UNIVERSITY OF KERALA
OUTCOME BASED REVISED SYLLABUS

FOR

FIRST DEGREE PROGRAMME IN PHYSICS AND COMPUTER APPLICATIONS

UNDER

CHOICE BASED-CREDIT & SEMESTER-SYSTEM (CBCSS)- CAREER RELATED

(2023 admission onwards)

BOARD OF STUDIES

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11. Smt. Jaya A. S., Govt. College, Kariavattom, Thiruvananthapuram (Member)

List of Teachers Contributed in the Syllabus Restructuring

1. Dr. Santhosh G., Govt. College, Kariavattom, Thiruvananthapuram
2. Sri. Srijith S., S. N. College, Kollam
3. Dr. Reshmy V. K., Govt. College, Nedumangad, Thiruvananthapuram
4. Dr. Jolly Bose; Govt. College, Kariavattom, Thiruvananthapuram
5. Dr.Sajeev D; Govt. College, Kariavattom, Thiruvananthapuram
6. Dr.Sankar S; S. N. College, Kollam
7. Smt. Asitha R; S. N. College, Kollam
8. Smt.Veena V S; S. N. College, Kollam
9. Dr. Roxy M.S; S. N. College, Kollam
10. Dr.Dedhila Devadathan, S. N. College, Kollam
11. Dr.Vidya S; S. N. College, Kollam
12. Smt.Rehna R; S. N. College, Kollam
13. Smt.Saranya Babu, S. N. College, Kollam
14. Smt.Deepthi S Nair; Govt. College, Kariavattom, Thiruvananthapuram
15. Dr.Sumithranand V B; Govt. College, Kariavattom, Thiruvananthapuram
16. Sri.Aneesh Kumar R; Govt. College, Kariavattom, Thiruvananthapuram
17. Smt.Nayanamadhu; Govt. College, Nedumangad, Thiruvananthapuram
18. Smt.Soumya M S; Govt. College, Nedumangad, Thiruvananthapuram
19. Dr.Veena Gopal S ; Christ Nagar College, Maranalloor Thiruvananthapuram.

PROGRAMME OUTCOMES (PO)

The programme is designed with the intension that the graduate will be able to accomplish the following programme outcomes at the completion of the FDP in Physics

NO.	PROGRAMME OUTCOMES
PO – 1	**CRITICAL THINKING: -** Instill an attitude of being inquisitive, develop a capacity to become an active leaner through self-governing and reflective thinking in order to identify and analyze the logic connections between theoretical Physics and its applications
PO – 2	**EFFECTIVE COMMUNICATION: -** Competent proficiency in communication to deliver the acquired knowledge, problem solving skills, analyzing capacity formally or informally to a spectrum of spectators.
PO – 3	**SKILL DEVELOPMENT: -** Practical oriented and problem-solving approach provide opportunity to develop knowledge and skills to the best of their potential.
PO – 4	**INDIVIDUAL AND TEAM WORK:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO – 5	**DIGITAL COMPETENCE:** Ability to use techniques, skills and modern information technology tools at their study and work place.
PO – 6	**SOCIAL ACUITY AND OBLIGATION: -** Impart perception about social issues, human values, foster scientific temper, practice inclusiveness for the betterment of the society and disseminate scientific knowledge in appropriate situation.
PO – 7	**ENVIRONMENTAL AWARENESS: -** Discern the environmental issues and involves in promoting ethics and attitudes that endorse coexistence and sustainable living with reduced, minimal, or no damage upon ecosystems
PO – 8	**MULTIDISCIPLINARY APPROACH:** -Interdisciplinary and multidisciplinary approaches permit to gain a solid foundation in various disciplines of science and provide a basis for higher studies and research
PO – 9	**SUSTAINABLE LEARNING: -** make the students to realize that acquiring knowledge and skills suitable for their professional developments is a never-ending process
PO – 10	**ETHICAL STANDARDS:** - Inspire the students to recognize values such as justice, equity, trust, kindness and to develop a commitment and upholding standards of ethical behavior in all walks of life.

PROGRAMME SPECIFIC OUTCOMES (PSO)

The Programme Specific Outcomes that the graduates will be able to attain on completion of FDP in Physics are the following: -

No.	Upon completion of B.Sc. Physics Degree programme, the graduates will be able to	PO. No.
PSO – 1	Conceptual understanding of Physics and its practical applications and scope in the present world.	PO – 1
PSO – 2	Analyzing the theory part with practical experiments, interpretation of experimental results, finding out errors, suggestions to improve the errors.	PO – 1 PO – 2 & PO – 3
PSO – 3	Develop and construct practical model systems from their conceptual knowledge.	PO – 1 PO – 2 & PO – 3
PSO – 4	Acquire conceptual understanding of properties of matter, fundamentals of mechanics and their practical applications	PO – 1 & PO – 3
PSO – 5	Acquire knowledge about basics of thermodynamics and working of heat engines and their practical applications	PO – 1 PO – 3 & PO – 7
PSO – 6	Acquire the theoretical basis of electrodynamics, Magnetism, Super conductivity, Classical, Statistical and Relativistic Mechanics, Optics, Solid State Physics, Quantum Mechanics, Nano technology	PO – 1& PO – 8
PSO – 7	Distinguish Microscopic Macroscopic Systems and statistical distributions	PO – 1
PSO – 8	Acquire conceptual understanding of Physics to General real-world situations.	PO – 1 & PO – 6
PSO – 9	Integrate the Quantum Mechanics to understand the fundamentals of other branches of Physics such as Vibrational, Raman, Electronic, Resonance Spectroscopy	PO – 1 & PO – 6
PSO – 10	Identify possible atomic and molecular energy levels and transitions and predict the existence of new elements	PO – 1
PSO – 11	Develop an idea regarding X-rays, and different spectroscopic techniques	PO – 1
PSO – 12	Acquire the knowledge of the basic idea about Electronics, Digital Electronics and working of different electronic components	PO – 1&

		PO – 2
PSO – 13	Apply the Langrangian and Hamiltonian formalisms to solve various dynamical problems which involve constraints.	PO – 1 & PO – 3
PSO – 14	Basic understanding and concepts of the causes, effects, and control of various types of environmental pollution.	PO – 1& PO – 7
PSO – 15	Students will use the knowledge of Mechanics to describe the motion of objects in different force fields.	PO – 1
PSO – 16	Develop Basic idea about linear and non- linear optical phenomena and their practical application in real world	PO – 1 & PO – 3
PSO – 17	Use advanced computer language for problem solving and practical applications	PO –3 PO – 5 PO – 8& PO – 9
PSO – 18	Acquire knowledge about the concept of project and methodology in research	PO – 4 PO – 5 PO – 8 & PO – 10
PSO-19	Develop the ability to collaborate with peers in a scientific/lab atmosphere.	PO – 2 PO – 4

