN. Sankar Rao,Allied Publications
2. 2 The Physics of Atmosphere: J.T.Houghton, Cambridge University
3. Renewal Energy Resources:J.T Widell and J Weir,ELBS 1988
4. Numerical Weather Prediction:G.J.Haltiner and R.T.Williams, John Wiley

PY1551.5. ENERGY PHYSICS

(54 HOURS)

Unit I (7 hrs)

Various forms of energy – renewable and conventional energy systems –comparison – coal, oil and natural gas – availability – applications – merits and demerits.

Unit 2 (10 hrs)

Solar energy - Solar radiation measurements, solar energy collector, principle of the conversion of solar radiation in to heat, Solar energy storage, solar heaters, space cooling, solar ponds, solar cookers, solar distillation, solar furnaces, solar green houses, merits and demerits of solar energy.

Unit 3 (9 hrs)

Wind energy: Basic principle of wind energy conversion, basic components of wind energy conversion system (WECS), wind energy collectors. application of wind energy.

Unit 4 (9 hrs)

Biomass energy, classification, photosynthesis, biomass conversion process, Gober gas plants, wood gasification, ethanol from wood, merits and demerits of biomass as energy source

Unit 5 (9 hrs)

Energy from Oceans and Chemical energy resources: Ocean thermal energy Conversion, energy from waves and tides – basic ideas, nature, applications, merits and demerits.

Unit 6 (10 hrs)

Patterns of energy consumption in domestic, industrial, transportation and agricultural sectors –energy crisis and possible solutions – energy options for the developing countries – energy storage-primary and secondary cells – fuel cells (basics) – impact due to non-conventional energy sources – global warming.

Books for Study:

1. Non – Conventional Energy Resources: G. D. Rai, Khanna Publishers,2008.
2. Solar energy: G.D. Rai, 5th edition, 1995.
3. Solar Energy Fundamentals and application: H.P. Garg and J. Prakash, Tata McGraw - Hill Publishing company Ltd., 1997.

Books for Reference:

1. Energy Technology: S. Rao and Dr. B.B. Parulekar, 1997, 2ndEdn.
2. Power Plant Technology: A. K. Wahil. 1993.
3. Solar energy: S. P. Sukhatme, Tata McGraw- Hill Publishing company Ltd.,1997.

PY 1641SOLID STATE PHYSICS
(72 HOURS -4 CREDITS)

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO – 1	Able to distinguish types of crystals according to their structure		Distinguish
CO – 2	Able to illustrate the concepts of unit cell and lattice of crystals		Illustrate
CO – 3	Able to discuss diffraction of X rays by crystals and to demonstrate its experimental techniques		Discuss, Demonstrate
CO – 4	Learn to explain crystal bonding		Explain
CO – 5	Able to describe and evaluate mechanical, electrical and magnetic properties of metals		Describe, Evaluate
CO – 6	Learn to discuss various electron models and band theories of conductors, semi conductors and insulators		Discuss
CO – 7	Learn to discuss and evaluate dielectric properties of materials		Discuss, Evaluate
CO - 8	Able to interpret optical phenomena in dielectrics		Interpret
CO -	Able to discuss types of magnetic properties of materials		

9 CO - 10 CO - 11 CO - 12	Able to formulate theories regarding different magnetic properties of matter Learn to explain different physical characteristics of superconductors Able to illustrate theoretical formulation of superconductors		Discuss Formulate Explain Illustrate

Unit 1Crystal Structure(18hrs)

Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors.Lattice with a Basis – Unit Cell-Elements of symmetry-Types of Lattices -two and three dimensional- Miller Indices-Reciprocal Lattice.-.Brillouin Zones.Diffraction of X-rays by Crystals.Bragg's Law.X- ray diffraction techniques-Inter atomic forces. Types of bonding

Unit 2 Conduction in Metals- Free electron model (12 hrs) Introduction-conduction electrons-free electron gas-electrical conductivity-electrical resistivity versus temperature-heat capacity of conduction electrons -Fermi surface -electrical conductivity-effects of the Fermi surface-thermal conductivity in metals-Hall effect and magneto resistance -A.C conductivity and optical properties-failure of free electron model. -The Kronig -Penney model- conductors, semiconductors and insulators.

Unit 3 Band theory(10 hrs)

Bloch theorem- Kronig Penny model-Band Gaps- Conductors-Semiconductors and insulators- P and N type Semiconductors- Conductivity of Semiconductors-mobility- Hall Effect- Hall coefficient.

Unit 4 Dielectric Properties of Materials (12 hrs)

Polarization- Local Electric Field at an Atom- Depolarization Field- Electric Susceptibility- Polarizability- Clausius Mosotti Equation- Classical Theory of Electric Polarizability- Normal and Anomalous Dispersion- Cauchy and Sellmeir

relations- Langevin-Debye equation- Complex Dielectric Constant- Optical Phenomena- Application: Plasma Oscillations- Plasma Frequency- Plasmons

Unit 5Magnetic Properties of Matter(12hrs) Dia, Para, Ferri and Ferromagnetic Materials.Classical Langevin Theory ofDia and Paramagnetic Domains.Quantum Mechanical Treatment of Para magnetism.Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains.Discussion of B-H Curve. Hysteresis and Energy Loss

Unit 6 Superconductivity(8 hrs)

Critical Temperature-Critical magnetic field-Meissner effect- Type I and type II Superconductors- London's Equation and Penetration Depth- Isotope effect-.BCS theory- Tunnelling and Josephson effect(Qualitative study)

Books for Study:

1.Elements of Solid State Physics: J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India

2.Elementary Solid State Physics: 1/e M. Ali Omar, Pearson India, 1999

3.Solid State Physics: M.A.Wahab,NarosaPublication, 2011

4. Elements of Solid State Physics: J.P. Srivastava, 2nd Edn., Prentice-Hall of India, 2006

Books for Reference:

1. Introduction to Solid State Physics: Charles Kittel, 8th Edn., Wiley India Pvt. Ltd., 2004
2. Introduction to Solids: Leonid V. Azaroff, Tata Mc-Graw Hill,2004
3. Solid State Physics: Neil W. Ashcroft and N. David Mermin, Cengage Learning,1976
4. Solid State Physics: Rita John, McGraw Hill, 2014
5. Solid-state Physics: H. Ibach and H Luth, Springer,2009

PY 1642NUCLEAR ANDPARTICLE PHYSICS
(72 HOURS-4 CREDITS)

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed
CO –1	General properties of nucleus and concept of binding energy and nuclear forces.	
CO –2	Various nuclear models	
CO –3	Natural radioactivity, alpha decay, beta decay, positron emission ,electron capture etc.	
CO –4	Nuclear reactions, its types ,Q –value of a nuclear reaction	
CO –5	Particle accelerators, Nuclear fission, Nuclear fusion and the source of stellar energy	
CO –6	Fundamental particles and their properties.	

Unit 1.General Properties of Nuclei(14hrs)

Constituents of nucleus and their Intrinsic properties-quantitative facts about size- mass- charge density (matter energy), binding energy- average binding energy and its variation with mass number- main features of binding energy versus mass number curve- nuclear stability- angular momentum- parity- magnetic moment- electric quadrupole moments- Nuclear forces-meson theory.

Unit 2. Nuclear Models(11 hrs)

Liquid drop model -semi empirical mass formula and significance of various terms, condition of nuclear stability. Shell model-evidence for nuclear shell structure, nuclear magic numbers, basic assumptions of shell model, Collective model.

Unit 3. Radioactivity:**(12 hrs)**

Alpha decay-basics of α-decay processes, theory of α-emission, Gamow's theory, Geiger Nuttall law, □-decay- energy kinematics for □-decay, positron emission, electron capture, neutrino hypothesis, Gamma decay: Gamma ray emission & kinematics, internal conversion.

Unit 4.Nuclear Reactions (9 hrs)

Types of Reactions, Conservation Laws, kinematics of reactions, Q-value- reaction rate- reaction cross section- reaction mechanism-Concept of compound nucleus.

Unit 5. Particle Detectors & Accelerators (6 hrs)

GM counter-scintillation counter- Linear accelerator- Cyclotron- Synchrotron-betatron.

Unit 6 – **Nuclear fission and fusion (12 hrs)**

Nuclear fission-energy released in fission-Bohr and Wheeler's theory-chain reaction -multiplication factor-critical size-atom bomb-nuclear reactors-breeder reactors-uses of nuclear reactors. Nuclear fusion-sources of stellar energy-thermonuclear reactions-hydrogen bomb-controlled thermo-nuclear reactions-magnetic bottle-Tokamak- inertial confinement-nuclear power in India.

Unit 7.Particle physics: (8 hrs) Particle interactions- basic features- types of particles and its families-Symmetries and Conservation Laws-baryon number-Lepton number- Isospin- Strangeness and charm- concept of quark model-Cerenkov radiation.

Books for Study

1. Modern Physics: R. Murugesan, S. Chand & Co., Reprint,2008
2. Modern Physics: G. Aruldhas and P. Rajagopal, PHI, New Delhi, 2005.
3. Nuclear Physics: D. C. Tayal, Himalaya Publishing House, 4thEdn.
4. Concepts of Modern Physics: A. Beiser, Tata McGraw-Hill, New Delhi, 6thEdn.
5. Atomic and Nuclear Physics:N. Subramaniam and Brijlal, S.Chand & Co.
6. Atomic Physics: J.B.Rajam, S.Chand & Co.
7. Introduction to Elementary Particles: D. Griffith, John Wiley & Sons
8. Nuclear Physics: S.N.Ghoshal, S.Chand & Co.

Books for Reference:

1. Concepts of nuclear physics: Bernard L. Cohen, Tata Mcgraw Hill, 1998
2. Nuclear Physics: Kaplan, Narosa publications
3. Introductory nuclear Physics: Kenneth S. Krane, Wiley India Pvt. Ltd., 2008
4. Introduction to the physics of nuclei & particles: R.A. Dunlap, Thomson Asia, 2004
5. Quarks and Leptons: F. Halzen and A.D. Martin, Wiley India, New Delhi

6. Basic ideas and concepts in Nuclear Physics An Introductory Approach: K. Heyde, Institute of Physics Publishing, 2004
7. Radiation detection and measurement: G.F. Knoll, John Wiley & Sons, 2000
9. Theoretical Nuclear Physics: J.M. Blatt & V.F. Weisskopf, Dover Pub.Inc., 1991

PY1643- CLASSICAL AND MODERN OPTICS
(72 HRS-4 CREDITS)

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO – 1	Review the principle of superposition, Explain interference, Produce interference by division of amplitude and division of wavefront, classification of fringes, Determine optical flatness	PSO - 1 PSO - 2 PSO - 3	Knowledge Remember Application Analysis
CO – 2	Distinguish between Fresnel and Fraunhofer diffraction Demonstrate single slit and double slit Diffraction, Identify plane transmission grating and explain resolving power of a grating	PSO - 1 PSO - 2	Knowledge Remember Application
CO – 3	Explain Dispersion and Demonstrate Dispersion	PSO - 1 PSO - 2	Knowledge Remember Application
CO – 4	Describe Polarization, Classification, Produce and Analyze different types.	PSO - 1 PSO - 2 PSO - 3	Knowledge Remember Application Analysis

CO – 5	Recall the applications of Laser, Describe the conditions to obtain Laser, Analyze different types of Lasers, Define Non Linear Optics and extend the ideas to Second Harmonic Generation	PSO - 1 PSO - 2 PSO - 3	Knowledge Remember Application Analysis
CO – 6	Classify different types of optical fibres, Employ Optical fibre in different Applications, Construct a model of an effective Fibre optic communication system	PSO - 1 PSO - 2 PSO - 3	Knowledge Remember Application Creation
CO – 7	Underline the basis of Holography, Classify different types of Hologram, Discover its application in modern world	PSO - 1 PSO - 2	Knowledge Remember Application

Unit 1. Interference of light (12 hrs)

The principle of superposition - coherent sources – Double slit interference (theory of interference fringes and band width) - Interference by division of wave front and amplitude – Fresnel's biprism-interference in thin films-classification of fringes-wedge shaped films-testing of optical flatness-Newton's rings(reflected system)-refractive index of a liquid-Michelson interferometer – determination of wavelength

Unit 2. Diffraction (14 hrs)

Fresnel diffraction: - Half-period zones - explanation of rectilinear propagation of light– diffraction at a straight edge-zone plate. Fraunhofer diffraction: - Diffraction at a single slit, double slits – plane transmission grating - Rayleigh's criterion for resolution - resolving power ofdiffraction grating.

Unit 3.Dispersion (5 hrs)

Unit 4. Polarisation (12 hrs)

Plane polarized light -polarization by reflection – Brewster's law - pile of plates -

Malus law - Double refraction - Huygens explanation for double refraction in uniaxial crystals - Nicol prism - Nicol prism as a polarizer and analyzer – Theory- production and analysis of plane, circularly and elliptically polarized light - quarter and half wave plates.

Unit 4. Laser (**14 hrs**)

Basic principle of laser operation Einstein coefficient, light propagation through medium and condition for light amplification population inversion by pumping and cavity threshold condition, line shape function- optical resonators (qualitative) Q factor various laser systems – Ruby laser - He-NE laser, Dye laser, semiconductor laser, (working principle only) Application of lasers- characteristics of laser beams -spatial coherence - Temporal coherence and spectral energy density Nonlinear optics : Nonlinear Polarization –second harmonic generation – phase matching

Unit 5. Fibre Optics (8 hrs)

Introduction, optical fibre, the numerical aperture, coherent bundle, pulse dispersion in step index fibre, graded index fibre, single mode fibre, multimode fibre, Fibre optic sensors (qualitative), fibre optic communication (qualitative), Advantages of fibre optic communication system.

Unit 6. Holography: (7 hrs)

Principle of holography, recording of holograms, reconstruction of images (Theory not needed), application of holography, different types of holograms, transmission and reflection types.

Books for Study:

1 Text Book of Optics: Subramaniam & Brijlal, .Avadhanulu, 23rd edition,2006
2 Optics: Ajoy Ghatak, TMH, 2005
3 Optics and spectroscopy: R.Murugesan and K Sivaprasad, S. Chand & Co., 2010
4 Lasers Principles, Types and applications: K.R.Nambiar, New Age International Pvt. Ltd. 2006
5 Optics: Eugene Hecht, Addison-Wesley 2002

Books for Reference:

1. Fundamentals of Optics: Jenkins and White, MCH

2. Modern Classical Optics: Geoffrey Brooker, Oxford University Press, 2003

3.Fundamentals of Optics-Geometrical Physical and Quantum:D. R. Khanna and H. R. Gulati, R. Chand,1984

4.Lasers &Non-Linear Optics: B. B. Laud,New Age International Pvt. Ltd., 2011

5.Electronic Communications: Dennis Roddy & John Coolen, Pearson, 1995

Topics for assignments/discussion in the tutorial session (sample)

1. Michelson's interferometer-Standardization of metre.
2. Diffraction at a rectangular aperture and circular aperture
3. Optical activity-Fresnel's theory of optical rotation.
4. Resolving power of prism and telescope

5. Constant deviation spectrometer.

6.Laurent's half shade polarimeter.

8. Laser applications.

9.Study of Fraunhofer lines using spectrometer. .

10. Determination of refractive index of liquid by Newton's rings method.

11.Comparison of radii of curvature by Newton's rings method.

PY1644-DIGITAL ELECTRONICS AND COMPUTER SCIENCE

(72HRS-4 CREDITS)

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO –1	Understand the different number system and their mathematical operations.		
CO –2	Understand boolean algebra and logic gates		
CO-3	Analyze Karnaugh's map		
CO –4	Analyze the arithmetic and sequential circuits.		
CO -5	Differentiate between software and hardware		
CO –6	Get a deep knowledge of various memories used in computer.		
CO –7	Be trained in programming C++ language		
CO –8	Attain the basic knowledge about the internal architecture and addressing modes of intel 8085 micro processor.		

Unit-1 (22hrs)

Number systems :-Decimal number system-binary number system-conversion 2of binary number to decimal and decimal number to binary-binary addition and subtraction-21's complement-2's complement-binary subtraction using 2's complement-signed arithmetic operation-conversion of real numbers-conversion of decimal fraction to binary fraction-binary coded decimal -hexadecimal number system-conversion of hexadecimal number to decimal, decimal to hexadecimal, binary to hexadecimal and hexadecimal to binary-real or floating point representation of numbers-ASCII code.

Boolean algebra and logic gates: - Logic gates AND, OR, NOT, NAND,NOR And Ex-OR gate-realization of other logic functions using NAND / NOR gates-tri state logic gate-Boolean laws- Demorgan's theorem-Simplification of Boolean equations using Boolean laws. Karnaugh map

Arithmetic circuits:-Half adder-full adder-controlled inverter-binary adder- subtractor.

Sequential circuits:- Flip-Flop, S-R Flip Flop, J-K Flip-flop, Master slave JK Flip- Flop

Unit2 (11hrs)

Basics of computers:-Hardware- input and output units- memory unit-ALU-control unit– basicoperational concepts-Software – operating systems

The memory systems:- Basic concepts-semiconductor RAM- internal organization memorychips-static memories-asynchronous and synchronous DRAM-structure of large memories– ROM,PROM,EPROM, EEPROM–flash memory-speed size and cost-Basic concepts of cache memory and virtual memories. Secondary storage-magnetic hard disks-optical disks-magnetic tape systems.

Unit-3: Programming in C++ (25 hrs)

Features of c++ - basic structure of c++ program – library files-header files – preprocessor directives- inbuilt functions- output using cout- input with cin - constants and variables – data types – declaration of variables – integer variables, character variables, floating point types, type bool - assigning values to variables–manipulators-operators and expressions–arithmetic operators, relational operators, logical operators, short hand operators-control statements-for loops , while loop, do…while loop- if statement, if……else, else….if constructions, switch statement- break, continue, goto statements-user defined functions-function definition, function declaration, function header and body, function call and execution, passing arguments to functions, returning values from functions, overloaded functions, inline functions, default arguments, scope rule for functions- storage classes-Arrays-array elements, array initialization, multidimensional arrays, passing arrays to functions-strings-basics of structures and pointers in c++, classes and objects (introduction only)-basic file operations-serial and sequential files, reading and writing -simple examples of c++ programs for solving problems in physics-compilation and execution of data.

Unit 4: Introduction to microprocessors (14 hrs)

Microprocessors and microcontrollers (definition only)-intel 8085- 8 bit microprocessor-pin disruption - 8085 instructions - addressing modes(definition only)- interrupts (definition only) -assembly language - simple programs- addition, subtraction.

Books for study:

1. Fundamentals of Microprocessors and Microcomputers: B. Ram,Dhanpat Rai Publications
2. Digital principles and Applications: Malvino and Leach.TMH, New Delhi, 4th Edn.
3. Fundamentals of Computers: V.Rajaram, PHI, New Delhi, 4th Edn.

4. A first course in Computers: S. Saxena, Vikas Publishing House Pvt. Ltd.,
5. Programming in C++: D. Ravichandran, Tata Mc Graw Hill, 2011
6. Object oriented programming in C++:Robert Lfore,Galgotia publications Pvt Ltd., 3Edn., 2004
7. The C++ programming language:Bjome Stroustrup, 4th Edn. Addison Wesley
8. Object oriented programming with C++: E. Balaguruswami, 5Edn., Tata Mc Graw Hill
9. Programming in C++: M.T. Somasekharan, PHI Pvt. Publishing,2005
10. Numerical Methods with computer programs in C++:P. Ghosh, PHI Learning Pvt. Ltd.
11. The 8085 microprocessors:K. Udayakumar and B. S. Umasankar, Dorling Kindersley (India) Pvt. Ltd.,2008
12. Microprocessor 8085,8086:Abhishek yadav, University Science Press, New Delhi 2008
13. Microprocessor-Architecture, Programming and applications with 8085:R.S. Gaonkar,

Books for Reference: -

1.Introduction to digital electronics:NIIT, PHI.
2.A first course in Computers:Sanjay Saxena, Vikas publishing house Pvt. Ltd.

PRACTICAL

PY1442- Basic Physics Lab 1
(minimum 18 experiments to be done)

1. Fly Wheel - Moment of Inertia
2. Compound Bar Pendulum – Symmetric
3. Compound Bar Pendulum – Asymmetric
4. Uniform Bending---Y---Pin and Microscope
5. Uniform bending—Y- optic lever method
6. Non-uniform bending-Y-Optic lever& telescope
7. Rigidity modulus –Static torsion
8. Torsion pendulum I- By Torsional oscillations
9. Torsion pendulum I- By Equal masses
11. Kater’s pendulum-Acceleration due to gravity

12. Melde's string-----Frequency of fork
13. Phase transition-determination of M.P of wax.
14. Determination of thermal conductivity of rubber
15. Lee's disc-determination of thermal conductivity of a bad conductor
16. Viscosity-Continuous flow method using constant pressure head.
17. Viscosity-Variable pressure head arrangement
18. Surface tension-Capillary rise
19. Sonometer-frequency of A.C
20. Kundt's tube-determination of velocity of sound.
21. Determination of m and Bh using deflection and vibration magnetomers.
22. Potentiometer-Resistivity.
23. Comparison of least counts of measuring instruments.
24. Evaluation of errors in simple experiments.