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

L-Lecture, P-Practical, CE-Continuous Evaluation, ESE-End Semester Examination

Semester	Course code and title	Instructional hours/week		Credit	ESE Duration (hr.)	Percentage of Evaluation/ Examination		Total Credit
		L	**P**			CE	ESE	
1	EN1111.3 English Language I	5		3	3	20	80	16
	ML/HN 1111.3 Additional Language I	5		3	3			
	PC1121 Core Course I (Foundation Course)	3		3	3			
	PC 1242 Core practical I	-	2	-				
	PC 1171 Voc. Course I	3	2	3	3			
	MM1131.6 Complimentary Course I	5		4	3			
2	EN1211.3 English Language II	5		3	3	20	80	21
	ML/HN 1211.3 Additional Language II	5		3	3			
	PC1241 Core Course II	5		4	3			
	PC 1242 Core practical II		2	2	3			
	PC 1221 Voc. Course II (Foundation Course)	3		2	3			
	PC 1271 Voc. Course II (Lab)		2	3	3			
	MM1231.6 Complimentary Course II	5		4	3			
3	EN1311.3 English Language III	5		3	3	20	80	16
	PC1341 Core Course III	3		3	3			
	PC 1443 Core practical IV		4					
	PC 1371 Voc. Course III	3		3	3			
	PC 1372 Voc. Course IV	3	2	3	3			
	MM1331.6 Complimentary Course III	5		4	3			
4	EN1411.3 English Language IV	5		3	3	20	80	25
	PC1441 Core Course IV	3		3	3			
	PC1441 Core Course V	3		3	3			
	PC 1443 Core practical IV(Lab)		2	3	3			
	PC 1471 Voc. Course V	3		3	3			
	PC 1472 Voc. Course VI	2		2	3			

	PC 1473 Voc. Course IV (Lab)		2	4	3			
	MM1431.6 Complimentary Course IV	5		4	3			
5	PC 1541 Core Course VI	3		3	3	20	80	16
	PC1542 Core Course VII	4		4	3			
	PC 1643 Core practical V		2					
	PC 1644 Core practical VI and Project (core)		2					
	PC 1571 Voc Course VII	3		3	3			
	PC 1572 Voc Course V (Lab)		7	4	3			
	PC 1551 Open Course I (Voc)	3		2	3			
6	PC 1641 Core Course VI	3		3	3	20	80	26
	PC 1642 Core Course VI	4		4	3			
	PC 1643 Core practical VII		2	3	3			
	PC 1644 Core practical VIII and Project (core)		2	3	3			
	PC 1661 Elective Course (Core)	3		2	3			
	PC 1671 Voc. Course VIII	4		4	3			
	PC 1672 Voc. Course IX	3		3	3			
	PC 1673 Project (Voc)		5	4	3			

II. Course structure: -

(1a). ***Core Courses (Theory)***

Semester	Course		No. of Hours/ week	Credit	Total hours /semester	ESE Duration
	Code	Title				
1	PC1141	Dynamics of Rigid Bodies	3	3	54	3
2	PC1241	Environmental Science	3	4	50	3
3	PC1341	Electrodynamics and Circuit Theory	3	3	54	3
4	PC1441	Classical Mechanics and Theory of Relativity	3	3	54	3
	PC 1442	Optics	3	3	54	3
5	PC1541	Quantum Mechanics	3	3	54	3
	PC1542	Electronics	4	4	72	3
6	PC1641	Solid State Physics	3	3	54	3
	PC1642	Atomic, Molecular and Nuclear Physics	4	4	72	3
	PC1661	Elective Courses	3	2	54	3

(1b). Core Courses (*Practical and Project Work)*

Semester	Course		Duration of Examination	Credit	Allotted Hours	
	Code	Title			Per week	Per year
2	PC1242	Mechanics, Properties of Matter, Heat and Acoustics	3	2	S1-2 S2-2	144
4	PC1443	Electricity & magnetism	3	3	S3-4 S4-2	144
6	PC1643	Optics & Electronics	3	3	S5-2 S6-2	144
	PC 1644	Digital electronics, Computational Physics and Project work (Core)	3	3	S5-2 S6-2	144

III. QUESTION PAPER PATTERN

For all semesters

1. The examination has a 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 EXAMINATION			
Question No	Type of Question	No. of Questions to be answered	Marks
Part A: 1-10	One word/One sentence	10	10
Part B: 11-22	Short answer	8 out of 12	16
Part C: 23-31	Short essay/problem	6 out of 9	24
Part D: 32-35	Essay	2 out of 4	30
			Total=80 marks

IV. ELECTIVE COURSES

Elective Courses offered by Physics department for the students of their own department.

Sl. No.	Course Code	Course Title
1	PY1661.1	Astronomy and Astrophysics
2	PY1661.2	General Meteorology
3	PY1661.3	Space Science
4	PY1661.4	Photonics
5	PY1661.5	Nanoscience and Technology

V. IMPLEMENTATION OF PROJECT WORK

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 the 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 V 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 VI semester, well before the commencement of the examination. The reports are to be produced before the external examiners appointed by the University, for valuation during the VI semester.

VI. 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 tests, assignments, seminars etc. and ESE 80 marks. Out of the 20 marks in continuous evaluation, 10 marks to test papers and 10 marks to seminar / assignments (minimum one test & one assignment). The components of the continuous evaluation for theory and practical and their marks are given below.

a) Theory

The continuous evaluation (CE) shall be based on periodic written tests, assignments, and viva / seminar 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.

No	Component	Marks
1	Assignment / Seminar	10
2	Test paper	10
Total		20

(i) Written Tests

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 marks secured 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.

(ii) Assignments and Seminars

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.

b) Practical

(i) **General Lab course**: 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 she / he submit a certified record with a minimum of 6 experiments** This is to be endorsed by the examiners.

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

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

No of experiments recorded	**Marks**
16	5
14	4
12	3
10	2
08	1

The allotment of marks for attendance shall be as follows.

	% of attendance	Marks
	Attendance less than 50%	0

Attendance	51%-60%	1
	61%-70%	2
	71%-80%	3
	81%-90%	4
	91%-100%	5

VII. 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.

VIII. EVALUATION OF PROJECT

(a) Project

(i) VI Semester Project evaluation for core course (External)

The evaluation of the project at the end of Sixth semester along with the practical's. It should be done by two external examiners according to the scheme given below. Each candidate shall be evaluated separately. However, there shall be no continuous evaluation for the project.