References

1. Yarwood and Wittle; Experimental Physics for Students, Chapman &Hall Publishers.

2. An advanced course in practical physics, Chathopadhyaya, Rakshit and Saha, New central agency, Kolkata.

3. A text book of practical physics, S.Viswanathan & Co., Chennai.

4. Advanced Practical Physics, B.L.Worsnop and H.T.Flint, Khosla Publishers, Delhi.

PY1645-Advanced Physics Lab 2
(Minimum 18 experiments to be done)

1. Spectrometer-A, D and n of a solid prism.
2. Spectrometer –Dispersive power and Cauchy's constants
3. Spectrometer Grating—Normal incidence- N & wavelength
4. Spectrometer-i-d curve
5. Spectrometer- Hollow prism
6. Liquid lens-refractive index of liquid and lens
7. Newton's Rings—Reflected system

8. Air wedge-diameter of a wire

9. Potentiometer-Resistivity.

10. Potentiometer-Calibration of ammeter

11. Potentiometer –Reduction factor of T.G
12. Potentiometer –Calibration of low range voltmeter

13. Potentiometer – Calibration of high range voltmeter

14. Thermoemf-measurement of emf using digital multimeter.

15. Carey Foster's bridge-Resistivity

16. Carey Foster's bridge-Temperature coefficient of resistance.

17. Mirror galvanometer-figure of merit.

18. BG- Absolute capacity of a condenser

19. Conversion of galvanometer into ammeter and calibration using digital Multimeter

20. Conversion of galvanometer into voltmeter and calibration using digital Voltmeter.

21. Circular coil-Calibration of ammeter.

22. Study of network theorems-Thevenin's & Norton's theorems and maximum power transfer theorem.

23. Circular coil-Study of earth's magnetic field using compass box.

24. Absolute determination of m and Bh using box type and Searle's type vibration magnetometers.

25. Searle's vibration magnetometer-comparison of magnetic moments.

References

1. Yarwood and Wittle; Experimental Physics for Students, Chapman & Hall Publishers.

2. An advanced course in practical physics, Chathopadhyaya, Rakshit and Saha, New central agency, Kolkata.

3. A text book of practical physics, S.Viswanathan & Co., Chennai.

4. Advanced Practical Physics, B.L.Worsnop and H.T.Flint, Khosla Publishers, Delhi.

PY1646—Advanced Physics Lab 3
(Minimum 18 experiments to be done – 4 from Computer Science)

ELECTRONICS

1. PN junction Diode (Ge & Si) characteristics-To draw the characteristic curves of a PN junction diode and to determine its ac and dc forward resistances.

2. Full wave (centre tapped) rectifier-To construct a full wave rectifier using junction diode and to calculate the ripple factor with and without shunt filter (10 readings for R_L 100 to 5000).

3. Full wave (centre tapped) rectifier-To construct a full wave rectifier using junction diode and to study effect of L,C, and LC filters on the ripple factor (for different R_L).
4. Bridge rectifier-To construct a bridge rectifier using junction diodes and to calculate the ripple factor with and without shunt filter (10 readings for R_L 100 to 5000).

5. Bridge rectifier- Dual power supply-To construct a dual power supply using bridge rectifier and measure the output voltages for different pair of identical load resistors.

6. Zener diode characteristics-To draw the I-V characteristic of a Zener diode and to find the break down voltage and the dynamic resistance of the diode.

7. Zener diode as a voltage regulator-To construct a voltage regulator using Zener diode and to study the output voltage variation (i) for different RL and (ii) for different input voltage with same R_L.

8. Transistor characteristics-CE-To draw the characteristic curves of a transistor in the CE configuration and determine the current gain, input impedance and output impedance.

9. Transistor characteristics-CB-To draw the characteristic curves of a transistor in the CB configuration and determine the current gain, input impedance and output impedance.

10. Single stage CE amplifier-To construct a single stage CE transistor amplifier and study its frequency

response.

11. OP amp. IC741- Inverting amplifier-To construct an inverting amplifier using IC741 and determine its voltage gain.

12. OP amp. IC741- Non inverting amplifier

To construct a non inverting amplifier using IC741 and determine its voltage gain.

13. OP amp. IC741- Differentiator-To construct an OP amp. Differentiator, determine its voltage gain and study the output response to pulse and square wave.

14. OP amp. IC741- Integrator-To construct an OP amp. Integrator, determine its voltage gain and study the output response to pulse and square wave.

15. Phase shift oscillator-To construct a phase shift oscillator using transistor and measure the frequency of the output waveform.

16. Logic gates- OR and AND-To verify the truth tables of OR and AND gates using diodes.

17. Logic gate- NOT-To verify the truth tables of NOT gate using a transistor.

18. Network theorems (Superposition, Thevenin's & Norton's theorems)

To verify the (i) Superposition, (ii) Thevenin's & (iii) Norton's theorems

19. RC-Filter circuits (Low pass)

To construct an RC –low pass filter circuit and to find the upper cut off frequency.

20. RC-Filter circuits (High pass)-To construct an RC –high pass filter circuit and to find the lower cut off frequency.

Computer Science (C++ Programs)

1. Program to find the roots of a quadratic equation (both real and imaginary root)
2. Program to find the dot product and cross product of vectors
3. Program to plot the functions Sin x, Tan x and e^x

4. Program to find the matrix addition, multiplication, trace, transpose and inverse.
5. Program to convert hexadecimal to decimal number, decimal to hexadecimal number, binary to hexadecimal numbers and hexadecimal to binary numbers
6. Program to find the result of binary addition and subtraction.
7. Program to find the moment of inertia of regular bodies about various axes of rotation.
8. Program to find the velocity of a rolling body (without sliding) at any point in an inclined plane
9. Program to study the motion of a spherical body in a viscous fluid
10. Program to study the motion of projectile in central force field
11. Program to study the planetary motion and Kepler's law
12. Monte carlo simulation

References:

1. Basic electronics and linear circuits; N.N. Bhargava, D.C. Kulshreshtha, S.C.Gupta

2. OP- Amps and linear integrated circuits; Ramakant A. Gayakwad

3. Basic electronics; Santiram Kal

4. Basic electronics; B. L. Theraja

5. Principles of electronics; V. K. Mehta

6. A first course in Electronic s; Anwar A. Khan, Kanchan K. Dey

PY1661. ELECTIVE COURSES

(54 HOURS-2CREDITS) FOR EACH COURSE

PY1661.1 ELECTRONIC INSTRUMENTATION

Unit 1 (14 hrs)

Basic concepts of measurements- Instruments for measuring basic parameters-ammeter-voltmeters-multimeter- digital voltmeter-accuracy and resolution of DVM.

Unit 2 – Oscilloscopes (14 hrs)

Cathode ray tubes- CRT circuits- vertical deflection system- delay line- horizontal deflection system-multiple trace- oscilloscope probes and transducer- storage oscilloscopes.

Unit 3 – Transducers (10 hrs)

Basic principles- classification of transducers- Passive and Active transducers- strain gauges- temperature measurements- thermistors-photosensitive devices.

Unit 5 – Signal Generation and Analysis (16 hrs)

Sine wave generator- frequency synthesizer- sweep generator- astable multivibrator- laboratory pulse generator- function generator- wave analysers harmonic distortion analyzer- wave meter- spectrum analyzer (qualitative idea only).

Books for Study:

1. Modern Electronic Instrumentation and Measurement Techniques: Albert D.Helfrick & William D.Cooper, PHI, Ltd.
2. Electronic Instrumentation:Kalsi H. S, 2nd Edn, TMH Publishers.

3. Instrumentation-Devices and Systems: C.S. Rangan, G.R.Sarma, V.S.V.Mani, TMH Publishers.

4. Electronic Instruments and Instrumentation Technology: M.M.S.Anand, PHI Ltd.

Books for Reference:

1. Sensors and Transducers: D.Patranabis, Wheeler Publishing Co. Ltd.
2. Industrial Electronics and Control: S.K.Bhattacharya & S.Chatterjee,TMH Publishers.

3. Electronic measurement and Instrumentation: K.B.Klaassen,Cambridge University Press.

4. Measurement Systems-Applications and Design: Ernest O.Doebelin & Dhanesh N.Manik, 5th Edn.TMH Publishers.

5. Principles of Measurement systems: John P.Bentley,Longman, Pearson Education Publishers. 3rd Edn.

PY1661.2. SPACE SCIENCE
54 HOURS-2CREDITS)

Unit 1. Universe (12 hrs) [Book3]

Large Scale Structure of the Universe: Astronomy and Cosmology, Our Galaxy,Galaxy types, Radio sources, Quasars, Structures on the largest scale, Coordinates and catalogues of astronomical objects, Expansion of the Universe

Unit 2. The evolution of Stars (9hrs) [Book4]

Introduction, Classification of Stars: The Harvard classification, Hertzsprung –Russel diagram, Stellar evolution, White dwarfs, Electrons in a white dwarf star,Chandrasekhar limit, Neutron stars, Black holes, Supernova explosion, Photon diffusion time, Gravitational potential energy of a star, Internal temperature of a star,Internal pressure of a star.

Unit 3. The active Sun (10 hrs) [Book2]

Introduction, Sunspots and Solar storms, Sunspots and Solar activity, Cosmic rays of Solar origin, The Solar wind, Solar corona and the origin of the solar wind, Disturbed Solar wind.

The earth's Atmosphere (15 hrs) [Book 1]

Introduction, Nomenclature and temperature profile, Temperature distribution in the troposphere, Temperature of stratosphere, temperature of mesosphere and thermosphere,Temperature variability, The pressure profile, Scale height, Density variation.The Ionosphere: Effect on scale height, Ionospheric electric fields, Ionization profile,Layer of charge, Ionospheric hydrogen and Helium.

Magnetosphere (8 hrs) [Book 2]

Introduction, The magnetic field of Earth, Earth's variable magnetic field, Solar activity and Earth's magnetic weather, solar wind interaction, The Chapman-Ferraro closed magnetosphere, Dungey's open magnetosphere, Structure of the magnetosphere: Magneto tail and Plasma sheet, Plasma sphere, Earth's radiation belts.

Books for Study

1. Introduction to Space Science – Robert C Hymes (1971), John Wiley & Sons Inc.

2. Earth's Proximal Space- Chanchal Uberoi (2000), Universities Press (India)

3. Introduction to Cosmology- J. V. Narlikar (1993), Cambridge University Press

4. Modern Physics- R. Murugeshan, Kiruthika Sivaprasath (2007), S.Chand & Company Ltd.

Books for reference

1. Space Physics and Space Astronomy – Michael D Pappagiannis (1972), Gordon and Breach Science Publishers Ltd.

2. Introductory Course on Space Science and Earth's environment-Degaonkar (Gujarat University, 1978)

3. Introduction to Ionosphere and magnetosphere- Ratcliffe (CUP, 1972)

4. The Physics of Atmospheres-Houghton (Cambridge University Press)

5. Introduction to Ionospheric Physics-Henry Rishbeth &Owen K. Garriot (Academic Press, 1969)

6. Space Science –Louise K. Harra& Keith O. Mason(Imperial College Press,London, 2004)

7. Introduction to Space Physics- Kivelson and Russel
8. Introduction to Astrophysics – Baidyanadh Basu

9.Astrophysics - K. D. Abhayankar (University Press)

PY1661.3. PHOTONICS

(54 HOURS)

Unit 1: (5 hrs)

Photons in semiconductors-semiconductors-energy band and charge carriers-direct and indirect gap semiconductors –Different type of semi conducting materials—generation, recombination and injection-electron hole injection homo andhetero junctions-quantum wells ,quantum dots and quantum wires.

Unit 2: (6 hrs)

Semiconductor photon sources -light emitting diodes-injection electroluminescence-in thermal equilibrium –in the presence of carrier injection- LED characteristics- internal photon flux-output

photon flux and efficiency-responsivity- spectral distribution- materials- response time-device structures (Basics).

Unit 3: (10 hrs)

Semiconductor laser amplifiers-gain-amplifier band width-optical pumping-electrical current pumping-hetero structures -semiconductor injection lasers-amplification-feedback and oscillators-laser amplification-resonator losses -gain condition-Laser threshold-Power-internal photon flux-output photon flux.

Unit 4: (10 hrs)

Semiconductor photon detectors-The external photo effect-photo electron emission-The internal photo effect-properties of semiconductor photo detectors--quantum efficiency-responsivity devices with gain-response time-photoconductors-gain-spectral response- p-n photo diodes-PIN photo diodes-hetero structure photo diode- Schotky barrier photodiodes - array detectors-avalanche photodiodes (basics)-

Unit 5: (8 hrs)

Electro optics, Pockels and Kerr effects- electro optic modulators and switches phase modulators–dynamic wave retarders- intensity Modulators- scanners- directional couplers-spatial light modulators-

Unit 6: (7 hrs)

Non linear optics-second order non-linear optics - electro-optic effect-three wave mixing- third order non-linear optics- self phase modulation-optical kerr effect-self focusing. .

Unit 7: (8 hrs)

Photonic switching and computing-photonic switches-switches-opto mechanical, electro optic, acousto-optic and magneto optic switches-all optical switches-optical computing-digital optical computing-analog optical processing.

Book for Study:

1. Fundamentals of Photonics: BFA Saleh and M.C.Teich, John Wiley &Sons, Inc.

Books for Reference:

1. Semiconductor optoelectronic devices: Pallab Bhattacharya, Printice Hall of India.
2. Optics and Photonics- An introduction: F. Graham Smith and Terry A.King, John Wiley & Sons,Inc.
3. Lasers and Non linear Optics: B.B.Laud, New Age International Pvt Ltd.

Core Course – XII (ELECTIVE) 54 hrs (Credit – 2)

PY 1661.4: NANO SCIENCE AND TECHNOLOGY

Module 1: Introduction : (6 Hrs)

Length scales in Physics- nanometre- Nanostructures: Zero, One Two and Three dimensional nanostructures (Chapter 3, Text 2)

Band Structure and Desnsity of State at nanoscale: Energy Bands, Density of States at low dimensional structures. (Chapter 3, Text 1)

Module 2: Electrical Transport in Nanostructure: (15 hours)

Electrical conduction in metals, The free electron model. Conduction in insulators/ionic crystals - Electron transport in semiconductors - Various conduction mechanisms in 3D (bulk), 2D(thin film) and low dimensional systems: Thermionic emission, field enhanced thermionic emission (Schottky effect).(Chapter 4, Text 1)

Module 3: Introductory Quantum Mechanics for Nanoscience: (8 hrs)

Size effects in small systems, Quatum behavious of nanometric world: Applications of Schrödinger equation – infinite potential well, potential step, potenial box; trapped particle in 3D (nanodot), electron trapped in 2D plane (nanosheet), electrons moving in 1D (nanowire, nanorod, nanobelt), Excitons, Quantun confinement effect in nanomaterials (Chapter 5, Text 1)

Module 4: Growth Techniques of Nanomaterials (Elementary ideas only): (9 hrs)

Top down vs bottom up techniques, Lithographic process, Non Lithographic techniques: Plasma arc discharge, sputtering. Evaporation: Thermal evaporation, Electron beam evaporation. Chemical Vapour Deposition (CVD). Pulsed Laser Deposition, Molecular Beam Epitaxy, Sol-Gel Technique, Electro-deposition., Ball-milling. (Chapter 6, Text 1)

Module 5: Characterization tools of nanomaterials: (Qualitative ideas only) (10 hrs)

Atomic Structures -Grain size determination – XRD (Debye Scherrer equation), Microscopy – Scanning Electron Microscope (SEM), Tunneling Electron Microscope (TEM), Scanning Probe Microscope (SPM), Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM). (Text -1).

Module 6: Applications of nanotechnology: (Elementary ideas only) (6 hrs)

Buckminster fullerene, Carbon nanotube, nano diamomd, BN Nanotune, Nanoelectronics - single electron transistor (no derivation), Molecular machine, Nanobiomatrics (Chapter 8, Text 1).

Applications of nanotechnology: (**Elementary ideas only**) Potential applications, Expected benefits from nanotechnologies, Can nanotechnology helps in addressing various challenges?, Energy and Energy Efficiency, new energy producers, Medicine, security, Other Applications. (Text book-2,

Chapter 5, 6, 7 &8, Nanotechnology: Technology Revolution of 21st Century, Rakesh Rathi, S Chand & Company, New Delhi.).

Text books:

1. Introduction to Nanoscience & Nanotechnology by K. K. Chattopadhyay and A. N. Banerjee, Publisher: PHI Learning and Private Limited

2. Nanotechnology, Rakesh Rathi, S Chand & Company, New Delhi

3.NANO: The Essentials, T.Pradeep, McGraw Hill Education (India) Private Limited

References:

1. Nanoparticle Technology Handbook – M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama (Eds.), Elsevier 2007

2. Encyclopaedia of Materials Characterization, Surfaces, Interfaces, Thin Films, Eds. Brundle, Evans and Wilson, Butterworth – Heinmann, 1992

3. Springer Handbook of nanotechnology, Bharat Bhushan (Ed.), Springer-Verlag, Berlin, 2004

4. Nano Science and Technology, V. S. Muraleedharan and A Subramaniam, Ane Books Pvt. Ltd, New Delhi

5. A Handbook on Nanophysics, John D, Miller, Dominant Publishers and Distributors, Delhi-51 6. Introduction to Nanotechnology, Charles P Poole Jr. and Frank J Owens, Wiley Students Edition 7. Nano-and micro materials, K Ohno et. al, Springer International Edition 2009, New Delhi

PY1661.5. COMPUTER HARDWARE & NETWORKING(54 HRS)

Unit 1 - 3 hrs
P.C. Architecture Functional block diagram of a computer. Processors Introduction to Microprocessor.CISC, RISC processors Type of Processors and their specification.(Intel: Celeron, Pentium family-PII, PIII, PIV, dual core, core 2duo - AMD-K5,K6 series
Unit 2 -10 hrs
Motherboards:Motherboard components Types, Form factor, Different components of Motherboard

(BIOS, CMOS,BICMOS, RAM, CMOS Battery, I/O slots, I/O connectors), Riser architecture, Main Memory (SIMM, DIMM, RIMM), extended/expanded/cache memories. Chipsets (Intel & AMD)-ROM, DRAM, SDRAM, CDRAM, RDRAM, WRAM. Bus standards: Types of Buses (PC, ISA, MCA, AGP, PCI, USB, IEEE FireWire).Add on Cards Different latest Add on Cards (TV Tuner Card, DVR card, Video Capture,Internal Modem, Sound Card)

Unit 3 -9 hrs
Drivers:

1. Floppy Disk Drive- Floppy Drive Components(overview only)
2. Hard Disk Drive (HDD)
Types, Capacity, Hard Disk Components (Media, Read/Write Head, Spindle Motor Head Actuator), Connector, Jumper setting, trouble shooting in HDD.Hard Disk Controller (HDC) – Block diagram,

Working, Interfacing (IDE,SCSI, ATA and SATA series) Configuration of HDD- Installation, Formatting, File Format (FAT, NTFS).Pen drive, i-pods
3.Optical Disk Drive
Types (ROM, R/W, DVD ROM, DVD R/W), Capacity, Difference between CD &DVD (capacity, format)-trouble shooting.
Unit 4 -5 hrs
Peripherals . Keyboard and Mouse- operation

Types of VDU (CRT, LCD, and TFT), Resolution, and Dot pitch -Printers – Types (dot matrix, inkjet, laser) Scanner- operation.Power conditioning Device:SMPS- Block diagram, operation-UPS- Types (online, off line, Hybrid)-trouble shooting in all these devices.

Unit 5- 4 hrs

Viruses & Vaccines-Virus- Introduction, infection methods,Types of viruses, Different symptoms of virus attack, precautions.Vaccine- Method of vaccine, Different types of Antivirus used in PC,Firewalls
Unit 6- 7 hrs

NETWORKING ESSENTIALS
Introduction-Need for networking-Network Topology-OSI Model-Types of networks (LAN, WAN, MAN)

Protocols-LAN Protocols- Classification, Examples, Ethernet networking-WAN Protocols- PPP, X

.25, PPTP, L2TP, ISDN
Unit 7-- 8 hrs

LAN Connectivity Devic es- NIC, Repeater, Hub, Switch, Bridge.Internet Connectivity Device- Routers, Gateways, CSU/DSU-TCP/IP Protocol Suite-What is TCP/IP, Importance, OSI vs TCP/IP

Unit 8- 6 hrs

IP Addressing-Overview, Address classes, Network ID, Host ID and Subnet Mask,Addressing guidelines, Reserved IP Address, Subnetting and Supernetting(overview)

Unit 9 -2 hrs

Emerging Technologies-Wireless Technology - Bluetooth, WAP-Mobile Technology- GSM, CDMA, GPRS

Books for Study:

1. D. Balasubramanian, "Computer Installation & Servicing", Tata McGraw Hill.

2. Rom Gilster, Black book, "PC Upgrading and Repairing", Dream tech, New Delhi.

3. Street Smart, James Pyler, "PC Upgrading and Repairing", Wiley Publishing, Inc.

4. Stephen.J.Bigelow,"Bigelow's Troubleshooting, Maintenance & Repairing PCs",Tata McGraw Hill

5. Craig Zacker, "The Complete Reference- Networking", Tata McGraw Hill

6. Douglowe, "Networking All in One Desk Reference"-3Edn, Wiley India Pvt Ltd

Books for Reference:

1. Mark Minasi, "The Complete PC Upgrade & Maintenance Guide" BPB Publication

2. C.A. Schmidt, "The Complete Computer Upgrade & Repair Book", Dreamtech

3. Craig Zacker, John Rourke, "The Complete Reference- PC Hardware"Tata McGraw Hill

4. Scott Mueller, "Upgrading & Repairing PC's", Pearson Education

5. Vishnu Priya Sing & Meenakshi Singh, "Computer Hardware Course", Computech

6. Manahar Lotia, Pradeep Nair, Payal Lotia, "Modern Computer Hardware Course",BPB Publication.

7. Richard Mc Mohan, “Introduction to Networking”, Tata McGraw Hill.

Internet Resources:

www.edugrid.ac.in/webfolder/courses/cn/cn_resourses.htm

www.howstuffwork.com

www.e-tutes.com

www.learnthat.com

www.intel.com

www.amd.com

http://en.wikipedia.org

FIRST DEGREE PROGRAMME for B.Sc. Physics

Complementary MACHINE LEARNING

SCHEME AND SYLLABI [w.e.f. 2020 Admission]

The goal of this programme is to equip the students with the concepts, principles and methods of artificial intelligence and machine learning. There are practical sessions in each semester. It is mandatory to submit a fair record of practical done and print-out of the output of the same duly certified at the time of ESE of practical course. ESE of the practical course will be held under the supervision of external examiners duly appointed by the University.

Semester	Title of the course	Hours/ Week		No. of credits	Total Hrs/ week	ESE Duration	Weightage	
		L	P				CE	ESE
I	MI 1131.1:Python Programming	2	2	2	72	3 hrs	20	80
II	MI 1231.1:Artificial Intelligence	2	2	2	72	3 hrs	20	80
III	MI 1331.1: Knowledge Represe-ntation And Intelligence Agents	3	2	3	90	3 hrs	20	80
IV	MI 1431.1: Machine Learning	3	2	3	90	3 hrs	20	80
	MI 1432.1: Machine Learning using Python Lab			2		2 hrs	20	80

Division of marks (Lab examination)

1. First program should be sufficiently simple – **25 marks**
   (Logic – 10 marks, Successful compilation – 10 marks, Result– 5 marks)
2. Second program should be based on advanced concepts **- 30 marks**
   (Logic – 15 marks, Successful compilation – 10 marks, result – 5 marks)
3. Viva Voce **- 15 marks**
4. Lab Record **- 10 marks**

Total Marks - 80 marks

Semester I | **Course Code:** MI 1131.1 | **Credits: 2** | **Hrs/Week: 2+2**

PYTHON PROGRAMMING

COURSE OUTCOMES: At the end of the Course, the Student will be able to

CO1	Remember features, operators
CO2	Understand types of loops
CO3	Apply object oriented terminologies
CO4	Analyse data using various plots
CO5	Evaluate regular expressions
CO6	Create user defined function

COURSE CONTENT

Module 1: Features of Python, Identifiers, Reserved Keywords, Variables, Input, Output and Import Functions, Operators, Numbers, String - String Formatting Functions, Lists - Built-in List Functions, Built-in List Methods, Tuple - Built-in Tuple Functions, Set - Built-in Set Functions, Built-in Set Methods, Dictionary - Built-in Dictionary Functions, Built-in Dictionary Methods

Module 2: Decision Making, Loops, Nested Loops, Control Statements, Types of Loops, List Comprehensions, Set Comprehensions, Dictionary Comprehensions, Nested Dictionaries. Function Definition - Function Calling, Function Arguments, Anonymous (Lambda) Functions, *filter()* function, *reduce()* function, Recursive Functions, Function with more than one return value. Built-in Modules, Creating Modules, *import* Statement, Locating Modules, Namespaces and Scope, The *dir()* function, The *reload()* function, Packages in Python.

Module 3: File handling - opening a file, closing a file, writing to a File, *with* statement, reading from a file, file methods, renaming a file, deleting a file, directories in Python. Object Oriented Programming - Advantages. Class definition, Creating objects, Built-in attribute methods, Built-in class attributes, Destructors, Encapsulation, Data hiding, Inheritance, Method overriding, Polymorphism. Built-in Exceptions, Handling Exceptions, Exception with arguments, Raising an Exception, User-defined Exception, Assertions in Python.

Module 4: Regular expressions- Introduction, match() function, search() function, search and replace, regular expression modifiers, regular expression patterns, Character classes, special character classes, repetition cases, findall() method, compile() method. Introduction to numpy – Creating arrays, indexing, data types. Plotting with matplotlib – bar plot, histogram, pie chart, scatterplot. Pandas - Data frame, descriptive statistics, indexing and selecting data.

TEXT BOOK

1. Jeeva Jose, Taming Python by Programming, Khanna Publishers, New Delhi, 2016.

REFERENCES

1. https://www.w3schools.com/python/numpy_intro.asp
2. https://www.tutorialspoint.com/matplotlib/index.htm
3. https://www.tutorialspoint.com/python_pandas/index.htm

SAMPLE LAB EXERCISES

1. To write, test, and debug simple Python programs.
2. To implement Python programs with conditionals and loops.
3. Use functions for structuring Python programs.
4. Programs using Python strings, lists, tuples, and dictionaries.
5. Read and write data from/to files in Python.
6. Programs to demonstrate creating and handling of modules and packages
7. Programs involving–regular expressions
8. Programs to draw simple bar chart, pie chart, histogram and scatterplot

Semester II	Course Code: MI 1231.1	Credits: 2	Hrs/Week: 2+2

ARTIFICIAL INTELLIGENCE

COURSE OUTCOMES: At the end of the Course, the Student will be able to

CO1	Remember features of AI and knowledge-based systems
CO2	Understand basic parsing techniques
CO3	Apply search and control strategies
CO4	Analyse different matching techniques
CO5	Evaluate the performance of various searching algorithms
CO6	Create AND-OR graphs

COURSE CONTENT

Module 1: Overview of Artificial Intelligence: What is AI, The importance of AI; Knowledge: Introduction, Definition and Importance of knowledge, Knowledge–Based Systems, Representation of Knowledge, Knowledge Organization, Knowledge Manipulation, Acquisition of Knowledge.

Module 2: Formalized Symbolic Logics: Introduction, Syntax and Semantics for Propositional Logic and FOPL, Properties of WFFs, Conversion to Clausal Form, Inference Rules, The Resolution Principle; Structured Knowledge: Associative Networks, Frame Structures, Conceptual Dependencies and Scripts.

Module 3: Search and Control Strategies: Preliminary concepts, Examples of Search Problems, Uniformed or blind Search, Informed Search, Searching And-Or graphs; Matching Techniques: Introduction, Structures Used in Matching, Measures for Matching, Partial Matching, The RETE Matching Algorithm.

Module 4: Natural Language Processing: Introduction, Overview of Linguistics, Grammars and Languages, Basic Parsing Techniques, Semantic Analysis and Representation Structures, Natural Language Generation, Natural Language Systems

TEXT BOOK

- Dan W. Patterson, Introduction to Artificial Intelligence And Expert Systems, PHI Learning 2014

REFERENCES

- Elaine Rich, Kevin Knight, Shivashankar B Nair, Artificial Intelligence, Third Edition, McGraw Hill Education (India) PVT LTD

SAMPLE LAB EXERCISES

1. Python program to accept a user name and print them in reverse order with a space between them.
2. Python program that accepts a word from the user and reverse it.
3. Write a Python Program to count the character frequency (number of each character in a string.
4. Python program to count occurrences of each word in a string.
5. Write a Python program to find the list of words that are longer than N from a given list of words.
6. Write a Python program to read a list of words and returns the longest one.
7. Write a Python function that takes two lists and returns True if they have at least one common member.

8. Write a module to check whether a string is palindrome. Import the module to see whether a string is a palindrome.
9. Write a Python program to delete the sentences from a file, if it contains a particular word.
10. Write a Python program to print the contents of a file in reverse order.
11. Write a Python program with regular expression to check the validity of password entered by the user.
12. Write a program to draw the Bar chart of rainfall for the last 10 years.

Semester III	**Course Code:** MI 1331.1	**Credits: 3**	**Hrs/Week: 3+2**

KNOWLEDGE REPRESENTATION AND INTELLIGENCE AGENTS

COURSE OUTCOMES: At the end of the Course, the Student will be able to

CO1	Remember time and space complexity
CO2	Understand types of intelligent agents
CO3	Apply heuristic search techniques
CO4	Analyse the efficiency of different search techniques
CO5	Evaluate efficiency of algorithms
CO6	Create search graphs

COURSE CONTENT

Module 1: Concepts in algorithm analysis – the efficiency of algorithms, average and worst – case analysis, Asymptotic notation, time and space complexity.

Module 2: Techniques - brute force, divide and conquer, decrease and conquer, dynamic programming, shortest paths, backtracking

Module 3: Heuristic search techniques - Generate and test, Hill climbing, Simulated annealing, Problem reduction, AO* algorithm, Constraints satisfaction, Means - Ends analysis. Search Techniques - Graph search, Depth First Search, Breadth First Search, Best first search, A* algorithm.

Module 4: Intelligent agents - structure, types of agents, environment, autonomous agents. Nature inspired agents.

TEXT BOOK

- Vinod Chandra S S, Anand H S, Artificial Intelligence: Principles and Applications, Prentice Hall of India, New Delhi, 2020

REFERENCE

- Kevin Knight, Elaine Rich, Artificial Intelligence, 3rd Edn, Pearson, Chennai
- Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition Prentice Hall of India, New Delhi, 2009

SAMPLE LAB EXERCISES

1. Implementation of brute force algorithm
2. Implementation of divide and conquer algorithm

3. Implementation of decrease and conquer algorithm
4. Implementation of shortest paths algorithm
5. Implementation of Heuristic search techniques
6. Implementation of AO* algorithm
7. Implementation of Depth First Search method
8. Implementation of Breadth First Search method
9. Implementation of Best first search method
10. Implementation of A* algorithm.

Semester IV	Course Code: MI 1431.1	Credits: 3	Hrs/Week: 3+2

MACHINE LEARNING

COURSE OUTCOMES: At the end of the Course, the Student will be able to

CO1	Remember applications of machine learning
CO2	Understand different learning techniques
CO3	Apply clustering of raw data
CO4	Analyse the performance of classification methods
CO5	Evaluate hierarchical methods
CO6	Create a semi supervised learning model

COURSE CONTENT

Module 1: What is Machine Learning? Machine Learning Vs. Traditional Programming, How Machine Learning Works? Applications of Machine Learning, Types of Learning - Supervised Learning, Unsupervised Learning, Semi-supervised Learning, Reinforcement Learning, Active Learning. Challenges in Machine Learning Regression – Introduction, Types of Regression, Linear Regression, Multiple Linear Regression, Non-Linear Regression (Polynomial Regression), Logistic Regression.

Module 2: Classification – Introduction, Decision Trees, Naïve Bayes Classification, Multinomial Naïve Bayes Classification, Support Vector Machines, K-Nearest Neighbours, Random Forest

Module 3: Clustering- Introduction, Requirements of Clustering, Types of Data in Cluster Analysis - Interval-Scaled Variables, Binary Variables, Categorical Variables, Ordinal Variables, Ratio-Scaled Variables, Variables of Mixed Types. Categorization of Major Clustering Methods - Partitioning Methods - K-means, K-medoids, CLARANS. Hierarchical Methods - Agglomerative Clustering, BIRCH, Density-based Methods – DBSCAN, OPTICS

Module 4: Advanced multivariate analysis – Introduction-Dimensionality Reduction - Principal Component Analysis, Linear Discriminant Analysis, Principal Component Analysis Vs. Linear Discriminant Analysis. Factor Analysis, Multidimensional scaling. Semi-supervised, Reinforcement & Active Learning- Introduction - Semi-supervised Learning, Pseudo Labelling. Reinforcement Learning - Concepts and Terminologies, Implementation, ϵ(epsilon)-Greedy Algorithm. Active Learning - Concepts of Active Learning, Query Strategies, Steps in Active Learning. Introduction to Deep learning, Applications of Deep Learning, Deep Learning Process, Types of Deep Learning Networks, Limitations of Deep Learning

TEXT BOOK

- Jeeva Jose, Introduction to MACHINE LEARNING using PYTHON, Khanna Publishers, New Delhi, 2018 Edition.

REFERENCES

- Vinod Chandra S S, Anand H S, Artificial Intelligence and Machine Learning, Prentice Hall of India, New Delhi, 2014
- C. Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
- K. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
- Vinod Chandra S S, Anand H S, Machine Learning: A Practitioners Approach, Prentice Hall of India, New Delhi, 2020

SAMPLE LAB EXERCISES

1. Program to implement simple linear regression.
2. Program to implement multiple linear regression.
3. Program to implement polynomial regression.
4. Program to implement logistic regression.
5. Write a program to implement a decision tree classification.
6. Write a program to implement Naïve Bayesian classification.
7. Write a program to implement support vector machines.
8. Write a program to implement KNN algorithm.
9. Write a program to implement random forest.
10. Write a program to implement K-means.
11. Write a program to implement hierarchical clustering.
12. Write a program to implement linear discriminant analysis.

Semester IV	**Course Code:** MI 1431.2	**Credits: 3**	**Hrs/Week: 3+2**

MACHINE LEARNING USING PYTHON LAB

Students should undergo the similar type of lab exercises given each semester and write at least 6 programs in the final record. The distribution of marks in the ESE is as follows

Part A:	One question from MI 1131.1/MI 1231.1 Lab exercise	- 25 marks
Part B:	One question from MI 1331.1/MI 1431.1 Lab exercise	- 35 marks
	Record	- 10 marks
	Viva-Voce	- 10 marks
	Total	**- 80 marks**

Board of Studies in Mathematics (UG)
UNIVERSITY OF KERALA

First Degree Programme in MATHEMATICS under Choice Based Credit and Semester System

SYLLABUS for 2018 admission onwards

Structure of Core Courses

Sem	Course Code	Course title	Instr.hrs. per week	Credit
I	MM 1141	Methods of Mathematics	4	4
II	MM 1221	Foundations of Mathematics	4	3
III	MM 1341	Elementary Number Theory and Calculus – I	5	4
IV	MM 1441	Elementary Number Theory and Calculus – II	5	4
V	MM 1541	Real Analysis – I	5	4
	MM 1542	Complex Analysis – I	4	3
	MM 1543	Abstract Algebra – Group Theory	5	4
	MM 1544	Differential Equations	3	3
	MM 1545	Mathematics Software – LaTeX & SageMath (Practical Examination Only)	4	3
	MM 1551	Open Course	3	2
	——	Project preparation - From selecting the topic to presenting the final report	1	
VI	MM 1641	Real Analysis – II	5	4
	MM 1642	Complex Analysis – II	4	3
	MM 1643	Abstract Algebra – Ring Theory	4	3
	MM 1644	Linear Algebra	5	4
	MM 1645	Integral Transforms	4	3
	MM 1651	Elective Course	3	2
	MM 1646	Project		4

Structure of Open Courses

Sem	Course Code	Course title	Instr.hrs. per week	Credit
V	MM 1551.1	Operations Research	3	2
V	MM 1551.2	Business Mathematics	3	2
V	MM 1551.3	Basic Mathematics	3	2

Structure of Elective Courses

Sem	Course Code	Course title	Instr.hrs. per week	Credit
VI	MM 1661.1	Graph Theory	3	2
VI	MM 1661.2	Linear Programming with SageMath	3	2
VI	MM 1661.3	Numerical Analysis with SageMath	3	2
VI	MM 1661.4	Fuzzy Mathematics	3	2

Structure of the Complementary Courses

Complementary Course in Mathematics for First Degree Programme in Physics

Course Code	Sem.	Title of Course	Contact hrs/week	No. of Credits
MM 1131.1	1	Calculus with applications in Physics – I	4	3
MM 1231.1	2	Calculus with applications in Physics – II	4	3
MM 1331.1	3	Calculus and Linear Algebra	5	4
MM 1431.1	4	Complex Analysis, Special Functions and Probability Theory	5	4

Complementary Course in Mathematics for First Degree Programme in Chemistry

Course Code	Sem.	Title of Course	Contact hrs/week	No. of Credits
MM 1131.2	1	Calculus with applications in Chemistry – I	4	3
MM 1231.2	2	Calculus with applications in Chemistry – II	4	3
MM 1331.2	3	Linear Algebra, Probablity Theory & Numerical Methods	5	4
MM 1431.2	4	Differential Equations, Vector Calculus and Abstsract Algebra	5	4

Complementary Course in Mathematics for First Degree Programme in Geology

Course Code	Sem.	Title of Course	Contact hrs/week	No. of Credits
MM 1131.3	1	Algebra, Geometry and Trigonometry	4	3
MM 1231.3	2	Calculus and Linear Algebra	4	3
MM 1331.3	3	Complex Numbers, Algebra and Calculus	5	4
MM 1431.3	4	Basic Statistics and Differential Equations	5	4

Complementary Course in Mathematics for First Degree Programme in Statistics

Course Code	Sem.	Title of Course	Contact hrs/week	No. of Credits
MM 1131.4	1	Basic Calculus for Statistics	4	3
MM 1231.4	2	Advanced Differential and Integral Calculus	4	3
MM 1331.4	3	Fourier Series, Numerical Methods and ODE	5	4
MM 1431.4	4	Linear Algebra	5	4

Complementary Course in Mathematics for First Degree Programme in Economics

Course Code	Sem.	Title of Course	Contact hrs/week	No. of Credits
MM 1131.5	1	Mathematics for Economics I	3	2
MM 1231.5	2	Mathematics for Economics II	3	3
MM 1331.5	3	Mathematics for Economics III	3	3
MM 1431.5	4	Mathematics for Economics IV	3	3

Syllabus for the First Degree Programme in Mathematics of the University of Kerala

Semester I
Methods of Mathematics

CODE: MM 1141 Instructional hours per week: 4
No.of credits: 4

In this paper, we quickly review the fundamental methods of solving problems viz. the limiting method, finding the rate of changes through differentiation method, and finding the area under a curve through the integration method.

Module I - Methods of Differential Calculus (36 Hours)
In the beginning of this module, the basic concepts of calculus like limit of functions especially infinite limits and limits at infinity, continuity of functions, basic differentiation, derivatives of standard functions, implicit differentiation etc. should be reviewed with examples.
The above topics which can be found in chapter 2 of text [1] **below are not to be included in the end semester examination.** A maximum of 5 hours should be devoted for the review of the above topics. After this quick review, the main topics to discuss in this module are the following:
Differentiating equations to relate rates, how derivatives can be used to approximate non-linear functions by linear functions, error in local linear approximation, differentials;

Increasing and decreasing functions and their analysis, concavity of functions, points of inflections of a function and applications, finding relative maxima and minima of functions and graphing them, critical points, first and second derivative tests, multiplicity of roots and its geometrical interpretation, rational functions and their asymptotes, tangents and cusps on graphs;

Absolute maximum and minimum, their behaviour on various types of intervals, applications of extrema problems in finite and infinite intervals, and in particular, applications to Economics;

Motion along a line, velocity and speed, acceleration, Position - time curve, Rolle's, Mean Value theorems and their consequences;

Indeterminate forms and L'Hôpital's rule;
The topics to be discussed in this module can be found in chapter 2,3 and 6 of text [1] *below.*

Module II - Methods of Integral Calculus (36 Hours)
The module should begin with revising integration techniques, like integration by substitution, fundamental theorem of calculus, integration by parts, integration by partial fractions, integration by substitition and the concept of definite integrals.

The above topics which can be found in chapter 4 and 7 of text [1] **below are not to be included in the end semester examination.** A maximum of 5 hours should be devoted for the review of the above topics.
After this quick review, the main topics to discuss in this module are the following:
Finding position, velocity, displacement, distance travelled of a particle by integration, analysing the distance-velocity curve, position and velocity when the acceleration is constant, analysing the free-fall motion of an object, finding average value of a function and its applications;

Area, volume, length related concepts : Finding area between two curves, finding volumes of some three dimensional solids by various methods like slicing, disks and washers, cylindrical shells, finding length of a plane curve, surface of revolution and its area;

Work done : Work done by a constant force and a variable force, relationship between work and energy;

Relation between density and mass of objects, center of gravity, Pappus theorem and related problems

Fluids, their density and pressure, fluid force on a vertical surface.