Component	Marks
Involvement of the student	05
Relevance of the topic	05
Presentation of report	05
Viva-voce	05
Total	20

IX. END SEMESTER EVALUATION OF PRACTICAL EXAMINATION

(a) Core course

The practical examinations for the core course shall be conducted by the University at the end of semesters 2, 4 and 6 with a common time table and questions set by the University. 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 evaluation scheme for the end semester practical examinations shall be as follows.

II and IV Semester External Practical Examination

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 16 experiments	05
Viva voce	05
Total	80

VI Semester External Practical Examination

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 16 experiments	05
Viva voce	05
Total	80

For electronics experiments, the scheme shall be as follows.

Component	Marks
Formula, circuit, graph, brief procedure	20
Observations, skill and tabulations	20
Substitution, calculation, result with correct unit	10
Certified record with 16 experiments	05
Viva Voce	05
Total	60

For computer experiments, the following scheme shall be followed.

Component	Marks
Writing the programme	20
Execution of the programme	20
Output/Result	10
Certified record with 16 experiments	05
Viva Voce	05
Total	60

SEMESTER 1

PC1121: MECHANICS, THERMODYNAMICS & PROPERTIES OF MATTER (54 Hours – 3 Credits)

CO. No	Upon completion of this course student will be able to	Cognitive Level
CO -1	Understand the Moment of inertia of various bodies and apply this to find moment of inertia of rigid bodies	**U, An**
CO -2	Interpret the flavor of classical fields from oscillations	**U, Ap**
CO -3	Apply the laws of thermodynamics to various processes and systems.Solve problems related to thermodynamic systems	**U, Ap**
CO -4	To develop a fundamental understanding of entropy in different processes	**U**
CO -5	Understand the basic principles of heat transfer	**U, An**
CO -6	To understand the basic ideas of moduli of elasticity. Apply basic concepts of properties of matter in solving problems efficiently. To find practical applications of moduli of elasticity in different situations	**U, An, Ap**
CO -7	Understand the concepts of surface tension and viscosity	**U**

R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Unit 1- Dynamics of Rigid Bodies (12 hrs.)

(Book 2 Chapter 8)

Equations of motion for rotating rigid bodies-angular momentum and M.I-Theorems on M.I-calculation of M.I 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 M.I of a fly wheel (theory, experiment and applications).

Unit 2 - Oscillations (8 hrs.)

(Book 2 Chapter 9)

Simple harmonic motion – Energy of harmonic oscillators-simple pendulum - mass on a spring - oscillation of two particles connected by a spring- compound pendulum - interchange ability of suspension and oscillation points-collinear points-conditions for maximum and minimum periods - Determination of g using symmetric bar pendulum (Discussion only).

Unit 3 - Thermodynamics (10 hrs.)

(Book 3 Chapter 4 ,6)

Thermodynamic System- Zeroth Law Of Thermodynamics-first Law of Thermodynamics, Applications For First Law Of Thermodynamics- Isothermal , Adiabatic, Isochoric, Isobaric Process- Adiabatic equation of a perfect gas-Indicator diagram-Work done during isothermal process-Work done during adiabatic process- irreversible Process-reversible Process-slopes of Adiabatic And Isothermals- Heat engines-Carnot's ideal heat engine-Refrigerator- Coefficient of Performance - Second Law Of Thermodynamics –Kelvin's Statement-Clausius statement-Working and efficiency of Internal combustion engine (Otto engine) - Clausius and Clapeyron Latent Heat Equations – Applications

Unit 4 - Entropy (5 hrs.)

(Book 3 Chapter 5)

Concept of entropy, Change in entropy in adiabatic process-change of entropy in any reversible process- change of entropy in irreversible cycle- Principle of increase of entropy- Physical significance of Entropy-Kelvins thermodynamic scale of Temperature-Third law of thermodynamics- Nernst heat theorem

Unit 5 - Transference of heat (5 hrs.)

Book 3 Chapter 15

Coefficient of Thermal conductivity - Lee's Disc method for bad conductor- radial flow of heat, cylindrical flow-thermal conductivity of rubber-Wiedmann-Franz Law-Thermal radiation –Black Body-Stefan's-Boltzmann law.

Unit 6 - Elasticity (6 hrs.)

(Book 1 Chapter 12)

Modulus of elasticity, Relations connecting the three elastic Moduli-Poisson's ratio(revision) - 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 7- Fluid Mechanics (8 hrs.)

(Book 1, Chapter 14,16)

Surface tension-surface energy-expression for excess pressure on a curved liquid surface-excess pressure inside a spherical drop, measurement of ST by capillary rise method (Theory only), variation of surface tension with temperature.

Streamline and turbulent flow - Reynold's Number, Poiseuille's formula, Bernoulli's theorem- - viscosity-Newton's law- Stoke's formula.

Books for Study:

1 Mechanics- J.C. Upadhyaya (Ramaprasad)
2 Heat, Thermodynamics and Statistical Physics- Brijlal Dr. Subrahmanyam and P. S. Hemne (S. Chand &Co)

Books for Reference:

1 Mechanics- Hans H.S and Puri. S. P, THM: 2nd Edn.)
2. Properties of matter D. S. Mathur
3. Properties of matter Brijlal and Subrahmanyam
4. Statistical mechanics Sinha (TMH)

SEMESTER 2

PC1241: ENVIRONMENTAL STUDIES (50 hours – 4 credits)

Unit 1 - Multidisciplinary nature of environmental studies (2 lectures)

Definition, scope and importance, need for public awareness.

Unit 2 - Natural Resources: Renewable and non-renewable resources (8 lectures)

Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.

b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

• Role of an individual in conservation of natural resources.

• Equitable use of resources for sustainable lifestyles.

Unit 3 - Ecosystems (6 lectures)

• Concept of an ecosystem.

• Structure and function of an ecosystem.

• Producers, consumers and decomposers.

• Energy flow in the ecosystem.

• Ecological succession.

• Food chains, food webs and ecological pyramids.

• Introduction, types, characteristic features, structure and function of the following ecosystems:

a. Forest ecosystem

b. Grassland ecosystem

c. Desert ecosystem

d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 4 - Biodiversity and its conservation (8 lectures)

• Introduction – Definition: genetic, species and ecosystem diversity.

• Biogeographical classification of India

• Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values

• Biodiversity at global, National and local levels.