Introduction to Hyperbolic functions and their applications in hanging cables;

Improper integrals, their evaluation, applications such as finding arc length and area of surface.

The topics to be discussed in this module can be found in chapter 4, 5, 6 and 7 of text [1] *below.*

Text 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley& Sons

References

Ref. 1 – G B Thomas, R L Finney. *Calculus*, 9th Edition, Addison-Weseley Publishing Company

Ref. 2 – J Stewart. *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited

Semester II

Foundations of Mathematics

CODE: MM 1221 Instructional hours per week: 4
No.of credits: 3

The rigorous study of mathematics begins with understanding the concepts of sets and functions. After that, one needs to understand the way in which a mathematician formally makes statements and proves or disproves it. We start this course with an introduction to these fundamental concepts. Apart from that, the basic of vector calculus is to be revised before moving to more advanced topics.

Module I - Foundations of Logic and Proof (36 Hours)
The following are the main topics in this module :
Statements, logical connectives, and truth tables, conditional statements and parts of it, tautology and contradiction, using various quantifiers like universal and existential quantifiers in statements, writing negations, determining truth value of statements;

Proof : Various techniques of proof like inductive reasoning, counter examples, deductive reasoning, hypothesis and conclusion, contrapositive statements, converse statements, contradictions, indirect proofs;

Sets and relations: A review of basic set operations like union, intersection, subset, superset concepts, equality of sets, complements, disjoint sets, indexed family of sets and operations on such families, ordered pairs, relations on sets, cartesian products (finite case only), various types of relations (reflexive, symmetric, transitive, equivalence), partitions of sets;

Functions: domain, codomain, range of functions, one-one, onto, bijective functions, image, preimage of functions, composing functions and the order of composition, inverse functions, cardinality of a set, equinumerous (equipotent) sets
The topics to be discussed in this module can be found in chapter 1 and 2 of text [1] *below.*

Module II - Foundations of co-ordinate geometry (18 Hours)
The following are the main topics in this module :
Parametric equations of a curve, orientation of a curve, expressing ordinary functions parametrically, tangent lines to parametric curves, arc length of parametric curves;

Polar co-ordinate systems, converting between polar and rectangular co-ordinate systems, graphs in the polar co-ordinate system, symmetry tests in the polar co-ordinate system, families of lines, rays, circles, other curves, spirals;

Tangent lines to polar curves, arc length of the curve, area, intersections of polar curves;

Conic sections : definitions and examples, equations at standard positions, sketching them, asymptotes of hyperbolas, translating conics, reflections of conics, applications,

rotation of axes and eliminating the cross product term from the equation of a conic, polar equations of conics, sketching them, applications in astronomy such as Kepler's laws, related problems
The topics to be discussed in this module can be found in chapter 10 of text [2] *below.*

Module III - Foundations of vector calculus (18 Hours)
To begin with, the three dimesional rectangular co-ordinate system should be discussed and how distance is to be calculated between points in this sytem. Basic operations on vectors like their addition, cross and dot products should be introduced next. The concept of projections of vectors and the relation with dot product should be given emphasize. Equations of lines determined by a point and vector, vector equations in lines, equatins of planes using vectors normal to be should be discussed. Quadric surfaces which are three dimensinal analogues of conics should be discussed next. Various co-ordinate systems like cylindrical, spherical should be discussed next with the methods for conversion between various co-ordinate systems.
The topics to be discussed in this module can be found in chapter 11 of text [2] *below.*

Texts

Text 1 – S R Lay. *Analysis with an Introduction to Proof*, 5th Edition, Pearson Education Limited

Text 2 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

References

Ref. 1 – J P D'Angelo, D B West. *Mathematical Thinking - Problem Solving and Proofs*, 2nd Edition, Prentice Hall

Ref. 2 – Daniel J Velleman. *How to Prove it : A Structured Approach*, 2nd Edition, Cambridge University Press

Ref. 3 – Elena Nardi, Paola lannonne. *How to Prove it : A brief guide for teaching Proof to Year 1 mathematics undergraduates*, University of East Anglia, Centre for Applied Research in Education

Ref. 4 – G B Thomas, R L Finney. *Calculus*, 9th Edition, Addison-Weseley Publishing Company

Ref. 5 – J Stewart. *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited

Semester III

Elementary Number Theory and Calculus – I

CODE: MM 1341 Instructional hours per week: 5
No.of credits: 4

Towards beginning the study on abstract algebraic structures, this course introduces the fundamental facts in elementary number theory. Apart from that, calculus of vector valued functions and multiple integrals is also discussed.

Module I - Divisibility in integers (18 Hours)
The topic of elementary number theory is introduced for further developing the ideas in abstract algebra. The following are the main topics in this module :
The division algorithm, Pigeonhole principle, divisibility relations, inclusion-exclusion principle, base-b representations of natural numbers, prime and composite numbers, infinitude of primes, GCD, linear combination of integers, pairwise relatively prime integers, the Euclidean algorithm for finding GCD, the fundamental theorem of arithmetic, canonical decomposition of an integer into prime factors, LCM;

Linear Diophantine Equations and existence of solutions, Eulers Method for solving LDE's
The topics to be discussed in this module can be found in chapter 2 and 3 of text [2] *below.*

Module II - Vector valued functions (30 Hours)
Towards going to the calculus of vector valued functions, we define such functions. The other topics in this module are the following :
Parametric curves in the three dimensional space, limits, continuity and derivatives of vector valued functions, geometric interpretation of the derivative, basic rules of differentiation of such functions, derivatives of vector products, integrating vector functions, length of an arc of a parametric curve, change of parameter, arc length parametrizations, various types of vectors that can be associated to a curve such as unit vectors, tangent vectors, binormal vectors, definition and various formulae for curvature, the geometrical interpretation of curvature, motion of a particle along a curve and geometrical interpretation of various vectors associated to it, various laws in astronomy like Kepler's laws and problems
The topics to be discussed in this module can be found in chapter 12 of text [1] *below.*

Module III - Multivariable Calculus (42 Hours)
After introducing the concept of functins of more than one variable, the sketching of them in three dimensinal cases with the help of level curves should be discussed. Countours and level surface plotting also should be discussed. The other topics in this module are the following:
Limits and continuity of Multivariable functions, various results related to finding the limits and establishing continuity, continuity at boundary points, partial derivatives of

functions, partial derivative as a function, its geometrical interpretation, implicit partial differentiation, changing the order of partial differentiation and the equality conditions;

Differentiability of a multivariate function, differentiability of such a function implies its continuity, local linear approximations, chain rules - various versions, directional derivative and differentiability, gradient and its properties, applications of gradients;

Tangent planes and normal vectors to level surfaces, finding tangent lines to intersections of surfaces, extrema of multivariate functions, techniques to find them, critical and saddle points, Lagrange multipliers to solve extremum problems with constrains,
The topics to be discussed in this module can be found in chapter 13 of text [1] *below.*

Texts

Text 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Text 2 – Thomas Koshy. *Elementary Number Theory with Applications*, 2nd Edition, Academic Press

References

Ref. 1 – G B Thomas, R L Finney. *Calculus*, 9th Edition, Addison-Weseley Publishing Company

Ref. 2 – J Stewart. *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited

Ref. 3 – G A Jones, J M Jones. *Elementary Number Theory*, Springer

Semester IV

Elementary Number Theory and Calculus – II

CODE: MM 1441 Instructional hours per week: 5
No.of credits: 4

As in the previous semester, towards beginning the study on abstract algebraic structures, this course introduces the fundamental facts in elementary number theory. Apart from that, calculus of vector valued functions and multiple integrals is also discussed.

Module I - Congruence relations in integers (30 Hours)
Towards defining the congruence classes in $\mathbb{Z}$, we begin with defining the congruence relation. Its various properties should be discussed, and then the result that no prime of the form $4n + 3$ is a sum of two squares should be discussed. The other topics in this module are the following:
Defining congruence classes, complete set of residues, modulus exponentiation, finding reminder of big numbers using modular arithmetic, cancellation laws in modular arithmetic, linear congruences and existence of solutions, solving Mahavira's puzzle, modular inverses, Pollard Rho factoring method;

Certain tests for divisibility - The numbers here to test are powers of 2, 3, 5, 7, 9, 10, 11, testing whether a given number is a square;

Linear system of congruence equations, Chinese Remainder Theorem and some applications;

Some classical results like Wilson's theorem, Fermat's little theorem, Pollard $p - 1$ factoring method, Eulers' theorem,
The topics to be discussed in this module can be found in chapter 2 and 3 of text [2] *below.*

Module II - Multiple integrals (30 Hours)
Here we discuss double and triple integrals and their applications. The main topics in this module are the follwing:
Double integrals: Defining and evaluating double integrals, its properties, double integrals over non rectangular regions, determining limits of integration, revising the order of integration, area and double integral, double integral in polar coordinates and their evaluation, finding areas using polar double integrals, conversion between rectangular to polar integrals, finding surface area, surface of revolution in parametric form, vector valued function in two variables, finding surface area of parametric surfaces;

Triple integrals : Properties, evaluation over ordinary and special regions, determining the limits, volume as triple integral, modifying order of evaluation, triple integral in cylindrical co-ordinates, Converting the integral from one co-ordinate system to other;

Change of variable in integration (single, double, and triple), Jacobians in two variables.
The topics to be discussed in this module can be found in chapter 14 of text [1] *below.*

Module III - Vector Calculus (30 Hours)

After the differentiation of vector valued functions in the last semester, here we introduce the concept of integrating vector valued functions. Some important theorems are also to be discussed here. The main topics are the following :

Vector fields and their graphical representation, various type of vector fields (inverse-square, gradient, conservative), potential functions, divergence, curl, the $\bigtriangledown$ operator, Laplacian;

Integrating a function along a curve (line integrals), integrating a vector field along a curve, defining work done as a line integral, line integrals along piecewise-smooth curves, integration of vector fields and independence of path, fundamental theorem of line integrals, line integrals along closed paths, test for conservative vector fields, Green's theorem and applications;

Defining and evaluating surface integrals, their applications, orientation of surfaces, evaluating flux integrals, The divergence theorem, Gauss' Law, Stoke's theorem, applications of these theorems.

The topics to be discussed in this module can be found in chapter 15 of text [1] *below.*

Texts

Text 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Text 2 – Thomas Koshy. *Elementary Number Theory with Applications*, 2nd Edition, Academic Press

References

Ref. 1 – G B Thomas, R L Finney. *Calculus*, 9th Edition, Addison-Weseley Publishing Company

Ref. 2 – J Stewart. *Calculus with Early Transcendental Functions*, 7th Edition, Cengage India Private Limited

Ref. 3 – G A Jones, J M Jones. *Elementary Number Theory*, Springer

Semester V

Real Analysis – I

CODE: MM 1541 Instructional hours per week: 5
No.of credits: 4

In this course, we discuss the notion of real numbers, the ideas of sequence of real numbers and the concept of infinite summation in a formal manner. Many of the topics discussed in the first two modules of this course were introduced somewhat informally in earlier courses, but in this course, the emphasis is on mathematical rigor. A minimal introduction to the metric space structure of $\mathbb{R}$ is also included so as to serve as a stepping stone into the idea of abstract topological spaces. The course is mainly based on Chapters 1–3 of text [1].

All the chapters mentioned above contains a section titled *Discussions* in the beginning of the chapter. This section is intended only for motivating the students, and so should not be made as a part of the examination process.

Module I (25 Hours)

This module introduces the basic concepts about the real number system with some introduction to sets, functions, and proof techniques. The following are the main topics to be discussed: existence of an irrational number, the axiom of completeness, upper lower bounds of sets in $\mathbb{R}$, consequences of completeness like Archimedian property of real numbers, Density of $\mathbb{Q}$ in $\mathbb{R}$, existence of square roots, countability of $\mathbb{Q}$ and uncountability of $\mathbb{R}$, various cardinality results, Cantor's original proof for uncoubtability of $\mathbb{R}$, and Cantor's theorem on power sets.

The topics to be discussed in this module can be found in chapter 1 of text [1] *below. The first section 1.1 may be briefly discussed and is not meant for examination purposes.*

Module II (40 hours)

Students must have already encountered the idea of infinite series through the example of geometric progression. After discussing the rearrangement concept of infinite series, the following topics are to be introduced rigourously : Limit of a sequence, diverging sequences, examples, algebraic operations on limits, and order properties of sequences and limits, the Monotone Convergence Theorem, Cauchy's condensation test for convergence of a series, various other tests for the convergence series, the Bolzano-Weierstrass theorem, the Cauchy criterion for convergence of a sequence, rearrangement of absolutely convergent series.

The topics to be discussed in this module can be found in chapter 2 of text [1] *below. The first section 2.1 may be briefly discussed and is not meant for examination purposes.*

Module III (25 hours)

This module is intended to be a beginner for learning abstract metric spaces. To motivate the students, the Cantor set should be constructed and shown in the beginning. Then move to the topics open and closed sets in $\mathbb{R}$, and what about their complements, Compactness of sets (defined using sequential convergence), open covers and compactness, perfect and connected sets in $\mathbb{R}$, and finally the Baire's theorem.
The topics to be discussed in this module can be found in chapter 3 of text [1] *below. The first section 3.1 may be briefly discussed and is not meant for examination purposes.*

Texts

Text 1 – Stephen Abbot. *Understanding Analysis*, 2nd Edition, Springer

References

Ref. 1 – R G Bartle, D Sherbert. *Introduction to Real Analysis*, 3rd Edition, John Wiley & Sons

Ref. 2 – W. Rudin. *Principles of Mathematical Analysis*, Second Edition, McGraw-Hill

Ref. 3 – Terrence Tao. *Analysis I*, Hindustan Book Agency

Semester V

Complex Analysis – I

CODE: MM 1542 Instructional hours per week: 4
No.of credits: 3

Here we go through the basic complex function theory.

Module I (27 Hours)
Complex numbers : The algebra of Complex Numbers, Point Representation of Complex Numbers, Vectors and Polar forms, The Complex Exponential, Powers and Roots, Planar Sets
Analytic Functions : Functions of a complex variable, Limits and Continuity, Analyticity, The Cauchy Riemann Equations, Harmonic Functions
The topics to be discussed in this module can be found in chapter 1, sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.6 and chapter 2, sections 2.1, 2.2, 2.3, 2.4, 2.5 of text [1] *below.*

Module II (15 hours)
Elementary Functions : Polynomials and rational Functions (Proof of the theorem on partial fraction decomposition need not be discussed), The Exponential, Trigonometric and Hyperbolic Functions, The Logarithmic Function, Complex Powers and Inverse Trigonometric Functions.
The topics to be discussed in this module can be found in chapter 3, sections 3.1, 3.2, 3.3, 3.5 of text [1] *below.*

Module III (30)
Complex Integration : Contours, Contour Integrals, Independence of Path, Cauchy's Integral Theorem (Section 4.4a on deformation of Contours Approach is to be discussed, but section 4.4 b on Vector Analysis Approach need not be discussed), Cauchy's Integral Formula and Its Consequences, Bounds of Analytic Functions
The topics to be discussed in this module can be found in chapter 4, sections 4.1, 4.2, 4.3, 4.4a, 4.5 and 4.6 of text [1] *below.*

Texts

Text 1 – Edward B. Saff, Arthur David Snider. *Fundamentals of complex analysis with applications to engineering and science*, 3rd Edition, Pearson Education India

References

Ref. 1 – John H Mathews, Russel W Howell. *Complex Analysis for Mathematics and Engineering*, Jones and Bartlett Publishers

Ref. 2 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

Ref. 3 – James Brown, Ruel Churchill. *Complex Variables and Applications*, Eighth Edition, McGraw-Hill

Semester V

Abstract Algebra – Group Theory

CODE: MM 1543 Instructional hours per week: 5
No.of credits: 4

The aim of this course is to provide a very strong foundation in the theory of groups. All the concepts appearing in the course are to be supported by numerous examples mainly from the references provided.

Module I (30 Hours)
The concept of group is to be introduced before rigorously defining it. The symmetries of a square can be a starting point for this. After that, definition of group should be stated and should be clarified with the help of examples. After discussing various properties of groups, finite groups and their examples should be discussed. The concept of subgroups with various characterizations also should be discussed. After introducing the definition of cyclic groups, various examples, and important features of cyclic groups and results on order of elements in such groups should be discussed.
The topics to be discussed in this module can be found in chapter 1, 2 3 and 4 of text [1] *below.*

Module II (24 Hours)
This module starts with defining and analysing various properties permutation groups which forms one of the most important class of examples for non abelian, finite groups. After defining operations on permutations, their properties are to be discussed. To motivate the students, the example of check-digit scheme should be discussed (This section on check-digit scheme is not meant for the examinations). Then we proceed to define the notion of equivalence of groups viz. isomorphisms. Several examples are to be discussed for explaining this notion. The properties of isomorphisms are also to be discussed together with special classes of isomorphisms like automorphisms and inner automorphisms before finishing the module with the classic result of Cayley on finite groups.
The topics to be discussed in this module can be found in chapter 5 and 6 of text [1] *below.*

Module III (18 Hours)
In this module we prove one of the most important results in group theory which is the Langrange's theorem on counting cosets of a finite group. The concept of cosets of a group should be defined giving many examples before proving the Lagrange's theorem. As some of the applications of this theorem, the connection between permutation groups and rotations of cube and soccer ball should be discussed. The section on Rubik's cube and section on internal direct products need not be discussed.
The topics to be discussed in this module can be found in chapter 7 and 9 of text [1] *below.*

Module IV (18 Hours)

Here the concept of group homomorphisms should be defined with sufficient number of examples. After proving the first isomorphism theorem, the fundamental theorem of isomorphism should be introduced and proved. Classifying groups based on the fundamental theorem should be discussed in detail.
The topics to be discussed in this module can be found in chapter 10 and 11 of text [1] *below.*

Texts

Text 1 – Joseph Gallian. *Contemporary Abstract Algebra*, 8th Edition, Cengage Learning

References

Ref. 1 – D S Dummit, R M Foote. *Abstract Algebra*, 3rd Edition, Wiley

Ref. 2 – I N Herstein. *Topics in Algebra*, Vikas Publications

Semester V

Differential Equations

CODE: MM 1544 — Instructional hours per week: 3
No.of credits: 3

In this course, we discuss how differential equations arise in various physical problems and consider some methods to solve first order differential equations and second order linear equations. For introducing the concepts, text [1] may be used, and for strengthening the theoretical aspects, reference [1] may be used.

Module I - First order ODE (18 hours)
In this module we discuss first order equations and various methods to solve them. Sufficient number of exercises also should be done for understanding the concepts thoroughly. The main topics in this module are the following:
Modelling a problem, basic concept of a differential equation, its solution, initial value problems, geometric meaning (direction fields), seperable ODE, reduction to seperable form, exact ODEs and integrating factors, reducing to exact form, homogeneous and non homogeneous linear ODEs, special equations like Bernoulli equation, orthogonal trajectories, understanding the existence and uniqueness of solutions theorem.
The topics to be discussed in this module can be found in chapter 1 of text [1] *below.*

Module II - Second order ODE (18 hours)
As in the first module, we discuss second order equations and various methods to solve them. Sufficient number of exercises also should be done for understanding the concepts thoroughly. The main topics in this module are the following:
homogeneous linear ODE of second order, initial value problem, basis, and general solutions, finding a basis when one solution is known, homogeneous linear ODE with constant coefficients (various cases that arise depending on the characteristic equation), differential operators, Euler-Cauchy Equations, existence and uniqueness of solutions w.r. to wronskian, solving nonhomogeneous ODE via the method of undetermined coefficients, varius applications of techniques, solution by variation of parameters.
The topics to be discussed in this module can be found in chapter 2 of text [1] *below.*

Texts

Text 1 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

References

Ref. 1 – G. F. Simmons. *Differential Equations with applications and Historical notes*, Tata McGraw-Hill, 2003

Ref. 2 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 3 – Peter V. O' Neil. *Advanced Engineering Mathematics*, Thompson Publications, 2007

Semester V

Mathematics Software – LaTeX & SageMath

CODE: MM 1545 Instructional hours per week: 4
No.of credits: 3

Here we introduce two software which are commonly used by people working in Mathematics – a science typesetting software LaTeX, and a mathematical computation and visualization software SageMath. The aim of introducing LaTeX software is to enable students to typeset the project report which is a compulsory requirement for finishing their undergraduate mathematics programme succesfully. The aim of learning SageMath is to enable students to see how the computational techniques they have learned in the previous semesters can be put into action with the help of software so as to reduce human effort. Also, they should be able to use this software for further computations in their own in the forthcoming semester.

Module I - LaTeX for prearing a project report in Mathematics (36 Hours)

Graphical User Interface (GUI)/ Edtitor like Kile or TeXstudio should be used for providing training to the students. The main topics in this module are following:

Typesetting a simple article and compiling it;

How spaces are treated in the document;

Document layout : various options to be included in the `documentclass` command, page styles, splitting files into smaller files, breaking line and page, using boxes (like, `mbox`) to keep text unbroken across lines, dividing document in to parts like frontmatter, mainmatter, backmatter, chapters, sections, etc, cross referencing with and without page number, adding footnotes;

Emphasizing words with `\emph, \texttt, \textsl, \textit, \underline` etc.

Basic environments like `enumerate, itemize, description, flushleft, flusuright, center, quote, quotation`

Controlling enumeration via the `enumerate` package.

Tables : preparing a table and floating it, the longtable environment;

Typesetting mathematics : basic symbols, equations, operators, the `equation` environment and reference to it, the `displaymath` environment, exponents, arrows, basic functions, limits, fractions, spacing in the mathematics environments, matrices, aligning various objects, multi-equation environments, suppressing numbering for one or more equations, handling long equations, phantoms, using normal text in math mode, controlling font size, typesetting theorems, defintions, lemmas, etc, making text bold in math mode, inserting symbols and environments (`array, pmatrix` etc) using the support of GUIs;

Figures : Including JPG, PNG graphics with `graphicx` package, controlling width, height etc, floating figures, adding captions, the wrapfig package;

Adding references/bibliogrpahy and citing them, using the package `hyperref` to add and control hypertext links, creating presentations with `pdfscreen`, creating new commands;

Fonts : changing font size, various fonts, math fonts,

Spacing : changing line spacing, controlling horizontal, vertical spacing, controlling the margins using the geometry package, fullpage package

Preparing a dummy project with `titlepage`, acknowledgement, certificates, table of contents (using `\tableofcontents`), list of tables, table of figures, chapters, sections, bibliography (using the `thebibliography` environment). This dummy project should contain atleast one example from the each of the topic in the syllabus, and should be submitted for internal evaluation before the end semester practical examination.

Module II - Doing Mathematics with SageMath (36 hours)

Starting SageMath using a browser, how to use the sage cell server `https://sagecell.sagemath.org/`, how to use SageMathCloud, creating and saving a sage worksheet, saving the worksheet to an .sws file, moving it and re-opening it in another computer system;

Using sagemath as a calculator, basic functions (square root, logarithm, numeric value, exponential, trigonometric, conversion between degrees and radians, etc.);

Plotting : simple plots of known functions, controlling range of plots, controlling axes, labels, gridlines, drawing multiple plots on a single picture, *adding* plots, polar plotting, plotting implicit functions, contour plots, level sets, parametric 2D plotting, vector fields plotting, gradients;

Matrix Algebra : Adding, multiplying two matrices, row reduced echelon forms to solve linear system of equations, finding inverses of square matrices, determinants, exponentiation of matrices, computing the kernel of a matrix;

Defining own functions and using it, composing functions, multi variate functions;

Polynomials : Defining polynomials, operations on them like multiplication and division, expanding a product, factorizing a polynomial, finding gcd;

Solving single variable equations, declaring multiple variables, solving multi variable equations, solving system of non linear equations, finding the numerical value of roots of equations;

complex number arithmetic, finding complex roots of equations;

Finding derivatives of functions, higher order derivatives, integrating functions, definite and indefinite integrals, numerical integration, partial fractions and integration,

Combinatorcs & Number theory: Permutations, combinations, finding gcd, lcm, prime factorization, prime counting function, n^{th} prime funcion, divisors of a number, counting divisors, modular arithmetic;

Vector calculus : Defining vectors, operations like sum, dot product, cross product, vector valued functions, divergence, curl, multiple integrals;

Computing Taylor, McClaurins polynomials, minimization and Lagrange multipliers, constrained and unconstrained optimization;

Internal Evaluation : A dummy project report prepared in LaTeX should be submitted as assignment for internal evaluation for 5 marks. Another practical record should be submitted the content of which should be problems and their outputs evaluated using SageMath. This record should be awarded a maximum of 10 marks which is earmarked for the internal evaluation examination.

Problems to be included in the examination:

1. Find all local extrema and inflection points of a function
2. Traffic flow optimization
3. Minimum surface area of packaging
4. Newton's method for finding approximate roots
5. Plotting and finding area between curves using integrals
6. Finding the average of a function
7. Finding volume of solid of revolution
8. Finding solution for a system of linear equations
9. Finding divergence and curl of vector valued functions
10. Using differential calculus to analyze a quintic polynomials features, for finding the optimal graphing window
11. Using Pollard's $p - 1$ Method of factoring integers, to try to break the RSA cryptosystem
12. Expressing gcd of two integers as a combination of the integers (Bezout's identity)

References

Ref. 1 – Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlegl. *The (Not So) Short Introduction to LaTeX2e*, Samurai Media Limited (or available online at `http://mirrors.ctan.org/info/lshort/english/lshort.pdf`)

Ref. 2 – Leslie Lamport. *LaTeX: A Document Preparation System*, Addison-Wesley, Reading, Massachusetts, second edition, 1994

Ref. 3 – *LaTeX Tutorials—A Primer*, Indian TeX Users Group, available online at `https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf`

Ref. 4 – H. J. Greenberg. *A Simplified introduction to LaTeX*, available online at `https://www.ctan.org/tex-archive/info/simplified-latex/`

Ref. 5 – *Using Kile - KDE Documentation*, `https://docs.kde.org/trunk4/en/extragear-office/kile/quick_using.html`

Ref. 6 – *TeXstudio : user manual*, `http://texstudio.sourceforge.net/manual/current/usermanual_en.html`

Ref. 7 – *The longtable package - TeXdoc.net*, `http://texdoc.net/texmf-dist/doc/latex/tools/longtable.pdf`

Ref. 8 – *wrapfig - TeXdoc.net*, `http://texdoc.net/texmf-dist/doc/latex/wrapfig/wrapfig-doc.pdf`

Ref. 9 – *The geometry package*, `http://texdoc.net/texmf-dist/doc/latex/geometry/geometry.pdf`

Ref. 10 – *The fullpage package*, http://texdoc.net/texmf-dist/doc/latex/preprint/fullpage.pdf

Ref. 11 – *The SageMathCloud*, https://cloud.sagemath.com/

Ref. 12 – Gregory V. Bard. *Sage for Undergraduates*, American Mathematical Society, available online at http://www.gregorybard.com/Sage.html

Ref. 13 – Tuan A. Le and Hieu D. Nguyen. *SageMath Advice For Calculus* available online at http://users.rowan.edu/~nguyen/sage/SageMathAdviceforCalculus.pdf

Semester V

Operations Research (Open Course)

CODE: MM 1551.1 — Instructional hours per week: 3
No. of Credits: 2

Module I – Linear Programming (18 hours)
Formulation of Linear Programming models, Graphical solution of Linear Programs in two variables, Linear Programs in standard form - basic variable - basic solution- basic feasible solution -feasible solution, Solution of a Linear Programming problem using simplex method (Since Big-M method is not included in the syllabus, avoid questions in simplex method with constraints of $\geq$ or $=$ type.)

Module II – Transportation Problems (18 hours)
Linear programming formulation - Initial basic feasible solution (Vogel'sapproximation method/North-west corner rule) - degeneracy in basic feasible solution - Modified distribution method - optimalitytest.

ASSIGNMENT PROBLEMS: Standard assignment problems - Hungarian method for solving an assignment problem.

Module III – Project Management (18 hours)
Activity -dummy activity - event - project network, CPM (solution by network analysis only), PERT.

The topics to be discussed in this course can be found in text [1].

Texts

Text 1 – Ravindran, Philps, Solberg. *Operations Research- Principles and Practice*, 2nd Edition, Wiley India Pvt Ltd

References

Ref. 1 – Hamdy A. Taha. *Operations Research : An Introduction*, 9th Edition, Pearson

Semester V

Business Mathematics (Open Course)

CODE: MM 1551.2 — Instructional hours per week: 3
No. of Credits: 2

Module I – Basic Mathematics of Finance (18 hours)
Nominal rate of Interest and effective rate of interest, Continuous Compounding, force of interest, compound interest calculations at varying rate of interest, present value, interest and discount, Nominal rate of discount, effective rate of discount, force of discount, Depreciation.
(Chapter 8 of Unit I of text [1] - Sections: 8.1, 8.2, 8.3, 8.4. 8.5, 8.6, 8.7, 8.9)

Module II – Differentiation and their applications to Business and Economics (18 hours)
Meaning of derivatives, rules of differentiation, standard results (basics only for doing problems of chapter 5 of Unit 1)
(Chapter 4 of unit I of text [1] - Sections: 4.3, 4.4, 4.5, 4.6)
Maxima and Minima, concavity, convexity and points of inflection, elasticity of demand, Price elasticity of demand
(Chapter 5 of Unit I of text [1] - Sections: 5.1, 5.2, 5.3, 5.4, 5.5. 5.6, 5.7)
Integration and their applications to Business and Economics: Meaning, rules of integration, standard results, Integration by parts, definite integration (basics only for doing problems of chapter 7 of Unit 1 of text)
(Chapter 6 of unit I of text [1] - Sections: 6.1, 6.2, 6.4, 6.10, 6.11)
Marginal cost, marginal revenue, Consumer's surplus, producer's surplus, consumer's surplus under pure competition, consumer's surplus under monopoly
(Chapter 7 of unit I of text [1] - Sections: 7.1, 7.2, 7.3, 7.4, 7.5)

Module III – Index Numbers (18 hours)
Definition, types of index numbers, methods of construction of price index numbers, Laspeyer's price index number, Paasche's price index number, Fisher ideal index number, advantages of index numbers, limitations of index numbers
(Chapter 6 of Unit II of text [1] - Sections: 6.1, 6.3, 6.4, 6.5, 6.6, 6.8, 6.16, 6.17)
Time series: Definition, Components of time series, Measurement of Trend
(Chapter 7 of Unit II of text [1] - Sections: 7.1, 7.2, 7.4)

Texts

Text 1 – B M Agarwal. *Business Mathematics and Statistics*, Vikas Publishing House, New Delhi, 2009

References

Ref. 1 – Qazi Zameeruddin, et al . *Business Mathematics*, Vikas Publishing House, New Delhi, 2009

Ref. 2 – Alpha C Chicny, Kevin Wainwright. *Fundamental methods of Mathematical Economics*, 4th Edition, Mc-Graw Hill

Semester V

Basic Mathematics (Open Course)

CODE: MM 1551.3 Instructional hours per week: 3
No. of Credits: 2

This course is specifically designed for those students who might have not undergone a mathematics course beyond their secondary school curriculum. The structure of the course is so as to give an exposure to the basic mathematics tools which found a use in day today life, say in the fields general finance and basic sciences.

Module I : Basic arithmetic of whole numbers, fractions and decimals (24 hours)

Place Value of numbers, standard Notation and Expanded Notation, Operations on whole numbers : exponentiation, square roots, order of operations, computing averages, rounding, estimation, applications of estimation, estimating product of numbers by rounding, exponents, square roots, order of operations, computing averages;

Fractions: multiplication and division of fractions, applications, primes and composites, factorization, simplifying fractions to lowest terms, multiplication of fractions, reciprocal of fractions, division of fractions, operations of mixed fractions, LCM,

Decimal notation and rounding of numbers, fractions to decimals, multiplication of decimals, division of decimals, order of operations involving decimals,

Scientific notation of numbers, operations in scientific notations, square and cube roots of numbers, laws of exponents and logarithms

The topics to be discussed in this module can be found in chapters 1–3 of text [1] *and chapters 1 and 2 of* text [2] *below.*

Module II - Ratios, proportions, percents and the relation among them (15 hours)

Ratio and proportions : Simplifying ratios to lowest terms, ratios of mixed numbers, unit rates and cost, ratios and proportion, similar figures;

Percents: Fractions - decimals - percents, converting between these three relation with proportions, equations involving percents, increase and decrease in percent, finding simple and compound interests

The topics to be discussed in this module can be found in chapters 4, 5 of text [1] *below.*

Module III – Basic Statistics, Simple Equations (15 hours)

Basic Statistics : Data and tables, various graphs like bar graphs, pictographs, line graphs, frequency distributions and histograms, circle graphs (pie charts), interpreting them, circle graphs and percents, mean, median, mode, weighted mean

Solving simple equations, quadratic equations (real roots only), cubic equations, arithmetic geometric series, systems of two and three equations, matrices and system of equations

The topics to be discussed in this module can be found in chapters 9 of text [1] *and chapters 2, 3 of* text [2] *below.*

Texts

Text 1 – J Miller, M O'Neil, N Hyde. *Basic College Mathematics*, 2nd Edition, McGraw Hill Higher Education

Text 2 – Steven T Karris. *Mathematics for Business, Science and Technology*, 2nd Edition, Orchard Publications

References

Ref. 1 – Charles P McKeague. *Basic Mathematics*, 7th Edition, Cengage Learning

Semester V

Project preparation - From selecting the topic to presenting the final report

Instructional hours per week: 1

To complete the undergraduate programme, the students should undertake a project and prepare and submit a project report on a topic of their choice in the subject mathematics or allied subjects. The work on the project should start in the beginning of the 5th semester itself, and should end towards the middle of the 6th semester. This course (without any examination in the 5th semester, with a project report submissin and project viva in the 6th semester) is introduced for making the students understand various concepts behind undertaking such a project and preparing the final report. Towards the end of this course the students should be able to choose and prepare topics in their own and they should understand the layout of a project report.

To quickly get into the business, the first chapter of text [1] may be completely discussed. Apart from that, for detailed information, the other chapters in this book may be used in association with the other references given below. The main topics to discuss in this course are the following:

Quick overview : The structure of Dissertation, creating a plan for the Dissertation, planning the results section, planning the introduction, planning and writing the abstract, composing the title, figures, tables, and appendices, references, making good presentations, handling resources like notebooks, library, computers etc., preparing an interim report.

Topics in detail : Planning and Writing the Introduction, Planning and Writing the Results, Figures and Tables, Planning and Writing the Discussion, Planning and Writing the References, Deciding On a Title and Planning and Writing the Other Bits, Proofreading, Printing, Binding and Submission, oral examinations, preparing for viva, Taking the Dissertation to the Viva

Layout : Fonts and Line Spacing, Margins, Headers, and Footers, Alignment of Text, Titles and Headings, Separating Sections and Chapters

Texts

Text 1 – Daniel Holtom, Elizabeth Fisher. *Enjoy Writing Your Science Thesis or Dissertation – A step by step guide to planning and writing dissertations and theses for undergraduate and graduate science students*, Imperial College Press

References

Ref. 1 – Kathleen McMillan, Jonathan Weyers. *How to write Dissertations & Project Reports*, Pearson Education Limited

Ref. 2 – Peg Boyle Single. *Demystifying dissertation writing : a streamlined process from choice of topic to final text*, Stylus Publishing, Virginia

Semester VI

Real Analysis – II

CODE: MM 1641 Instructional hours per week: 5
No.of credits: 4

In the second part of the Real Analysis course, we focus on functions on $\mathbb{R}$, their continuity, existence of derivatives, and integrability. The course is mainly based on Chapters 4,5 and 7 of text [1].

All the chapters mentioned above contains a section titled *Discussions* in the beginning of the chapter. These sections are intended only for motivating the students, and so should not be made a part of the examination process.

Module I (35 Hours)

Here we move towards the basic notion of limits of functions and their continuity. Various version of definition of limits are to be discussed here. The algebra of limits of functions and the divergence criterion for functional limits are to be discussed next. The other topics to be discussed in this module are the discontinuity criterion, composition of functions and continuity, continuity and compct sets, results on uniform continuity, the intermediate value theorem, Monotone functions and their continuity.

The topics to be discussed in this module can be found in chapter 4 of text [1] *below. The first section 4.1 may be briefly discussed and is not meant for examination purposes.*

Module II (25 hours)

Here we discuss the derivative concept more rigorously than what was done in the previous calculus courses. After (re)introducing the definition of differentiability of functions, we verify that differentiability implies continuity. Algebra and composing of differentiable functions should be discussed next. The interior extremum theorem and Darboux's theorem should be discussed after that. The mean value theorems should be discussed and proved, and the module ends with L'Hospitals results. A continuous everywhere but notwhere differentiable function should be discussed, but it is not meant for the examination. It may be infact used for student seminars.

The topics to be discussed in this module can be found in chapter 5 of text [1] *below. The sections 5.1 and 5.4 may be briefly discussed and is not meant for examination purposes.*

Module III (30 hours)

In the last module, the theory of Riemann integration is to be discussed. Main topics to be included in this module are defining the Riemann integral using upper, lower Riemann sums, and the integrability criterion, continuity and the existence of integral, algebraic operations on integrable functions, (The results and examples on convergence of sequence of functions and integrability may be omitted), the fundamental theorem of calculus and its proof, Lebesgue's criterion for Riemann integrability.

The topics to be discussed in this module can be found in chapter 7 of text [1] *below. The first section 7.1 may be briefly discussed and is not meant for examination purposes.*

Texts

Text 1 – Stephen Abbot; *Understanding Analysis*, 2nd Edition, Springer

References

Ref. 1 – R G Bartle, D Sherbert ; *Introduction to real analysis*, 3rd Edition, John Wiley & Sons

Ref. 2 – W. Rudin, *Principles of Mathematical Analysis*, Second Edition, McGraw-Hill

Ref. 3 – Terrence Tao; *Analysis I*, Hindustan Book Agency

Semester VI

Complex Analysis – II

CODE: MM 1642 Instructional hours per week: 4
No.of credits: 3

Module I (32 Hours)
Series Representations for Analytic Functions : Sequences and Series, Taylor Series, Power Series, Mathematical Theory of Convergence, Laurent series, Zeros and Singularities, The point at Infinity. *The topics to be discussed in this module can be found in chapter 5, sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7 of* text [1] *below.*

Module II (20 Hours)
Residue Theory : The Residue Theorem, Trigonometric Integrals over $[0, 2\pi]$, Improper integrals of Certain functions over $[-\infty, \infty]$, Improper integrals involving Trigonometric Functions, Indented Contours
The topics to be discussed in this module can be found in chapter 6, sections 6.1, 6.2, 6.3, 6.4, 6.5 of text [1] *below.*

Module III (20 Hours)
Conformal Mapping : Geometric Considerations, Mobius Transformations
The topics to be discussed in this module can be found in chapter 7, sections 7.2, 7.3, 7.4 of text [1] *below.*

Texts

Text 1 – Edward B. Saff, Arthur David Snider. *Fundamentals of complex analysis with applications to engineering and science*, 3rd Edition, Pearson Education India

References

Ref. 1 – John H Mathews, Russel W Howell. *Complex Analysis for Mathematics and Engineering*, 6th Edition, Jones and Bartlett Publishers

Ref. 2 – Murray R Spiegel. *Complex variables: with an introduction to conformal mapping and its applications*, Schaum's outline.

Ref. 3 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

Ref. 4 – James Brown, Ruel Churchill. *Complex Variables and Applications*, Eighth Edition, McGraw-Hill

Semester VI

Abstract Algebra – Ring Theory

CODE: MM 1643 Instructional hours per week: 4
No.of credits: 3

After discussing the theory of groups thoroughly in the previous semester, we move towards the next higher algebraic structure rings. As in the last semester, all the new concepts appearing in the course is to be supported by numerous examples mainly from the references provided.

Module I (24 Hours)
The concept of rings, subrings with many examples should be discussed here. Next comes the definition and properties of integral domains, fields, and the characteristic of rings. Ideals, how factor rings are defined using ideals, should be explained next. The definition of prime and maximal ideals with examples should be discused after that.
The topics to be discussed in this module can be found in chapter 12, 13 and 14 of text [1] *below.*

Module II (24 Hours)
After introducing the definition of ring homomorphisms, their properties should be discussed. The field of quotients of an integral domain should be discussed next. The next topic is the definition and various properties of polynomial rings over a commutative ring. Various results on operations on polynomials such as division algorithm, factor theorem, remainder theorem etc should be discussed next. The definition and examples of PID's should be discussed next, before moving to the factorization of polynomials. Tests of irreducibility and reducibility and the unique factorization of polynomials over special rings should be discused. .
The topics to be discussed in this module can be found in chapter 15, 16 and 17 of text [1] *below.*

Module III (24 Hours)
In the last module, we introduce more rigorous topics like various type of integral domains. The divisibility properties of integral domains and definition of primes in a general ring should be introduced. Unique factorization domains and the Euclidean domains should be discussed next with examples. Results on these special integral domains are aslo to be discussed.
The topics to be discussed in this module can be found in chapter 18 of text [1] *below.*

Texts

Text 1 – Joseph Gallian; *Contemporary Abstract Algebra*, 8th Edition, Cengage Learning

References

Ref. 1 – D S Dummit, R M Foote; *Abstract Algebra*, 3rd Edition, Wiley

Ref. 2 – I N Herstein, *Topics in Algebra*, Vikas Publications

Semester VI

Linear Algebra

CODE: MM 1644 Instructional hours per week: 5
No.of credits: 4

The main focus of this course is to introduce linear algebra and methods in it for solving practical problems.