• India as a mega-diversity nation

• Hot-sports of biodiversity

• Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.

• Endangered and endemic species of India

• Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit 5 - Environmental Pollution (8 lectures)

Definition

• Cause, effects and control measures of: -

a. Air pollution

b. Water pollution

c. Soil pollution

d. Marine pollution

e. Noise pollution

f. Thermal pollution

g. Nuclear hazards

• Solid waste Management: Causes, effects and control measures of urban and industrial wastes.

• Role of an individual in prevention of pollution.

• Pollution case studies.

• Disaster management: floods, earthquake, cyclone and landslides.

Unit 6 - Social Issues and the Environment (7 lectures)

• From Unsustainable to Sustainable development

• Urban problems related to energy

• Water conservation, rain water harvesting, watershed management

• Resettlement and rehabilitation of people; its problems and concerns. Case Studies

• Environmental ethics: Issues and possible solutions.

• Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Case Studies.

• Wasteland reclamation.

• Consumerism and waste products.

• Environment Protection Act.

• Air (Prevention and Control of Pollution) Act.

• Water (Prevention and control of Pollution) Act

• Wildlife Protection Act

• Forest Conservation Act

• Issues involved in enforcement of environmental legislation.

• Public awareness.

Unit 7 - Human Population and the Environment (6 lectures)

• Population growth, variation among nations.

• Population explosion – Family Welfare Programme. VII

• Environment and human health.

• Human Rights.

• Value Education.

• HIV/AIDS.

• Women and Child Welfare.

• Role of Information Technology in Environment and human health.

• Case Studies.

Unit 8: Field work (Field work Equal to 5 lecture hours)

• Visit to a local area to document environmental assets river/ forest/grassland/hill/mountain

• Visit to a local polluted site-Urban/Rural/Industrial/Agricultural

• Study of common plants, insects, birds.

• Study of simple ecosystems-pond, river, hill slopes, etc.

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q) Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut

r) Survey of the Environment, The Hindu (M)

s) Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science

t) Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media (R)

u) Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)

v) Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p

(M) Magazine

(R) Reference

(TB) Textbook

SEMESTER 3

PC 1341-ELECTRODYNAMICS AND CIRCUIT THEORY (54 Hours -3 Credits)

CO. No.	Upon completion of this course student will be able to	Cognitive Level
1	To define, explain and illustrate fundamental concepts from electricity, magnetism , electromagnetism and circuit theory	**R,U**
2	To apply fundamentals laws like Gauss's law etc. to solve and analyze problems and formulations from electricity, magnetism and electrodynamics	**Ap,An**
3	To explain and illustrate alternating current and analyze AC circuits	**Ap,An**
4	To illustrate and design electric circuits using circuit theory.	**An,C**

R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Unit1-Electrostatic Field (10 hrs.)
(Book 1 Chapter 2)

Electric field: Introduction, Coulomb's Law, Electric field, Continuous charge Distribution, Divergence and curl of electrostatic fields; Field lines, flux and Gauss' law, The divergence of E, Applications of Gauss's Law : E due to (i) a Uniformly charged solid sphere (ii) an Infinite plane of uniform charge density, and (iii) Two infinite parallel planes with equal & opposite charge densities, the Curl of E. Electric potential: Introduction to potential, Poisson's and Laplace's equations, Potential of a localized charge distribution, electrostatic boundary conditions, Work and energy in Electrostatics: The work done to move a charge, The energy of a point charge distribution, Capacitors: capacitance of a parallel plate capacitor, work done to charge up a capacitor.

Unit 2-Electrostatic fields in matter (10 hrs.)
(Book 1 Chapter 4)

Polarization: Dielectrics, induced dipoles, alignment of polar molecules, Polarization, The field of a polarized object: Bound charges, Physical interpretation of bound charges. Electric displacement: Gauss's law in the presence of dielectrics, Boundary conditions.

Unit 3-Magnetostatics (8 hrs.)
(Book 1 Chapter 5)

The Lorentz Force Law, surface and volume current density, continuity equation, The Biot-Savart Law, The Divergence and Curl of B**,** Applications of Ampere's Law, Comparison of Magneto statics and Electrostatics, Magnetic vector potential.

Unit 4-Electromagnetic induction (8 hrs.)
(Book 1 Chapter 7)

Electromotive force: Ohm's law Electromagnetic induction: Faraday's law, the induced electric field Maxwell's Equations: Electrodynamics before Maxwell, How Maxwell fixed Ampere's law, Maxwell's equations, Magnetic charge, Maxwell's equations in matter, Boundary conditions.

Unit 5-Electromagnetic waves (8 hrs.)
(Book 1 Chapter 9)

Waves in one dimension: The wave equation Electromagnetic waves in vacuum: The wave equation for E and B, Monochromatic plane waves, The Poynting Vector, The Poynting Theorem (Derivation not required), Energy and momentum in electromagnetic waves.

Unit 6-Alternating current (6 hrs.)
(Book 2 Chapter 13,19)

AC through series LCR (acceptor circuit) and parallel LCR circuit (rejecter circuit) - Q factor, Power in AC-power factor -AC bridges Maxwell's L/C bridge and Owens's bridge.

Unit 7-Circuit theory (4 hrs.)
(Book 2 Chapter 6,18 & Book 3 Chapter 5,6,9)

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

Books for study:

1. Electrodynamics - David J Griffith (PHI III Edn)
2. Electricity and Magnetism - R Murugesan, (IV Edn, S. Chand and Company Ltd.)
3. Introductory Circuit Analysis – Robert L Boylestad (V Edn, Universal Book Stall, New Delhi.

Books for Reference:

1. Electricity and Magnetism – E.M. Purcell, Berkley Physics course, Vol.2 (MGH)
2. electricity and Magnetism -_K. K. Tiwari (S. Chand & Co.)
3. Electricity and Magnetism- D. C. Tayal (Himalaya Publishing Co)
4. Electricity and Magnetism_ - Muneer H. Nayfeh & Norton K. Bressel (John Wiley & Sons)
5. Classical Electrodynamics- Walter Greiner (Springer International Edition)
6. Electromagnetic waves and radiating systems-Jordan & Balmain (PHI)
7. Electromagnetics B. B. Laud (Wiley Eastern Ltd.2nd edition)
8. Introduction to Electrodynamics-Reitz &Milford (Addison Wesley)
9. A text book of Electrical Technology- B. L. Theraja & A.K. Theraja (Volume1, 22nd Edn.)