Module I (15 Hours)
This module deals with a study on linear equations and their geometry. After introducing the geometrical intrepretation of linear equations, following topics should be discussed: various operations on column vectors, technique of Gaussian elimination, operations involving elementary matrices, interchanging of rows using elementary matrices, triangular factorisation of matrices and finding inverse of matrices by the elimination method.
The topics to be discussed in this module can be found in chapter 1 of text [1] *below. The section 1.7 may be omitted.*

Module II (25 hours)
Towards the study of vector spaces, specifically $\mathbb{R}^n$, we define them with many examples. Subspaces are to be defined next. After discussing the idea of nullspace of a matrix. The solving linear equations (which was one to some extent in the first module) and finding solutions to non-homogeneous systems from the corresponding homogeneous systems. After this, linear independence and dependence of vectors, their spanning, basis for a space, its dimension concepts are to be introduced. The column, row, null, left null spaces of a matrix is to be discussed next. When inverses of a matrix exists related to its column/row rank should be discussed. Towards the end of this module, linear transformations (through matrices) and their properties are to be discussed. Types of transformations like rotations, projections, reflections are to be considered next.
The topics to be discussed in this module can be found in chapter 2 of text [1] *below. The section 2.7 on graphs and networks may be omitted.*

Module III (25 hours)
This module is intended for making the idea and concepts of determinants stronger. Its properties like what happens when rows are interchanged, linearlity of expansion along the first row, etc are to be discussed. Breaking a matrix into triangular, diagonal forms and finding the determinants, expansion in cofactors, their applications like solving system of equations, finding volume etc are to be discussed next.
The topics to be discussed in this module can be found in chapter 4 of text [1] *below.*

Module IV (25 hours)
Here we conclude our analysis of matrices. The problem of finding eigen values a matrix is to be introduced first. Next goal is to diagonalize a matrix. This concept should be

discussed first, and move to the discussion on the use of eigen vectors in diagonalization. Applications of finding the powers of matrices should be discussed next. The applications like the concept of Markov Matrices, Positive Matrices and their applications in Economics should be discussed. Complex matrices and operations on them are to be introduced next. The concept orthoganality of vectors may be required here from one of the previous sections in text [1] and it should be briefly introduced and discussed here. The module ends with similar matrices, and similarity transformation related ideas. How to diagonalize some special matrices like symmetric and Hermitial matrices are also to be discussed in this module.
The topics to be discussed in this module can be found in chapter 5 of text [1] *below. The section 5.4 on applications to differential equations may be omitted*

Texts

Text 1 – Gilbert Strang, *Linear Algebra and Its Applications*, 4th Edition, Cengage Learning

References

Ref. 1 – *Video lectures of Gilber Strang Hosted by MITOpenCourseware* available at `https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/`

Ref. 2 – Thomas Banchoff, John Wermer; *Linear Algebra Through Geometry*, 2nd Edition, Springer

Ref. 3 – T S Blyth, E F Robertson: *Linear Algebra*, Springer, Second Edition.

Ref. 4 – David C Lay: *Linear Algebra*, Pearson

Ref. 5 – K Hoffman and R Kunze: *Linear Algebra*, PHI

Semester VI

Integral Transforms

CODE: MM 1645 Instructional hours per week: 4
No.of credits: 3

After completing courses in ordinary differential equations and basic integral calculus, we see here some of its applications.

Module I (38 Hours)
Laplace Transforms : Laplace Transform. Linearity. First Shifting Theorem (s-Shifting), $s-$ Shifting: Replacing s by $s-a$ in the Transform, Existence and Uniqueness of Laplace Transforms, Transforms of Derivatives and Integrals. ODEs, Laplace Transform of the Integral of a Function, Differential Equations, Initial Value Problems, Unit Step Function (Heaviside Function), Second Shifting Theorem ($t-$Shifting) Time Shifting ($t-$Shifting): Replacing t by $t-a$ in $f(t)$, Short Impulses. Diracs Delta Function. Partial Fractions Convolution , Application to Nonhomogeneous Linear ODEs, Differentiation and Integration of Transforms, ODEs with Variable Coefficients, Integration of Transforms, Special Linear ODEs with Variable Coefficients, Systems of ODEs
The topics to be discussed in this module can be found in sections 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7 of text [1] below.

Module II (34 hours)
Fourier Series, Basic Examples, Derivation of the Euler Formulas, Convergence and Sum of a Fourier Series, Arbitrary Period. Even and Odd Functions. Half-Range Expansions From Period 2π to any Period $P = 2L$, Simplifications: Even and Odd Functions, Half-Range Expansions, Fourier Integral, From Fourier Series to Fourier Integral, Applications of Fourier Integrals, Fourier Cosine Integral and Fourier Sine Integral, Fourier Cosine and Sine Transforms, Linearity, Transforms of Derivatives, Fourier Transform, Complex Form of the Fourier Integral, Fourier Transform and Its Inverse, Linearity. Fourier Transform of Derivatives, Convolution.
The topics to be discussed in this module can be found in Sections 11.1, 11.2, 11.7, 11.8, 11.9 (Excluding Physical Interpretation: Spectrum and Discrete Fourier Transform (DFT),Fast Fourier Transform (FFT)) of text [1] below.

Texts

Text 1 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

References

Ref. 1 – Peter V. O' Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007

Ref. 2 – M Greenberg, *Advanced Engineering Mathematics*, 2nd Edition, Prentice Hall

Semester VI

Graph Theory (Elective)

CODE: MM 1661.1 Instructional hours per week: 3
No. of credits: 2

Overview of the Course: The course has been designed to build an awareness of some of the fundamental concepts in Graph Theory and to develop better understanding of the subject so as to use these ideas skillfully in solving real world problems.

Module I (27 Hours)

Basics : The Definition of a Graph, Graphs as Mathematical Models, other basic concepts and definitions, Vertex Degrees, Subgraphs, Paths and Cycles, The Matrix Representation of Graphs, Fusing graphs (The fusion algorithm for connectedness need not be discussed).

Trees and Connectivity : Definitions and Simple Properties of trees, Bridges, Spanning Trees, Cut Vertices and Connectivity *The topics in this module can be found in Chapter 1, Sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7 and 1.8, Chapter 2, Sections 2.1, 2.2, 2.3 and 2.6 of* text [1].

Module II (27 Hours)

Euler Tours and Hamiltonian Cycles : Euler Tours (Fleury's algorithm need not be discussed), The Chinese Postman Problem (Only Statement of the problem is to be discussed) , Hamiltonian Graphs, The Travelling Salesman Problem (Only Statement of the problem is to be discussed, The Two-Optimal Algorithm and The Closest Insertion Algorithm need not be discussed)

Planar Graphs : Plane and Planar Graphs, Euler's Formula, The Platonic Bodies, Kuratowski's Theorem (Without proof).

The topics in this module can be found in Chapter 3, Sections 3.1, 3.2, 3.3 and 3.4, Chapter 5, Sections 5.1, 5.2, 5.3 and 5.4 of text [1].

Texts

Text 1 – John Clark, Derek Allan Holton. *A first look at Graph Theory*, World Scientific

References

Ref. 1 – R Balakrishnan, Ranganatahan. *A Text Book of Graph Theory*, 2nd Edition, Springer

Ref. 2 – V Balakrishnan. *Graph Theory*, Schaums Outline

Ref. 3 – J A Body, U S R Murthy. *Graph Theory with Applications*, The Macmillan Press

Ref. 4 – Robin J Wilson. *Introduction to Graph Theory* 5th edition, Prentice Hall

Semester VI

Linear Programming with SageMath (Elective)

CODE: MM 1661.2 Instructional hours per week: 3
No. of credits: 2

This course is aimed at providing an introduction to linear programming and solving problems in it using very basic methods.

Note :

1. There should not be any problems to solve using the SageMath software in the End Semester Examination (ESE). The ESE should be based only on the theory and problems to be solved either manually or using a non programmable scientific calculator.
2. Students may be permitted to use non programmable scientific calculator in the end semester examination.
3. One of the internal evaluation examinations should be done using SageMath Software, as a practical examination.

Module I (18 Hours)

This module is aimed at providing a strong introduction to various type of problems that can be solved via linear programming. Main topics in this module are the following:
Introduction to linear programming through problems, basic underlying assumptions like Proportionality, Divisibility, Additivity, Certainty, more general problems, standard form of a linear program, conversion rules to arrive at such a form like Converting unrestricted variables, Converting inequality constraints, Converting maximization to minimization, their examples, standard linear programming terminology, examples on planning, transportation, assignment, workforce scheduling, portfolio optimization, Minimum Cost Flow Problem, Maximum Flow Problem.
The topics to be discussed in this module can be found in chapter 1 of text [1] *below.*

Module II (18 hours)

This module begins with the geometry of linear programming and later proceeds to the Fundamental Theorem of Linear Programming which is a basis for algorithm development for linear programs. The main topics in this module are the following:
Geometry of the Feasible Set, graphically representing the solution space, hyperplane, polyhedron, polytope, convex sets, geometry of optimal solutions, geometric characterisaion of optimality, extreme points and basic feasible solutions, generating basic feasible solutions, resolution theorem, fundamental theorem linear programming.
The topics to be discussed in this module can be found in chapter 2 of text [1] *below.*

Module III (18 hours)

Here we introduce the simplex method, which is an important method to solve linear programming problems. The main topics in this module are the following:
Introducing the simplex method, examples, adjacent basic feasible solutions, checking optimality of a basic feasible solution, direction-step length theorem, its application in developing the steps of simplex method, examples, finite termination under non-degeneracy, generating an initial basic feasible solution using two phase and Big M method, degeneracy and cycling, anti-cycling rules like Bland's rule, and lexicographic rules.
The topics to be discussed in this module can be found in chapter 3 of text [1] *below.*

All the problems in this course should be computationally also solved using the software SageMath. The references provided below, especially text [2] and chapter 4 of text [3] can be used mainly for this.

Texts

Text 1 – Roy H Kwon. *Introduction to Linear Optimization and extensions with MATLAB*, 4th Edition, CRC Press, New York

Text 2 – *Sage Reference Manual: Numerical Optimization, Release 7.6* by the Sage Development Team available online at `http://doc.sagemath.org/pdf/en/reference/numerical/numerical.pdf`

Text 3 – Gregory V. Bard. *Sage for Undergraduates*, American Mathematical Society, available online at `http://www.gregorybard.com/Sage.html`

References

Ref. 1 – Frederick S Hillier, Gerald J Lieberman. *Introduction to operations research*, 10th Edition, McGraw Hill Education

Ref. 2 – Paul R Thie, G. E. Keough. *An introduction to linear programming and game theory*, 3rd Edition, John Wiley & Sons

Ref. 3 – Wayne L Winston, *Operations Research Applications and Algorithms*, 4th Edition, Cengage Learning

Semester VI

Numerical Analysis with SageMath (Elective)

CODE: MM 1661.3 Instructional hours per week: 3
No. of credits: 2

This course is aimed at providing an introduction to Numerical analysis with particular emphasize to finding approximate solutions to problems like finding roots of equations, numerically evaluating differential and integral equations, finding polynomials from values that approximate a given function, solving systems of linear equations etc. SageMath can be used as the software for supporting computations.

Note :

1. There should not be any problems to solve using the SageMath software in the End Semester Examination (ESE). The ESE should be based only on the theory and problems to be solved either manually or using a non programmable scientific calculator.
2. Students may be permitted to use non programmable scientific calculator in the end semester examination.
3. One of the internal evaluation examinations should be done using SageMath Software, as a practical examination.

Module I (27 Hours)

General concepts in Numerical analysis : Introduction, Floating-Point Form of Numbers, Round off, Loss of Significant Digits, Errors of Numeric Results, Error Propagation, Basic Error Principle, Algorithm Stability.

Solution of Equations by Iteration : Fixed-Point Iteration for Solving Equations $f(x) = 0$, Newton's Method for Solving Equations $f(x) = 0$, Order of an Iteration Method Speed of Convergence, Convergence of Newton's Method, Secant Method for Solving $f(x) = 0$.

Interpolation : Lagrange Interpolation, Newton's Divided Difference Interpolation, Equal Spacing: Newton's Forward Difference Formula, Equal Spacing: Newton's Backward Difference Formula, Spline Interpolation,

The topics to be discussed in this module can be found in chapter 19, sections 19.1, 19.2,19.3,19.4 of text [1] *below.*

Module II (27 hours)

Numerical Integration and Differentiation : Rectangular Rule. Trapezoidal Rule, Simpson's Rule of Integration, Adaptive Integration, Gauss Integration Formulas Maximum Degree of Precision, Numeric Differentiation.

Numerical Methods for Ordinary Differential Equations : Methods for First-Order ODEs, Picard's Iteration Method, Euler's method (Numeric Method) , Improved Euler Method, Runge-Kutta Methods (RK Methods) of fourth order.

Numerical Methods in Linear Algebra : Linear Systems: Gauss Elimination, Linear Systems: LU-Factorization, Matrix Inversion, Cholesky's Method, GaussJordan Elimination. Matrix Inversion. Linear Systems: Solution by Iteration, GaussSeidel Iteration Method, Jacobi Iteration
The topics to be discussed in this module can be found in chapter 19 section 1.2 and Problem set 1.7 CAS PROJECT. 6 , Chapter 19 Sections 19.5, Chapter 20, Sections 20.1, 20.2, 20.3, Chapter 21 Sections 21.1, of text [1] *below.*

All the problems in this course should be computationally also solved using the software SageMath. The references provided below, especially text [2] and chapter 4 of text [3] can be used mainly for this.

Texts

Text 1 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

Text 2 – *Sage Reference Manual: Numerical Optimization, Release 7.6* by the Sage Development Team available online at `http://doc.sagemath.org/pdf/en/reference/numerical/numerical.pdf`

Text 3 – Gregory V. Bard. *Sage for Undergraduates*, American Mathematical Society, available online at `http://www.gregorybard.com/Sage.html`

References

Ref. 1 – Richard L Burden, J Douglas Faires. *Numerical Analysis*, 9th Edition, Cengate Learning

Ref. 2 – E Isaacson, H B Keller. *Analysis of Numerical Methods*, Dover Publications, New York

Ref. 3 – W. Cheney, D Kincaid. *Numerical Mathematics and Computing*, 6th Edition, Thomson Brooks/Cole

Semester VI

Fuzzy Mathematics (Elective)

CODE: MM 1661.4 — Instructional hours per week: 3
No. of credits: 2

Module I (18 hours)
FROM CRISP SETS TO FUZZY SETS: A PARADIGM SHIFT.Introduction-crisp sets: an overview-fuzzy sets: basic types and basic concepts of fuzzy sets, Fuzzy sets versus crisp sets, Additional properties of cuts, Representation of fuzzy sets.

Module II (18 hours)
OPERATIONS ON FUZZY SETS AND FUZZY ARITHMETIC:Operations on fuzzy sets-types of operations, fuzzy complements, fuzzy intersections, t-norms, fuzzy unions, t-conorms. Fuzzy numbers, Linguistic variables, Arithmetic operations on intervals, Arithmetic operations on fuzzy numbers.

Module III (18 hours)
FUZZY RELATIONS :Crisp versus fuzzy relations, projections and cylindric extensions, Binary fuzzy relations, Binary relations on a single set, Fuzzy equivalence relations.

The topics to be discussed in this module can be found in
Chapter 1: Sections 1.1 to 1.4
Chapter 2: Sections 2.1 and 2.2
Chapter 3: Sections 3.1 to 3.4 (proof of theorems 3.7, 3.8, lemma 3.1, 3.2, theorems 3.11,3.12 3.13 need not be discussed)
Chapter 4: Sections 4.1 to 4.4
Chapter 5: Sections 5.1 to 5.5
of text [1] *below.*

Texts

Text 1 – George J Klir, Yuan. *Fuzzy sets and fuzzy logic: Theory and applications*, Prentice Hall of India Pvt. Ltd., New Delhi, 2000

References

Ref. 1 – Klir G J and T Folger. *Fuzzy sets, Uncertainty and Information*, PHI Pvt.Ltd., New Delhi, 1998

Ref. 2 – H J Zimmerman. *Fuzzy Set Theory and its Applications*, Allied Publishers, 1996

Ref. 3 – Dubois D and Prade H. *Fuzzy Sets and Systems: Theory and Applications*, Ac.Press, NY, 1988

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Physics

Semester I

Mathematics – I
(Calculus with applications in Physics – I)
Code: MM 1131.1

Instructional hours per week: 4 No. of Credits:3

Module 1: Differentiation with applications to Physics (18 Hours)
(*The following topics should be quickly reviewed before going to advanced topics; students should be asked to do more problems from exercises, and these problems should be included in assignments:*) Differentiation of products of functions; the chain rule; quotients; implicit differentiation; logarithmic differentiation; Leibnitz theorem
The following topics in this module should be devoted more attention and time.
Special points of a function (especially, stationary points); curvature; theorems of differentiation – Rolles', Mean Value Theorems
The topics in this module can be found in chapter 2, sections 2.1.2, to 2.1.7, text [1] *(Review of ideas through problems), chapter 2, sections 2.1.8, 2.1.9, 2.1.10,* text [1]
More exercises related to the topics in this module can be found in chapter 2 and chapter 3 of reference [1].

Module 2: Integration with applications to Physics (18 Hours)
Integration by parts; reduction formulae; infinite and improper integrals; plane polar coordinates; integral inequalities; applications of integration (finding area, volume etc)
The topics in this module can be found in chapter 2, sections 2.2.8 to 2.2.13, text [1]
More exercises related to the topics in this module can be found in chapter 4, chapter 5 and chapter 7 of reference [1].

Module 3: Infinite series and limits (18 Hours)
Definition, Summation of series of various types (Arithmetic series; geometric series; arithmetico-geometric series; the difference method; series involving natural numbers; transformation of series) Convergence of infinite series (Absolute and conditional convergence; series containing only real positive terms; alternating series test)
Operations with series (Sum and product)
Power series (Convergence of power series; operations with power series)
Taylor series (Taylors theorem need not be proved, but the statement should be explained through problems); approximation errors; standard Maclaurin series
The topics in this module can be found in chapter 4, sections 4.1 to 4.6, text [1]
More exercises related to the topics in this module can be found in chapter 9 of reference [1] and chapter 1 of reference [2].

Module 4: Vector algebra (18 Hours)
Scalars and vectors, Addition and subtraction of vectors, Multiplication by a scalar, Basis vectors and components, Magnitude of a vector, Multiplication of vectors (Scalar product; vector product; scalar triple product; vector triple product), Equations of lines, planes and spheres, using vectors to find distances (Point to line; point to plane; line to line; line to plane)

The topics in this module can be found in chapter 7, sections 7.1 to 7.8, text [1]
More exercises related to the topics in this module can be found in chapter 11 of reference [1] and chapter 6 of reference [2].

Texts

Text 1 – K F Riley, M P Hobson, S J Bence. *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press

References

Ref. 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 2 – Mary L Boas. *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley

Ref. 3 – George B Arfken, Hans J Weber, Frank E Harris. *Mathematical Methods for Physicists*, 7th Edition, Academic Press

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Physics

Semester II

Mathematics – II
(Calculus with applications in Physics – II)

Code: MM 1231.1

Instructional hours per week: 4 No. of Credits: 3

Module 1 : Complex numbers and hyperbolic functions (18 hours)
Basic operations (Addition and subtraction; modulus and argument; multiplication; complex conjugate; division), Polar representation of complex numbers (Multiplication and division in polar form), de Moivers theorem (trigonometric identities; finding the nth roots of unity; solving polynomial equations), Complex logarithms and complex powers, Applications to differentiation and integration, Hyperbolic functions (Definitions; hyperbolictrigonometric analogies; identities of hyperbolic functions; solving hyperbolic equations; inverses of hyperbolic functions;calculus of hyperbolic functions)
The topics in this module can be found in chapter 3, sections 3.1 to 3.7 of text [1]
More exercises related to the topics in this module can be found in chapter 6 of reference [1] and chapter 13 of reference [4].

Module 2 : Partial differentiation (18 Hours)
Basics, The total differential and total derivative, Exact and inexact differentials, theorems of partial differentiation, The chain rule, Change of variables, Taylors theorem for many-variable functions, Stationary values of many-variable functions, Stationary values under constraints
The topics in this module can be found in chapter 5, sections 5.1 to 5.9 of text [1]
More exercises related to the topics in this module can be found in chapter 13 of reference [1].

Module 3 : Multiple integrals (18 Hours)
Double integrals, Triple integrals, Applications of multiple integrals (Areas and volumes), Change of variables in multiple integrals – Change of variables in double integrals; evaluation some special infinite integrals, change of variables in triple integrals; general properties of Jacobians
The topics in this module can be found in chapter 6, sections 6.1 to 6.4 of text [1]
More exercises related to the topics in this module can be found in chapter 14 of reference [1].

Module 4 : Vector differentiation (18 Hours)
Differentiation of vectors , Composite vector expressions; differential of a vector, Integration of vectors, Space curves, Vector functions of several arguments, Surfaces, Scalar and vector fields
Vector operators, Gradient of a scalar field; divergence of a vector field; curl of a vector

field Vector operator formulae, Vector operators acting on sums and products; combinations of grad, div and curl, Cylindrical and spherical polar coordinates
The topics in this module can be found in chapter 10, sections 10.1 to 10.9 of text [1].
More exercises related to the topics in this module can be found in chapter 3 of reference [3].

Texts

Text 1 – K F Riley, M P Hobson, S J Bence. *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press

References

Ref. 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 2 – Mary L Boas. *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley

Ref. 3 – George B Arfken, Hans J Weber, Frank E Harris. *Mathematical Methods for Physicists*, 7th Edition, Academic Press

Ref. 4 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Physics

Semester III

Mathematics – III
(Calculus and Linear Algebra)

Code: MM 1331.1

Instructional hours per week: 5 No. of Credits: 4

Module 1 : Ordinary Differential Equations (30 Hours)
First-order ordinary differential equations : General form of solution, First-degree first-order equations (Separable-variable equations; exact equations; inexact equations, integrating factors; linear equations; homogeneous equations; isobaric equations; Bernoullis equation; miscellaneous equations) Higher-degree first-order equations (Equations soluble for p; for x; for y; Clairaut's equation)

Higher-order ordinary differential equations : Linear equations with constant coefficients, (Finding the complementary function $y_c(x)$; finding the particular integral $y_p(x)$; constructing the general solution $y_c(x) + y_p(x)$; linear recurrence relations; Laplace transform method) Linear equations with variable coefficients (The Legendre and Euler linear equations; exact equations; partially known complementary function; variation of parameters; Green's functions; canonical form for second-order equations)

General ordinary differential equations – Dependent variable absent; independent variable absent; non-linear exact equations; isobaric or homogeneous equations; equations homogeneous in x or y alone; equations having $y = Ae^x$ as a solution
The topics in this module can be found in chapter 14 and chapter 15 of text [1]
More exercises related to the topics in this module can be found in chapter 1, 2 and 3 of reference [3].

Module 2 : Vector Integration – Line, surface and volume integrals (18 hours)
Evaluating line integrals; physical examples; line integrals with respect to a scalar Connectivity of regions, Greens theorem in a plane, Conservative fields and potentials, Surface integrals, Evaluating surface integrals; vector areas of surfaces; physical examples, Volume integrals, Volumes of three-dimensional regions, Integral forms for grad, div and curl, Green's theorems (without proof); other related integral theorems; physical applications, Stokes theorem and related theorems (without proof), Related integral theorems; physical applications
The topics in this module can be found in chapter 11 of text [1]
More exercises related to the topics in this module can be found in chapter 3 of reference [2].

Module 3 : Fourier series (18 Hours)
Basic definition, Simple Harmonic Motion and Wave Motion; Periodic Functions, Applications of Fourier Series, Average Value of a Function, Fourier Coefficients, Dirichlet Conditions, Complex Form of Fourier Series, Other Intervals, Even and Odd Functions, Parsevals Theorem, Fourier Transforms
The topics in this module can be found in chapter 7 of text [2]

More exercises related to the topics in this module can be found in chapter 11 of reference [3].

Module 4 : Basic Linear Algebra (24 Hours)

Matrices and row reduction, Determinants, Cramer's rule for solving system of equations, vectors, lines and planes, linear combinations, linear functions, linear operators, linear dependence and independence, special matrices like Hermitian matrices and formulas, linear vector spaces, eigen values and eigen vectors, diagonalizing matrices, applications of diagonalization

The topics in this module can be found in chapter 3 of text [2]

More exercises related to the topics in this module can be found in chapter 7 and 8 of reference [3].

Texts

Text 1 – K F Riley, M P Hobson, S J Bence. *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press

Text 2 – Mary L Boas. *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley

References

Ref. 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 2 – George B Arfken, Hans J Weber, Frank E Harris. *Mathematical Methods for Physicists*, 7th Edition, Academic Press

Ref. 3 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Physics

Semester IV

Mathematics – IV
(Complex Analysis, Special Functions, and Probability Theory)

Code: MM 1431.1

Instructional hours per week: 5 No. of Credits: 4

Module 1 : Advanced Complex Analysis (36 Hours)
Functions of a complex variable, Analytic functions, the Cauchy-Riemann relations, Contour integrals Cauchy's theorem, Cauchy's integral formula, Laurent series, the residue theorem, methods of finding residues, evaluation of definite integrals using residue theorem, residues at infinity, conformal mapping and some of its applications.
The topics in this module can be found in chapter 14 of text [1]
More exercises related to the topics in this module can be found in chapter 14, 15, 16 and 17 of reference [4].

Module 2 : Special functions (18 Hours)
The Factorial Function, Definition of the Gamma Function; Recursion Relation, The Gamma Function of Negative Numbers, Some Important Formulas Involving Gamma Functions, Beta Functions, Beta Functions in Terms of Gamma Functions
The topics in this module can be found in chapter 11 of text [1]
More exercises related to the topics in this module can be found in chapter 13 of reference [3].

Module 3 : Probability and Statistics (36 Hours)
Basics, Sample Space, Probability Theorems, Methods of Counting Random Variables, Continuous Distributions, Binomial Distribution, The Normal or Gaussian Distribution, The Poisson Distribution
The topics in this module can be found in chapter 15, sections 15.1 to 15.9 of text [1]
More exercises related to the topics in this module can be found in chapter 23 of reference [3].

Texts

Text 1 – Mary L Boas. *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley

References

Ref. 1 – K F Riley, M P Hobson, S J Bence. *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press

Ref. 2 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 3 – George B Arfken, Hans J Weber, Frank E Harris. *Mathematical Methods for Physicists*, 7th Edition, Academic Press

Ref. 4 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Chemistry

Semester I

Mathematics – I
(Calculus with applications in Chemistry – I)
Code: MM 1131.2

Instructional hours per week: 4 No. of Credits:3

Module 1: Differentiation with applications to Chemistry (18 Hours)
(*The following topics should be quickly reviewed before going to advanced topics; students should be asked to do more problems from exercises, and these problems should be included in assignments:*) Differentiation of products of functions; the chain rule; quotients; implicit differentiation; logarithmic differentiation; Leibnitz theorem
The following topics in this module should be devoted more attention and time.
Special points of a function (especially, stationary points); curvature; theorems of differentiation – Rolles', Mean Value Theorems
The topics in this module can be found in chapter 2, sections 2.1.2, to 2.1.7, text [1] *(Review of ideas through problems), chapter 2, sections 2.1.8, 2.1.9, 2.1.10,* text [1]
More exercises related to the topics in this module can be found in chapter 2 and chapter 3 of reference [1].

Module 2 : Complex numbers and hyperbolic functions (18 hours)
Basic operations (Addition and subtraction; modulus and argument; multiplication; complex conjugate; division), Polar representation of complex numbers (Multiplication and division in polar form), de Moivers theorem (trigonometric identities; finding the nth roots of unity; solving polynomial equations), Complex logarithms and complex powers, Applications to differentiation and integration, Hyperbolic functions (Definitions; hyperbolictrigonometric analogies; identities of hyperbolic functions; solving hyperbolic equations; inverses of hyperbolic functions;calculus of hyperbolic functions)
The topics in this module can be found in chapter 3, sections 3.1 to 3.7 of text [1]
More exercises related to the topics in this module can be found in chapter 6 of reference [1] and chapter 13 of reference [4].

Module 3: Basic vector algebra (18 Hours)
Scalars and vectors, Addition and subtraction of vectors, Multiplication by a scalar, Basis vectors and components, Magnitude of a vector, Multiplication of vectors (Scalar product; vector product; scalar triple product; vector triple product), Equations of lines, planes and spheres, using vectors to find distances (Point to line; point to plane; line to line; line to plane)
The topics in this module can be found in chapter 7, sections 7.1 to 7.8, text [1]
More exercises related to the topics in this module can be found in chapter 11 of reference [1] and chapter 6 of reference [2].

Module 4: Basic integration with applications to Chemistry (18 Hours)
Integration by parts; reduction formulae; infinite and improper integrals; plane polar coordinates; integral inequalities; applications of integration (finding area, volume etc)
The topics in this module can be found in chapter 2, sections 2.2.8 to 2.2.13, text [1]

More exercises related to the topics in this module can be found in chapter 4, 5 and 7 of reference [1].

Texts

Text 1 – K F Riley, M P Hobson, S J Bence. *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press

References

Ref. 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 2 – Mary L Boas. *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley

Ref. 3 – George B Arfken, Hans J Weber, Frank E Harris. *Mathematical Methods for Physicists*, 7th Edition, Academic Press

Ref. 4 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Chemistry

Semester II

Mathematics – II
(Calculus with applications in Chemistry – II)

Code: MM 1231.2

Instructional hours per week: 4 No. of Credits: 3

Module 1 : Partial differentiation (18 Hours)
Basics, The total differential and total derivative, Exact and inexact differentials, theorems of partial differentiation, The chain rule, Change of variables, Taylors theorem for many-variable functions, Stationary values of many-variable functions, Stationary values under constraints
The topics in this module can be found in chapter 5, sections 5.1 to 5.9 of text [1]
More exercises related to the topics in this module can be found in chapter 13 of reference [1].

Module 2: Infinite series and limits (18 Hours)
Definition, Summation of series of various types (Arithmetic series; geometric series; arithmetico-geometric series; the difference method; series involving natural numbers; transformation of series) Convergence of infinite series (Absolute and conditional convergence; series containing only real positive terms; alternating series test)
Operations with series (Sum and product)
Power series (Convergence of power series; operations with power series)
Taylor series (Taylors theorem need not be proved, but the statement should be explained through problems); approximation errors; standard Maclaurin series
The topics in this module can be found in chapter 4, sections 4.1 to 4.6, text [1]
More exercises related to the topics in this module can be found in chapter 9 of reference [1] and chapter 1 of reference [2].

Module 3 : Vector differentiation (18 Hours)
Differentiation of vectors , Composite vector expressions; differential of a vector, Integration of vectors, Space curves, Vector functions of several arguments, Surfaces, Scalar and vector fields
Vector operators, Gradient of a scalar field; divergence of a vector field; curl of a vector field Vector operator formulae, Vector operators acting on sums and products; combinations of grad, div and curl, Cylindrical and spherical polar coordinates
The topics in this module can be found in chapter 10, sections 10.1 to 10.9 of text [1].
More exercises related to the topics in this module can be found in chapter 3 of reference [3].

Module 4 : Multiple integrals (18 Hours)
Double integrals, Triple integrals, Applications of multiple integrals (Areas and volumes), Change of variables in multiple integrals – Change of variables in double integrals; evaluation some special infinite integrals, change of variables in triple integrals; general properties of Jacobians
The topics in this module can be found in chapter 6, sections 6.1 to 6.4 of text [1]

More exercises related to the topics in this module can be found in chapter 14 of reference [1].

Texts

Text 1 – K F Riley, M P Hobson, S J Bence. *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press

References

Ref. 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 2 – Mary L Boas. *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley

Ref. 3 – George B Arfken, Hans J Weber, Frank E Harris. *Mathematical Methods for Physicists*, 7th Edition, Academic Press

Ref. 4 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Chemistry

Semester III

Mathematics – III
(Linear Algebra, Probablity Theory & Numerical Methods)

Code: MM 1331.2

Instructional hours per week:5 No. of Credits: 4

Module 1 : Basic Linear Algebra (24 Hours)
Matrices and row reduction, Determinants, Cramer's rule for solving system of equations, vectors, lines and planes, linear combinations, linear functions, linear operators, linear dependence and independence, special matrices like Hermitian matrices and formulas, linear vector spaces, eigen values and eigen vectors, diagonalizing matrices, applications of diagonalization
The topics in this module can be found in chapter 3 of text [2]
More exercises related to the topics in this module can be found in chapter 7 and 8 of reference [3].

Module 2 : Probability and Statistics (36 Hours)
Basics, Sample Space, Probability Theorems, Methods of Counting Random Variables, Continuous Distributions, Binomial Distribution, The Normal or Gaussian Distribution, The Poisson Distribution
The topics in this module can be found in chapter 15, sections 15.1 to 15.9 of text [2]
More exercises related to the topics in this module can be found in chapter 23 of reference [2].

Module 3 : Numerical Methods (30 Hours)
Algebraic and transcendental equations (Rearrangement of the equation; linear interpolation; binary chopping; Newton-Raphson method)
Convergence of iteration schemes, Simultaneous linear equations (Gaussian elimination; Gauss-Seidel iteration; tridiagonal matrices) Numerical integration (Trapezium rule; Simpsons rule; Gaussian integration; Monte Carlo methods), Finite differences, Differential equations (Difference equations; Taylor series solutions; prediction and correction;Runge–Kutta methods; isoclines)
The topics in this module can be found in chapter 27, sections 27.1 to 27.6 of text [1]
More exercises related to the topics in this module can be found in reference [4].

Texts

Text 1 – K F Riley, M P Hobson, S J Bence. *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press

Text 2 – Mary L Boas. *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley

References

Ref. 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 2 – George B Arfken, Hans J Weber, Frank E Harris. *Mathematical Methods for Physicists*, 7th Edition, Academic Press

Ref. 3 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

Ref. 4 – Richard L Burden, J Douglas Faires. *Numerical Analysis*, 9th Edition, Cengate Learning

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Chemistry

Semester IV

Mathematics-IV
(Differential Equations, Vector Calculus, and Abstsract Algebra)

Code: MM 1431.2

Module 1 : Ordinary Differential Equations (30 Hours)
First-order ordinary differential equations : General form of solution, First-degree first-order equations (Separable-variable equations; exact equations; inexact equations, integrating factors; linear equations; homogeneous equations; isobaric equations; Bernoullis equation; miscellaneous equations) Higher-degree first-order equations (Equations soluble for p; for x; for y; Clairaut's equation)

Higher-order ordinary differential equations : Linear equations with constant coefficients, (Finding the complementary function $y_c(x)$; finding the particular integral $y_p(x)$; constructing the general solution $y_c(x) + y_p(x)$; linear recurrence relations; Laplace transform method) Linear equations with variable coefficients (The Legendre and Euler linear equations; exact equations; partially known complementary function; variation of parameters; Green's functions; canonical form for second-order equations)

General ordinary differential equations – Dependent variable absent; independent variable absent; non-linear exact equations; isobaric or homogeneous equations; equations homogeneous in x or y alone; equations having $y = Ae^x$ as a solution
The topics in this module can be found in chapter 14 and chapter 15 of text [1]
More exercises related to the topics in this module can be found in chapter 1, 2 and 3 of reference [3].

Module 2 : Vector Integration – Line, surface and volume integrals (18 hours)
Evaluating line integrals; physical examples; line integrals with respect to a scalar Connectivity of regions, Greens theorem in a plane, Conservative fields and potentials, Surface integrals, Evaluating surface integrals; vector areas of surfaces; physical examples, Volume integrals, Volumes of three-dimensional regions, Integral forms for grad, div and curl, Green's theorems (without proof); other related integral theorems; physical applications, Stokes theorem and related theorems (without proof), Related integral theorems; physical applications
The topics in this module can be found in chapter 11 of text [1]
More exercises related to the topics in this module can be found in chapter 3 of reference [2].

Module 3: Abstract Algebra (42 Hours)
Definition of a group; examples of groups, Finite groups, Non-Abelian groups, Permutation groups, Mappings between groups, Subgroups Subdividing a group (Equivalence relations and classes; congruence and cosets; conjugates and classes)

Representation theory, Equivalent representations, Reducibility of a representation, The orthogonality theorem for irreducible representations Characters (Orthogonality property of characters), Counting irreps using characters (Summation rules for irreps), Con-

struction of a character table
The topics in this module can be found in chapter 28 and chapter 29, sections 29.3, 29.4, 29.5, 29.6, 29.7, 29.8 of text [1]
More exercises related to the topics in this module can be found in reference [5].

Texts

Text 1 – K F Riley, M P Hobson, S J Bence. *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press

References

Ref. 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 2 – Mary L Boas. *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley

Ref. 3 – George B Arfken, Hans J Weber, Frank E Harris. *Mathematical Methods for Physicists*, 7th Edition, Academic Press

Ref. 4 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

Ref. 5 – David M Bishop. *Group theory and Chemistry*, Dover Publications

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Geology

Semester I
Mathematics-I
(Algebra, Geometry and Trigonometry)

CODE: MM 1131.3 — Instructional hours per week: 4
No. of Credits: 3 credits

Module 1 **: Preliminary algebra** (20 Hours)
Calculators and approximate numbers, exponents, scientific notation, roots and radicals, addition and subtraction of algebraic expressions, multiplication of algebraic expressions, division of algebraic expressions, solving equations: quadratic equations, solving them by factoring, completing the square, the quadratic formula, the graph of the quadratic function
The above topics can be found in chapter 1 and chapter 7 of text [1]

Module 2 : Plane Geometry (20 Hours)
Geometry : lines and angles, triangles, quadrilaterals, circles, measurement of irregular areas, solid geometric figures; plane analytic geometry : basic definitions, the straight line, the circle, the parabola, the ellipse, the hyperbola
The above topics can be found in chapter 2 and chapter 21 of text [1]

Module 3 : Basic Trigonometry (32 hours)
The trigonometric functions, angles, defining the trigonometric functions, values of the trigonometric functions, the right triangle, applications of right triangles, trigonometric functions of any angle, signs of the trigonometric functions, radians, applications of radian measure, vectors and oblique triangles, introduction to vectors, components of vectors, vector addition by components, applications of vectors, oblique triangles, the law of sines, graphs of $y = a\sin x$ and $y = a\cos x$, graphs of $y = a\sin bx$ and $y = a\cos bx$, graphs of $y = a\sin(bx + c)$ and $y = a\cos(bx + c)$, graphs of $y = \tan x$, $y = \cot x$, $y = \sec x, y = \csc x$, applications of the trigonometric graphs, Composite trigonometric curves
The above topics can be found in chapter 4, 8, 9 and 10 of text [1]

Texts

Text 1 – Allyn J Washington. *Basic technical mathematics with calculus*, 10th edition, Pearson

References

Ref. 1 – H Kruglak et al. *Theory and problems of basic Mathematics with applications to science and technology*, 2nd Edition, Schaum's Outline Series

Ref. 2 – Steven T Karris. *Mathematics for Business, Science, and Technology With MATLAB and Spreadsheet Applications*, 2nd Edition, Orchard Publications

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Geology

Semester II
Mathematics-II
(Calculus and Linear Algebra)

CODE: MM 1231.3 Instructional hours per week: 4
No. of Credits: 3

Module 1 : Exponential and logarithmic functions (12 Hours)
Exponential functions, logarithmic functions, properties of logarithms , logarithms to the base 10, natural logarithms, exponential and logarithmic equations
The above topics can be found in chapter 13 of text [1]

Module 2 : Basic Linear Algebra (20 hours)
Systems of linear equation; determinants, linear equations, graphs of linear functions, solving systems of two linear equations in two unknowns graphically, solving systems of two linear equations in two unknowns algebraically, solving systems of two linear equations in two unknowns by determinants, solving systems of three linear equations in three unknowns algebraically, solving systems of three linear equations in three unknowns by determinants,
Matrices: definitions and basic operations, multiplication of matrices, finding the inverse of a matrix, matrices and linear equations, gaussian elimination, higher-order determinants.
The above topics can be found in chapter 5 and 16 of text [1]

Module 3 : Sequences and series (10 hours)
Arithmetic sequences, geometric sequences, infinite geometric series, the binomial theorem
The above topics can be found in chapter 19 text [1]

Module 4 : Differentiation (30 hours)
Limits, the slope of a tangent to a curve, the derivative, the derivative as an instantaneous, rate of change, derivatives of polynomials, derivatives of products and quotients of func- tions, the derivative of a power of a function, differentiation of implicit functions, higher derivatives, tangents and normals, newtons method for solving equations, curvilinear motion, related rates, using derivatives in curve sketching, more on curve sketching, applied maximum and minimum problems, differentials and linear approximations Matrices: definitions and basic operations, multiplication of matrices, finding the inverse of a matrix, matrices and linear equations, gaussian elimination, higher-order determi- nants.
The above topics can be found in chapter 23 and 24 of text [1]

Texts

Text 1 – Allyn J Washington. *Basic technical mathematics with calculus*, 10th edition, Pearson

References

Ref. 1 – H Kruglak et al. *Theory and problems of basic Mathematics with applications to science and technology*, 2nd Edition, Schaum's Outline Series

Ref. 2 – Steven T Karris. *Mathematics for Business, Science, and Technology With MATLAB and Spreadsheet Applications*, 2nd Edition, Orchard Publications

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Geology

Semester III
Mathematics-III
(Complex Numbers, Algebra and Calculus)