TOPICS FOR DISCUSSION IN TUTORIAL SESSION/ASSIGNMENTS (SAMPLE)

1. Discuss concepts of Position, Displacement, and Separation Vectors [Ref1 Books for study]
2. Discussion on Differential Calculus: Ordinary Derivative, Gradient, Divergence and Curl. [Ref1 Books for study]
3. Discuss and solve Product rules and Second derivative. [Ref1 Books for study]
4. Discuss Integral calculus: Line, Surface and Volume integrals, [Ref1 Books for study]
5. Discuss Fundamental Theorem of calculus, gradient and curl, Integration by parts, [Ref1 Books for study]

6. Discuss Curvilinear coordinates: Spherical polar and cylindrical coordinates and problems involving Dirac delta function. [Ref1 Books for study]
7. Discuss Dirac delta function and problems involving Dirac delta function. [Ref1 Books for study]
8. Comment on how electrostatic energy is stored in a field
9. Discuss the peculiarities of electric displacement D and electric field E. How they are incorporated in
Maxwell's Equations
10. Discuss the properties of linear dielectrics. What differentiates a dielectric to be linear or not
13. Discuss applications of Ampere's circuital law
14. Compare electrostatics and magnetostatic
15. Why magnetic forces cannot do work
16. Discuss about cyclotron motion & cycloid motion
17. Discuss whether there existed any stand-off between ohm's law and Newton's second law
18. A battery has an emf. Can this emf. is a 'force'? How will you interpret electromotive force?
19. Discuss the role of motional emf in power generation
20. Discuss the orthogonality of E, B and propagation vector k
21. 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, frequency etc.
22. Complex representation of wave function has good advantage. Why? Discuss the linearity of wave function. (Use complex notation)
23. Discuss AC through LC, LR and CR circuits
24. Show that sharpness of resonance is equal to Q- factor
25. What is a choke coil? Discuss the advantage of using a choke coil instead of a resistor.

SEMESTER 4

PC1441: CLASSICAL MECHANICS AND THEORY OF RELATIVITY (54 hrs. - 3 Credits)

CO No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Familiarize with Newtonian Mechanics	**R**
CO-2	Understand various theories of classical mechanics	**U**
CO-3	Solve mechanical problems using Lagrangian Dynamics	**U, Ap**

CO-4	Solve mechanical problems involving Central Forces including planetary motion	**U, Ap**
CO-5	Solve mechanical problems using Hamiltonian Dynamics	**U, Ap**
CO – 6	Recognize the limitations of Classical Physics to explain certain physical phenomena	U
CO-7	Familiarize with nonexistence of ether medium and postulates of special theory of relativity	**R**
CO-8	Understand Galilean and Lorentz transformations	**U**
CO-9	Apply theory of relativity to find physical quantities in different situations	**U, Ap**

R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Unit 1 - Lagrangian Dynamics (10 hrs.)
(Book 1 Chapter 1 & Book 2 Chapter 2)

Review of Newtonian mechanics - qualitative idea only and not for evaluation (**Reference - Any book for study**),

Constraints, Generalized coordinates, Principle of virtual work. D' Alembert's principle, Lagrange's equation from D' Alembert's principle, some applications of Lagrange's equation such as - i) Single particle in space using cartesian coordinates, ii) Single particle in space using plane polar coordinates, iii) Attwood's machine, iv) time dependent constraint in the case of a bead sliding on a wire, v) Simple pendulum and vi) Compound pendulum

Unit 2 - Central Force Motion (10 hrs.)
(Book 3 Chapter 5)

Reduction to one-body problem, General properties of central force motion, Effective potential, Classification of orbits, Motion in central force field, Inverse square law force, Kepler's laws

Unit 3 - Hamiltonian Dynamics (8 hrs.)
(Book 2 Chapter 3)

Generalized momentum and cyclic coordinates, Hamiltonian function and conservation of energy, Hamilton's equation, Some examples of Hamiltonian dynamics such as - i) One dimensional harmonic oscillator ii) Particle in central force field and ii) Compound pendulum

UNIT 4 - LIMITS OF CLASSICAL PHYSICS (10 hrs.)

(Book 4 Sections A-E, Chapter 1, Book 5 Chapter 2, Book 6 Chapter 1)

Particle aspects of radiation: Blackbody Radiation, Photoelectric Effect, Compton Effect, Pair production, Electron diffraction, Bohr Atom, Correspondence Principle.

Unit 5 - Special Theory of Relativity (16 hrs.)
(Book 7 Chapter 11,12, 13)

Introduction, Michelson - Morley experiment, The postulates of special relativity, Galilean transformations, Lorentz transformations Simultaneity and the order of events, Length (Lorentz) contraction and time dilation, The twin paradox -qualitative idea only, Relativistic momentum, Relativistic energy.

Books for Study:

1. Classical Mechanics – Herbert Goldstein, Narosa Publishing House
2. Classical Mechanics- J. C. Upadhyaya, Himalaya Publishing House
3. Classical Mechanics - G. Aruldhas, PHI Learning Private Limited
4. Quantum Physics: Stephen Gasiorowicz, John Wiley and Sons.
5. Concepts of Modern Physics: Arthur Beiser, McGraw Hill. 6Edn
6. Quantum mechanics: Concepts &Applications, N. Zettilli, Second Edition, Wiley
7. An Introduction to Mechanics - Daniel Kleppner and Robert J Kolenkow, McGraw Hill Education Private Limited

Books for Reference:

1. Classical Mechanics - Systems of Particles & Hamiltonian Dynamics – Walter Greiner.
2. Mechanics – H. S. Hans and S. P. Puri (Tata-McGraw Hill)
3. Classical Mechanics – N.C. Rana and P. S. Joag
4. Classical Dynamics of Particles and Systems - Thornton and Marion, Cengage Learning India Private Limited.

PC1442: OPTICS (54 Hours -3 Credits)

CO. No	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Get knowledge on the basic concepts of light such as Interference, Diffraction, Dispersion and Polarisation	**U**
CO-2	Study the production and detection of polarized light.	**U**
CO-3	Understand the working principles of laser and optical fibers.	**U**
CO-4	Extend their knowledge in explaining different phenomena of light based on interference and diffraction.	**U , Ap**

CO-5	Solving problems related to refractive index, numerical aperture and acceptance angle	**U , Ap**
CO-6	Describe the concept of laser and optical fibers.	**U , Ap**

R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Unit 1 - Interference of light (12 hrs.)
(Book 1 Chapter 14 & 15 and Book 3 chapter 12 & 13)

The principle of superposition - coherent sources – Double slit interference (theory of interference fringes and band width)- conditions for sustained interference- interference in thin films –reflected and transmitted system- colours in thin films, fringes of equal inclination- fringes of equal thickness - 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 (12 hrs.)
(Book 1 Chapter 17, 18 & 19 and Book 3 Chapter 16 & 17)

Fresnel diffraction: - Half-period zones - explanation of rectilinear propagation of light- zone plate- diffraction at a circular aperture– diffraction at a straight edge. Fraunhofer diffraction: - Diffraction at a single slit, double slits – plane transmission grating – Dispersive power- Determination of wavelength of light (Normal incidence) - Rayleigh's criterion for resolution - resolving power of diffraction grating.

Unit 3 - Polarisation (12 hrs.)
(Book 1 Chapter 20 and Book 3 Chapter 19)

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 detection of plane, circularly and elliptically polarized light - quarter and half wave plates.

Unit 4 - Dispersion (4 hrs.)
(Book 2 Chapter 11)

Normal dispersion - Elementary theory of dispersion - Cauchy's and Hartmann dispersion formula - anomalous dispersion - Wood's experiment for anomalous dispersion of sodium vapour.

Unit 5 - Fiber Optics (6 hrs.)
(Book 1 Chapter 24 and Book 3 Chapter 24)

Optical fiber – Structure-Classifications based on materials, Refractive index and modes- Working principle- Derivation of numerical aperture and acceptance angle, Coherent bundle, pulse dispersion in step index fiber, Advantages and applications of optical fibers- Fiber optic communication system- Fiber optic sensors- examples.

Unit 6 - Laser (8 hrs.)
(Book 2 Chapter 12, Book 1 Chapter 23, Book 3 Chapter 23 and Book 4 Chapter. 6)

Characteristics of laser beams -spatial coherence (Qualitative)-Temporal coherence- Basic principle of laser operation- Spontaneous and stimulated emission, Einstein's coefficients-light propagation through medium and condition for light amplification, population inversion by pumping - optical resonators (qualitative) Q factor (qualitative), various laser systems –Ruby laser - He-NE laser, (construction and working).

Books for Study:

1. Text Book of Optics — N. Subramaniam & Brijlal
2. Optics and spectroscopy — R. Murugesan
3. Optics — Ajoy Ghatak
4. Lasers &Non-Linear Optics — B.B. Laud

Books for Reference:

1. Fundamentals of Optics — Jenkins and White
2. Modern Classical Optics — Geoffrey Brooker
3. Principles of Optics — B.K. Mathur
4. Fundamentals of Optics — Khanna and Gulati
5. Lasers: Principles, Types and applications — K. R. Nambiar

SEMESTER 5

PC 1541: STATISTICAL AND QUANTUM MECHANICS (54 hours- 3 credit)

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO – 1	Able to define phase space, microstate, macrostate and ensemble	U
CO – 2	Learn to distinguish different statistical distributions and judge which distribution applies to a given system	Ap

CO – 3	Identify the quantum mechanical concepts applicable to Physical systems	Ap
CO – 4	Apply the concepts of Quantum Mechanics to solve problems	Ap
CO – 5	Derive Equations of motion of Physical systems using quantum concepts	Ap

R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Unit 1 - Introduction to Statistical Mechanics (12 hrs.)

(Book 6)

Macro states and micro states, thermodynamic probability, Bose - Einstein statistics, Fermi - Dirac statistics, Maxwell - Boltzmann statistics, The statistical interpretation of entropy, The Bose - Einstein distribution function, the Fermi - Dirac distribution function, the classical distribution function, comparison of distribution functions for indistinguishable Particles, the Maxwell· Boltzmann distribution function

Unit 2 - Wave Packets and Uncertainty Relations (12 hrs.)

(Book 2 Sections 3.1-3.4, 3.7-3.8, Book 4 Section 2.2,2.3,2.4, Book5 Chapter 1)

De Broglie Waves, Wave- particle Duality, principle of linear superposition, Quantization rules, Wave Packets, Group and Phase Velocities, Uncertainty Principle and its applications

Unit 3 - Wave function and Schrodinger Equation (14 hrs.)
(Book 3 Chapter 1.1-1.5, Book 1, Book 4 Chapter 3)

Schrodinger Equation, Statistical Interpretation, fundamental postulates of Quantum mechanics, Expectation Values, Normalization of Wavefunction, Position and Momentum Operators.

Unit 4 - One-Dimensional Systems (16 hrs.)
(Book 3 Sections 2.1, 2.2, 2.3 (only 2.3.2), 2.4, 2.6, Book 2 Section5.8)

Stationary States, Time-Independent and time dependent Schrodinger Equation, Free Particle, Particle in Infinite Square Well Potential and Finite Potential Well, Quantum Tunnelling, Harmonic Oscillator (by solving the differential equation)

Books for study:

1. Quantum Physics: Stephen Gasiorowicz, John Wiley and Sons.
2. Concepts of Modern Physics: Arthur Beiser, McGraw Hill. 6Edn
3. Introduction to Quantum Mechanics: David J. Griffiths, Prentice Hall, 1995.
4. Quantum Mechanics: G. Aruldhas, PHI, 2Edn., 2002
5. Quantum mechanics: Concepts &Applications, N. Zettilli, Second Edition, Wiley
6. Thermodynamics Kinetic Theory and Statistical Thermodynamics: F. W. Sears and G. L. Salinger, Addison-Wesley Publishing Company

Books for reference:

1. A Text book of Quantum Mechanics: P.M. Mathews &K. Venkatesan- McGraw Hill, 2Edn., 2010
2. Quantum Mechanics: Robert Eisberg and Robert Resnick, Wiley, 2nd Edn. 2002
3. Quantum Mechanics: Leonard I. Schiff, TMH, 3rd Edn., 2010
4. Quantum Mechanics: Eugen Merzbacher, John Wiley and Sons Inc.,2004
5. Quantum Mechanics: Walter Greiner, Springer,4Edn., 2001
6. Quantum Mechanics: Bruce Cameron Reed, Jones and Bartlett, 2008.
7. Quantum Mechanics for Scientists &Engineers: D.A. B. Miller, Cambridge University Press, 2008
8. Thermal and Statistical Mechanics: S. K. Roy, New Age International- 2001
9. Statistical Mechanics: Kerson Huang
10. Statistical and Thermal Physics: S. Lokanathan and R. S. Gambhir, Prentice Hall, 1991.
11. Shaums outline series

PC 1542: ELECTRONICS (72 hrs. - 4 Credits)