CODE: MM 1331.3 Instructional hours per week: 5
No. of Credits: 4

Module 1 **: Complex Analysis** (15 Hours)
Complex numbers, basic definitions, basic operations with complex numbers, graphical representation of complex numbers, polar form of a complex number, exponential form of a complex number, products, quotients, powers, and roots of complex numbers
The above topics can be found in chapter 12 of text [1]

Module 2 : Solving equations and inequalities (25 hours)
The remainder and factor theorems, synthetic division, the roots of an equation, rational and irrational roots, inequalities, properties of inequalities, solving linear inequalities, solving nonlinear inequalities, inequalities involving absolute values, graphical solution of inequalities with two variables, linear programming
The above topics can be found in chapter 15 and 17 of text [1]

Module 3 : Integration (30 hours)
Antiderivatives, the indefinite integral, the area under a curve, the definite integral, numerical integration: the trapezoidal rule, simpsons rule, applications of the indefinite integral, areas by integration, volumes by integration, the general power formula, the basic logarithmic form, the exponential form, basic trigonometric forms, other trigonometric forms, inverse trigonometric forms, integration by parts, integration by trigonometric substitution, integration by partial fractions (various cases), integration by use of tables
The above topics can be found in chapter 25, 26 and 28 of text [1]

Module 4 : Expanding functions in series (20 hours)
Infinite series, Maclaurin series, operations with series, computations by use of series expansions, Taylor series, introduction to Fourier series
The above topics can be found in chapter 30 of text [1]

Texts

Text 1 – Allyn J Washington. *Basic technical mathematics with calculus*, 10th edition, Pearson

References

Ref. 1 – H Kruglak et al. *Theory and problems of basic Mathematics with applications to science and technology*, 2nd Edition, Schaum's Outline Series

Ref. 2 – Steven T Karris. *Mathematics for Business, Science, and Technology With MATLAB and Spreadsheet Applications*, 2nd Edition, Orchard Publications

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Geology

Semester IV
Mathematics-IV
(Basic Statistics and Differential Equations)

CODE: MM 1431 — Instructional hours per week: 5
No. of Credits: 4

Module 1 : Basic Statistics (35 hours)
Probability and sample spaces, probability of success and failure, probability of independent and dependent events, probability of exclusive events, probability of inclusive events, conditional probability. descriptive versus inferential statistics, population and samples, parameters and statistics, quantitative and qualitative data, frequency distributions and graphical representation of the data, bar charts, pie chart, frequency distribution of large data sets, determining the class width, class relative frequency, cumulative frequency, histograms, measurements of central tendency, average or arithmetic mean, weighted mean, median, mode, measures of dispersion, sample range, variance, standard deviation, random variable, normal distribution, empirical rule, converting values into standard units,
The above topics can be found in chapter 21 and 22 of text [1]

Module 2 : Fitting Functions to Data (25 hours)
Curve fitting, linear regression, parabolic regression, covariance, correlation coefficient
The above topics can be found in chapter 12 of text [2]

Module 3 : Differential Equations (30 hours)
Differential equations, solutions of differential equations, separation of variables, integrating combinations, the linear differential equation of the first order, numerical solutions of first-order equations, elementary applications, higher-order homogeneous equations, auxiliary equation with repeated or complex roots, solutions of nonhomogeneous equations, applications of higher-order equations, laplace transforms, solving differential equations.
The above topics can be found in chapter 31 of text [1]

Texts

Text 1 – Allyn J Washington. *Basic technical mathematics with calculus*, 10th edition, Pearson

Text 2 – Steven T Karris. *Mathematics for Business, Science, and Technology With MATLAB and Spreadsheet Applications*, 2nd Edition, Orchard Publications

References

Ref. 1 – H Kruglak et al. *Theory and problems of basic Mathematics with applications to science and technology*, 2nd Edition, Schaum's Outline Series

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Statistics

Semester I
Mathematics-I
(Basic Calculus for Statistics)

CODE: MM 1131.4 Instructional hours per week: 4
No. of Credits: 3

Module 1: Differential Calculus for Statistics (24 Hours)
(*The following topics should be quickly reviewed before going to advanced topics; students should be asked to do more problems from exercises, and these problems should be included in assignments:*) Differentiation of products of functions; the chain rule; quotients; implicit differentiation; logarithmic differentiation; Leibnitz theorem
The following topics in this module should be devoted more attention and time.
Special points of a function (especially, stationary points); curvature; theorems of differentiation – Rolles', Mean Value Theorems
The topics in this module can be found in chapter 2, sections 2.1.2, to 2.1.7, text [1] *(Review of ideas through problems), chapter 2, sections 2.1.8, 2.1.9, 2.1.10,* text [1]
More exercises related to the topics in this module can be found in chapter 2 and chapter 3 of reference [1].

Module 2: Infinite series and limits (24 Hours)
Definition, Summation of series of various types (Arithmetic series; geometric series; arithmetico-geometric series; the difference method; series involving natural numbers; transformation of series) Convergence of infinite series (Absolute and conditional convergence; series containing only real positive terms; alternating series test)
Operations with series (Sum and product)
Power series (Convergence of power series; operations with power series)
Taylor series (Taylors theorem need not be proved, but the statement should be explained through problems); approximation errors; standard Maclaurin series
The topics in this module can be found in chapter 4, sections 4.1 to 4.6, text [1]
More exercises related to the topics in this module can be found in chapter 9 of reference [1] and chapter 1 of reference [2].

Module 3: Integral Calculus for Statistics (24 Hours)
Integration by parts; reduction formulae; infinite and improper integrals; plane polar coordinates; integral inequalities; applications of integration (finding area, volume etc)
The topics in this module can be found in chapter 2, sections 2.2.8 to 2.2.13, text [1]
More exercises related to the topics in this module can be found in chapter 4, chapter 5 and chapter 7 of reference [1].

Texts

Text 1 – K F Riley, M P Hobson, S J Bence. *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press

References

Ref. 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 2 – Mary L Boas. *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley

Ref. 3 – George B Arfken, Hans J Weber, Frank E Harris. *Mathematical Methods for Physicists*, 7th Edition, Academic Press

Ref. 4 – Andre I Khuri. *Advanced Calculus with Applications in Statistics*, 2nd Edition, Wiley Interscience

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Statistics

Semester II
Mathematics-II
(Advanced Differential and Integral Calculus)

CODE: MM 1231.4 — Instructional hours per week: 4
No. of Credits: 3

Module 1 : Partial differentiation (24 Hours)
Basics, The total differential and total derivative, Exact and inexact differentials, theorems of partial differentiation, The chain rule, Change of variables, Taylors theorem for many-variable functions, Stationary values of many-variable functions, Stationary values under constraints
The topics in this module can be found in chapter 5, sections 5.1 to 5.9 of text [1]
More exercises related to the topics in this module can be found in chapter 13 of reference [1].

Module 2 : Multiple integrals (24 Hours)
Double integrals, Triple integrals, Applications of multiple integrals (Areas and volumes), Change of variables in multiple integrals – Change of variables in double integrals; evaluation some special infinite integrals, change of variables in triple integrals; general properties of Jacobians
The topics in this module can be found in chapter 6, sections 6.1 to 6.4 of text [1]
More exercises related to the topics in this module can be found in chapter 14 of reference [1].

Module 3 : Special functions (24 Hours)
The Factorial Function, Definition of the Gamma Function; Recursion Relation, The Gamma Function of Negative Numbers, Some Important Formulas Involving Gamma Functions, Beta Functions, Beta Functions in Terms of Gamma Functions
The topics in this module can be found in chapter 11 of text [2]
More exercises related to the topics in this module can be found in chapter 13 of reference [4].

Texts

Text 1 – K F Riley, M P Hobson, S J Bence. *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press

Text 2 – Mary L Boas. *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley

References

Ref. 1 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 2 – James Stewart, *Essential Calculus*, Thompson Publications, 2007.

Ref. 3 – Thomas and Finney, *Calculus and Analytic Geometry*, Ninth Edition, Addison-Wesley.

Ref. 4 – George B Arfken, Hans J Weber, Frank E Harris. *Mathematical Methods for Physicists*, 7th Edition, Academic Press

Ref. 5 – Peter V. O' Neil, *Advanced Engineering Mathematics*, ThompsonPublications, 2007

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Complementary Course in Mathematics
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Semester III
Mathematics-III
(Fourier Series, Numerical Methods and ODE)

CODE: MM 1331.4 Instructional hours per week: 5
No. of Credits: 4

Module 1 : Fourier series (20 Hours)
Basic definition, Simple Harmonic Motion and Wave Motion; Periodic Functions, Applications of Fourier Series, Average Value of a Function, Fourier Coefficients, Dirichlet Conditions, Complex Form of Fourier Series, Other Intervals, Even and Odd Functions, Parsevals Theorem, Fourier Transforms
The topics in this module can be found in chapter 7 of text [2]
More exercises related to the topics in this module can be found in chapter 11 of reference [1].

Module 2 : Ordinary Differential Equations (35 Hours)
First-order ordinary differential equations : General form of solution, First-degree first-order equations (Separable-variable equations; exact equations; inexact equations, integrating factors; linear equations; homogeneous equations; isobaric equations; Bernoullis equation; miscellaneous equations) Higher-degree first-order equations (Equations soluble for p; for x; for y; Clairaut's equation)

Higher-order ordinary differential equations : Linear equations with constant coefficients, (Finding the complementary function $y_c(x)$; finding the particular integral $y_p(x)$; constructing the general solution $y_c(x) + y_p(x)$; linear recurrence relations; Laplace transform method) Linear equations with variable coefficients (The Legendre and Euler linear equations; exact equations; partially known complementary function; variation of parameters; Green's functions; canonical form for second-order equations)

General ordinary differential equations – Dependent variable absent; independent variable absent; non-linear exact equations; isobaric or homogeneous equations; equations homogeneous in x or y alone; equations having $y = Ae^x$ as a solution
The topics in this module can be found in chapter 14 and chapter 15 of text [1]
More exercises related to the topics in this module can be found in chapter 1, 2 and 3 of reference [1].

Module 3 : Numerical Methods (35 Hours)
Algebraic and transcendental equations (Rearrangement of the equation; linear interpolation; binary chopping; Newton-Raphson method)
Convergence of iteration schemes, Simultaneous linear equations (Gaussian elimination; Gauss-Seidel iteration; tridiagonal matrices) Numerical integration (Trapezium rule; Simpsons rule; Gaussian integration; Monte Carlo methods), Finite differences, Differential equations (Difference equations; Taylor series solutions; prediction and correction;Runge–Kutta methods; isoclines)
The topics in this module can be found in chapter 27, sections 27.1 to 27.6 of text [1]
More exercises related to the topics in this module can be found in reference [3].

Texts

Text 1 – K F Riley, M P Hobson, S J Bence. *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press

Text 2 – Mary L Boas. *Mathematics Methods in the Physical Sciences*, 3rd Edition, Wiley

References

Ref. 1 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

Ref. 2 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons

Ref. 3 – Richard L Burden, J Douglas Faires. *Numerical Analysis*, 9th Edition, Cengate Learning

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Complementary Course in Mathematics
for First Degree Programme in Statistics

Semester IV
Mathematics-IV
(Linear Algebra)

CODE: MM 1431.4 Instructional hours per week: 5
No. of Credits: 4

Module 1: Vector Spaces over $\mathbb{R}$

- Vector in 3-space as an ordered triple of real numbers. Addition of two vectors and multiplication of a vector by a scalar. Algebra of vectors involving addition and scalar multiplication. The norm of a vector. The dotproduct and orthogonal vectors. Geometric interpretation of these concepts andtheir connection to the traditional method of representing a vector in terms ofstandard unit vectors.

- The $n-$tuple as a generalisation of ordered triple and the space $\mathbb{R}^n$of all $n-$tuples. Addition of two $n-$tuples and multiplication ofan $n-$tuple by a scalar. Listing of the algebraic properties of $\mathbb{R}^n$ thatmakes it a vector space. Dot product of $n-$tuples and orthogonality. The Cauchy-Schwarz inequality in $\mathbb{R}^n$.

- Sub space of $\mathbb{R}^n$. Geometric meaning of subspaces in $\mathbb{R}^2$.and $\mathbb{R}^3$. Linear dependence and independence of vectors in $\mathbb{R}^n$. Basis anddimension and the standard basis of $\mathbb{R}^n$. Orthogonal and orthonormal bases. Representation of an arbitrary vector in an orthonormal basis. The Gram-Schmidtorthogonalisation process.

Module 2: Theory of Matrices

- (Review only) basic concepts about matrices. Operations involving matrices,different types of matrices. Representation of a system of linear equation inmatrix form. Inverse of a matrix, Cramer's rule.

- The rows and columns of a matrix as elements of $\mathbb{R}^n$ for suitable n. Rank of a matrix as the maximum number of linearly independent rows/columns. Elementary row operations. Invariance of rank under elementary row operations. The Echelon form and its uniqueness. Finding the rank of a matrix by reducing to echelon form.

- Homogeneous and non-homogeneous system of linear equations. Resultsabout the existence and nature of solution of a system of equations in terms ofthe ranks of the matrices involved.

- The eigen value problem. Method of finding the eigen values and eigenvectors of a matrix. Basic properties of eigen values and eigen vectors. Eigen values and eigen vectors of a symmetric matrix. The result that theeigen vectors of a real symmetric matrix form an orthogonal basis of $\mathbb{R}^n$.

- Diagonalisable matrices. Advantages of diagonalisable matrices incomputing matrix powers and solving system of equations. The result that asquare matrix of order n is diagonalisabe (i) if and only if it has $n$linearly independent eigen vectors (ii) if it has n distinct eigen values. Method of diagonalising a matrix. Diagonalisation of real symmetric matrices.

- Quadratic forms in $\mathbb{R}^n$ and matrix of quadratic forms. Canonical formof a quadratic form and the principal axes theorem. Geometric meaning ofprinciple axes theorem for quadratic forms in $\mathbb{R}^2$. Use of these results inidentifying the type of a conic that a general second degree equation mayrepresent.

Module 3: Linear Transformations

- Linear transformations from $\mathbb{R}^n$ into $\mathbb{R}^m$. Matrix of alinear transformation relative to a given pair of bases and linear transformation defined by a matrix. Characterisation of linear transformationsfrom $\mathbb{R}^n$ into $\mathbb{R}^m$.

- Linear transformations from $\mathbb{R}^n$ into $\mathbb{R}^n$ and matix of such tranformations. Matrix representation of simple tranformations such asrotation, reflection, projection etc. on the plane. Relation between matricesof a given transformation relative to two different bases. Method of choosing a suitable basis in which the matrix of a given transformation has the particularly simple form of a diagonal matrix.

The topics for all the above modules in this semester can be found in text [1].

Distribution of instructional hours:

Module 1: 30 hours; Module 2: 30 hours; Module 3: 30 hours

Texts

Text 1 – David C. Lay, *Linear Algebra*, Thompson Publications, 2007

References

Ref. 1 – T S Blyth and E F Robertson: *Linear Algebra*, 2nd Edition, Springer,

Ref. 2 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

Ref. 3 – Peter V. O' Neil, *Advanced Engineering Mathematics*, Thompson Publications, 2007

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Economics

Semester I
Mathematics for Economics-I

CODE: MM 1131.5 — Instructional hours per week: 3
No. of Credits: 2

Overview of the course:
The complementary course intended for Economics students lays emphsis on the increased use of mathematical methods in Economics. The first Module of the first semester course discusses the basic concepts of functions, limits and continuity, which is essential to understand what is to follow in subsequent Modules. The second Module is on Differentiation. Applications to Economics abound in this area. The concepts should therefore be carefully motivated with suitable examples.

Module 1: Functions, Limits and Continuity

- Functions: Definition and examples of functions, domain and range of a function, graph of a function, notion of implicit and explicit functions, demand functions and curves, total revenue functions and curves, cost functions and curves, indifference function, indifference curves for flow of income over time.
- Limits and continuity of functions:Notion of the limit of a function with sufficient examples, algebra of limits (No proof), theorems on limits :$\lim_{x\to a}\frac{x^n-a^n}{x-a}=nx^{n-1}$, $\lim_{x\to 0}\frac{\sin x}{x}=1$,$\lim_{x\to 0}\frac{e^x-1}{x}=1$, $\lim_{x\to 0}\frac{a^x-1}{x}=\log a$, for $a>0$(No proof), definition and examples of continuous functions, discontinuity, examples, geometrical meaning of continuity

Module 2: Differentiation-I

- Differentiation: Differentiation of functions of one variable, derivative as a rate measure, rules of differentiation, derivative of a function at a point, product rule, quotient rule, function of a function rule, derivatives of standard functions, derivatives and approximate values, geometrical interpretation of the derivative, applications in economics (such as marginal revenue, marginal cost),

Texts

Text 1 - R G D Allen, *Mathematical Analysis for Economics*, AITBS Publishers, D-2/15. Krishnan Nagar, New Delhi

Text 2 - Taro Yamane, *Mathematics for Economists, An Elementary Survey*, PHI, New Delhi.

DISTRIBUTION OF INSTRUCTIONAL HOURS:

Module 1: 27 hours; Module 2: 27 hours

University of Kerala
Complementary Course in Mathematics
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Semester II
Mathematics for Economics-II

CODE: MM 1231.5 Instructional hours per week: 3

No. of Credits: 3

Overview of the course:
The first module on differentiation discusses differntials, increasing and decreasing functions and maxima and minima, along with several applications. The second module is on partial differentiation. It considers the maxima and minima of functions of two varibles and these are readily applied to problems in Economics.

Module 1: Differentiation-II

- Further differentiation:Successive derivatives of elementary functions, differentials and approximations, increasing and decreasing functions, turning points, points of inflexion, convexity of curves, maxima and minima of functions of one variable, the problem of average and marginal values,problems of monopoly and duopoly in economic theory.

Module 2: Partial Differentiation

- Partial Differentiation: Functions of several variables, Definition and examples partial differentiation of functions of two variables, maxima and minima of functions of many variables, Lagrangian multiplier method of maxima and minima of functions, illustrations from economics, geometrical interpretation of partial derivatives, total differentials, derivatives of implicit functions, higher order partial derivatives, homogeneous functions, applications(maxima and minima problems) in economics,

Texts

Text 1 - R G D Allen, *Mathematical Analysis for Economics*, AITBS Publishers, D-2/15. Krishnan Nagar, New Delhi

Text 2 - Taro Yamane, *Mathematics for Economists, An Elementary Survey*, PHI, New Delhi.

DISTRIBUTION OF INSTRUCTIONAL HOURS:

Module 1: 27 hours; Module 2: 27 hours

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Economics

Semester III
Mathematics for Economics-III

CODE: MM 1331.5 — Instructional hours per week: 3
No. of Credits: 3

Overview of the course:

The course follows the trends set in the first two semester. Integration techniques, definite integrals and approximate integration are discussed in the first module, highlighting applications to Economics. Various infinite series form the content of the second module.

Module 1: Integration

- Integration : Integral as an antiderivative, integration by substitution, integration by parts, definition of the definite integral, definite integrals and approximate integration (Simpson's rule and trapezoidal rule),total cost, marginal cost, capitalisation of an income flow, law of growth, Domar's models on public debt and national income.

Module 2: Series

- Series: geometric, binomial, exponential and logarithmic series, Taylor's formula, Taylor series, extension to many variables.

Texts

Text 1 - R G D Allen, *Mathematical Analysis for Economics*, AITBS Publishers, D-2/15. Krishnan Nagar, New Delhi

Text 2 - Taro Yamane, *Mathematics for Economists, An Elementary Survey*, PHI, New Delhi.

DISTRIBUTION OF INSTRUCTIONAL HOURS:

Module 1: 27 hours; Module 2: 27 hours

University of Kerala
Complementary Course in Mathematics
for First Degree Programme in Economics

Semester IV
Mathematics for Economics-IV

CODE: MM 1431.5 — Instructional hours per week: 3
No. of Credits: 3

Overview of the course

The two modules in this course treat differential equations, the solutions of which are important in most mathematical models. First order differential equations are considered in the first module, whereas second order differenetial equations with constant coefficients, together with the Euler equation are dealt with in the second module.

Module 1: Differential Equations-I

- Differential Equations: Formulation of differential equations, geometrical interpretation of a differential equation representing a family of curves, First order equations, Linear equations, Variables separable, Homogeneous equations.

Module 2: Differential Equations-II

- Differential equations of higher order: Second order differential equations with constant coefficients with RHS as one of $x, e^{ax}, \sin ax, \cos ax$, Euler equations, applications in economics, Domar's capital expansion model, equilibrium of a market and stability of equilibriumof a dynamic market.

Texts

Text 1 - R G D Allen, *Mathematical Analysis for Economics*, AITBS Publishers, D-2/15. Krishnan Nagar, New Delhi

Text 2 - Taro Yamane, *Mathematics for Economists, An Elementary Survey*, PHI, New Delhi.

DISTRIBUTION OF INSTRUCTIONAL HOURS:

Module 1: 27 hours; Module 2: 27 hours