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
1	Understand the working of semiconductor diodes and analyze diode circuits for rectifiers and voltage regulators	**U, An**
2	UExplain the working of bipolar junction transistors and analyze transistor biasing circuits	**An, Ap**
3	Design and analyze Single Stage Common Emitter amplifier	**An, Ap**
4	Understand feedback principles and construct sinusoidal oscillator circuits	**U, An**
5	Design and analyze basic operational amplifier circuits	**An. Ap**

6	Simplify Boolean expressions and construct binary adder, subtractor and flip flops using logic gates	**An, Ap**

R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Unit I - Diode Circuits (18 hrs.)
(Sections ***5.18-5.20, 6.3, 6.5-6.6 of Book 1***)
Characteristics of p-n junction diodes:

forward bias - characteristic curve, Knee Voltage, dc and ac resistances, reverse bias - characteristic curve, reverse resistance, reverse saturation current, breakdown voltage, limitations in the operating conditions - Maximum forward current, Peak Inverse Voltage, Maximum Power Rating

Diode Rectifiers
(***Sections 6.8 - 6.15, 6.17-6.18, 6.20-6.21 of Book 1)***
Half-wave rectifier - circuit, operation, output frequency, efficiency, full-wave rectifier - circuit and operation of center-tap and bridge rectifiers, output frequency, efficiency, rectifier output - ripple factor of half- and full-wave rectifiers, filters - capacitor, choke input and capacitor input filters

Zener Diode
(**Sections 6.26-6.28 of Book 1)**
characteristics - characteristic curve, equivalent circuit, voltage regulator - zener diode as regulator, analysis of zener diode circuits

Unit 2 - Transistor Circuits (26 hrs.)

Transistor Connections
(**Sections 9.1-9.16, 9.19 of Book 1)**

Common Base, Common Emitter and Common Collector connections - Input and output characteristics, input and output resistances, leakage currents (ICBO and ICEO), current amplification factors (α, β and γ) and the relationship among them. Transistor in Common Emitter(CE) configuration - Transistor as an amplifier, load line analysis, operating point, cut-off and saturation points and active region in CE configuration

Small Signal Amplifier
(**Sections 10.1-10.15 of Book 1)**

single stage CE amplifier - circuit, phase reversal, dc and ac equivalent circuits, load line analysis, circuit parameters - [**derivation not needed**] - voltage gain, ac emitter resistance, voltage gain (circuits with load, no load and no emitter capacitor), input impedance

Feedback

(**Sections 13.1-13.14 of Book 1**)
principles of feedback - negative and positive feedback, advantages of negative voltage feedback negative current feedback - effects of negative current feedback
emitter follower - voltage and current gain, input and output impedance, applications

Oscillators
(**Sections 14.1-14.7, 14.11 of Book 1**)
Sinusoidal Oscillators - oscillatory circuit, positive feedback, essentials of transistor oscillator, Barkhausen criterion, *Oscillator Circuits* - Hartley oscillator, phase shift oscillator.

Unit III: Operational Amplifiers (12 Hours)

Operational Amplifier Fundamentals
(**Sections 14.1-14.3 of Book 2)**
op-amp operation - single-ended input, double-ended input, double-ended output, differential and common-mode operation, common-mode rejection and rejection ratio (CMRR), op-amp basics - basic op-amp circuit with feedback, gain, virtual ground

OP-AMP Circuits
(**Sections 14.4, 14.5 of Book 2**)
Practical op-amp circuits - inverting and non-inverting amplifiers, summing amplifier, integrator, differentiator, Op-amp specifications - offset current and voltages, gain-bandwidth, slew rate, maximum signal frequency

Unit 4 - Digital Electronics (16 hrs.)

Binary Number System
(Sections 2.2, 2.4, 2.5, 4.1-4.3,4.5-4.7 of Book 3) (Sections 3.2-3.6, 5.1-5.3, 7.1-7.3, 6.1-6.2 of Book 3 and Sections 5.7-5.8 of Book 4)
Binary number system - binary numbers, binary addition and subtraction, 1's and 2's complement, addition and subtraction of signed numbers, Boolean algebra - Laws of Boolean algebra, de Morgan's theorems, simplification using Boolean algebra, standard form of Boolean expressions, Logic gates - NOT, OR, AND, NAND, NOR and Exclusive OR gates, forming logic circuits from truth tables, NAND and NOR gates as universal gates, Flip-Flops - S-R, D and J-K flip-flops, Adders and Subtractor - half adder, full adder, subtractor

Books for study:

1. Principles of Electronics - Sixth Edition, V. K. Mehta, PHI.
2. Electronic Devices and Circuit Theory - Seventh Edition, R. Boylestad and L. Nashelsky, Prentice Hall.
3. Digital Fundamentals - Tenth Edition, T. L. Floyd, Pearson.
4. Digital Principles and Applications - Fourth Edition, A. P. Malvino and D. P. Leach, Tata McGraw-Hill, 1991.

Books for Reference:

1. Electronic Devices and Circuits, B. L. Theraja and R. S. Sedha, S. Chand and Company Ltd.

Topics for Assignment/Seminar

1. Electronic projects using flip flops
2. Electronic projects using logic gates
3. Electronic projects using IC 741 OP amp.
4. Constant voltage power supplies
5. Constant current sources
6. Oscillators of different frequencies
7. Voltage regulated dc power supplies with variable output
8. Voltage regulated dual power supplies with variable output
9. Effect of temperature on electronic components

SEMESTER 6

PC1641: SOLID STATE PHYSICS (54 hrs. -3 Credits)

CO. No	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Understand the crystal structure of different materials and lattice dynamics.	**U**
CO-2	Understand the X ray diffraction.	**U**
CO-3	Extend their knowledge in theoretical fundamentals of electron theory	**U, Ap**
CO-4	Explain the concept of phonons and lattice vibrations.	**U**
CO-5	Understand the properties of dielectric and ferroelectric materials.	**U, Ap**
CO.6	Describe the concept of superconductivity.	**U, Ap**

R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Unit I- Crystal Structures and X-Ray diffraction (20 hrs.)
(Book 1 Chapter 1&3)

Introduction-Crystalline State- Crystal lattice –Basic Vectors -Unit Cell- Primitive verus Non primitive Cells-Fourteen Bravais lattices and seven crystal systems- Non Bravais lattice-nomenclature of crystal directions and crystal Planes-Miller indices- Examples of simple crystal structures (NaCl, CsCl, Diamond, ZnS, Hexagonal)-amorphous solids and liquids-. generation and absorption of X-Rays-Bragg's law- -reciprocal lattice and X-ray diffraction (Qualitative Only), diffraction condition and Bragg's law- (Qualitative Only), experimental techniques (Rotating Crystal method and Powder method)-neutron diffraction-electron diffraction.

Unit 2 – Conduction in metals and Free electron model (14 hrs.)
(Book 1 Chapter 4)

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 -failure of free electron model.

Unit 3- Thermal properties of Materials (4 hrs.)
(Book 2 Chapter 9)

Introduction-Specific Heat of Solid, Classical Model, Einstein Model- Phonon density of states (Qualitative Only), Debye model of lattice specific heat (Qualitative Only).

Unit 4- Dielectric and Magnetic properties of Materials (10 hrs.)
(Book 2 chapters 14, 16)

Introduction- Dipole moment- Polarization- dielectric constant - polarisability- electronic, ionic and dipolar polarizability (Qualitative Only), piezo, Pyro and Ferro electric properties of crystals Introduction- review of magnetic formulas and its susceptibility (Revision)- classification of magnetic materials -atomic theory of magnetism, Langevin's classical theory of diamagnetism-Quantum theory of Para magnetism (Qualitative Only) –Ferromagnetic Domains

Unit 5-Superconductivity (6 hrs.)
(Book 1 Chapter 10)

Introduction- Zero resistance-perfect diamagnetism or The Meissner effect-The critical field-intermediate state, Type I & II superconductors - electrodynamics of Superconductors- BCS Theory of superconductivity- tunneling and the Josephson effect (Qualitative Only).

Books for Study:

1. Elementary Solid State Physics – Principles and Applications, M. A. Omar, Pearson, 2005

2. Solid State Physics – Structure and Properties of Materials, M. A. Wahab, 2nd Edn., Narossa Publishing House,2011.

Books for Reference:

1. Introduction to Solid State Physics, Kittel, Wiley & Sons, 7th edition, 2005.
2. Concepts of Modern Physics by Beiser, Tata McGraw Hill, 5th Edition, 2003.
3. Elementary Solid State Physics, J.P. SRIVASATAVA, PHI Learning, 4th Edition, 2014.
4. Fundamentals of Physics, 6th Edition, by D. Halliday, R. Resnick and J. Walker, Wiley. NY, 2001.
5. The Feynman Lectures on Physics, Vol. I, II, and III, by R. P. Feynman, RB Leighton and M Sands, Narosa, New Delhi, 1998.

PC 1642- ATOMIC, MOLECULAR AND NUCLEAR PHYSICS (72hrs - 4 Credits)

CO. No	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Understand the fundamental aspects of atomic Physics	**U**
CO-2	Understand the behavior of atoms in electric and magnetic fields.	**U**
CO-3	Examine the construct of many electron atoms spectra.	**U, Ap**
CO-4	Understand the rotational and vibrational spectra of molecular structure	**U, Ap**
CO-5	Understand the general facts and fundamental properties of nucleus.	**U**
CO-6	Illustrate the various nuclear models such as Liquid drop model, Nuclear shell model.	**U, Ap**
CO-7	Describe the nuclear decays and nuclear reactions along with their occurrence probabilities.	**U, Ap**
CO-8	Explain the basic interaction mechanisms for charged particles and electromagnetic radiation and explain the working principles behind detectors and their characteristic properties with respect to energy resolution, efficiency etc.	**U**
CO-9	Acquire a thorough understanding of the fundamental interactions, elementary particles, the classifications of particles: leptons, hadrons	**U**

	(baryons and mesons), conservation laws and quarks models for elementary particles.	

R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Unit 1- Vector Atom Model (15 hrs.)
(Book 2 Chapter 6)

Bohr Atom Model-Effect of Nuclear Motion on Atomic Spectra- Evidences in Favour of Bohr's Theory- Somerfield's Relativistic Atom Model- The Vector Atom Model- Quantum Numbers Associated with the Vector Atom Model- Coupling Schemes- The Pauli Exclusion Principle- simple Examples of Electron Configurations with their Modern Symbolic Representations- Magnetic Dipole Moment due to Orbital Motion of the Electron- Magnetic Dipole Moment due to Spin-The Stern and Gerlach Experiment- Spin-Orbit Coupling

Unit 2- Atomic Spectra (12 hrs.)
(Book 2 Chapter 6)

Optical Spectra-Zeeman Effect – Larmor's Theorem- Quantum Mechanical Explanation of the Normal Zeeman Effect - Anomalous Zeeman Effect- Paschen-Back Effect (Qualitative Discussions Only)- Stark Effect (Qualitative Discussions Only)

Unit 3- Molecular spectra (15 hrs.)
(Book 1 Chapter 9)

Origin of Molecular Spectra- Nature of Molecular Spectra-Different Modes of Molecular Excitation- Factors Affecting Line Width of Molecular Spectra - Factors Affecting Intensity of Molecular Spectra- Born-Oppenheimer Approximation- Rotation of Linear System- Rotational Spectra of Rigid Linear Molecules - Non-Rigid Rotator- The Energy of a Diatomic Molecule- Vibrating Diatomic Molecule as a Harmonic Oscillator- Infra-red Spectra- Theory of the Origin of the Vibration-Rotation Spectrum of a Molecule-The anharmonic Oscillator- Fundamental and Overtone Frequencies- Calculation of Force Constant.

Unit 4 - Introduction to the nucleus (10 hrs.)
(Book 1 Chapter 17, Book 2)

Constituents of nuclei-nuclear size-binding energy-angular momentum of the nucleus-magnetic moment-nuclear quadrupole moment –Parity- The liquid drop model- semi empirical mass formula- -Shell model (Qualitative Discussions Only), Nuclear forces- General features, Meson theory of nuclear forces.

Unit 5 – Nuclear Reactions and Radioactivity (14 hrs.)
(Book 1 Chapter 18,19)

Types of Reactions, Conservation Laws, Q-value- reaction rate- reaction cross section- reaction mechanism-Concept of compound nucleus-Nuclear Fission-Theory of Nuclear fission-Chain reaction-Breeder reactor- Nuclear Fusion- Fusion reaction in Stars-Rate of decay- Half life-Mean life-Conservation laws in radioactive decays-Decay series-secular equilibrium-Transient equilibrium- radioactive dating-Alpha decay- Theory of alpha decay-Beta decay-Theory of beta decay-Gamma decay

Unit 6 - Elementary Particles (6 hrs.)
(Book 3 Chapter 21)

Particle interactions (concept of different types of forces); basic features, types of particles and its families. Conservation Laws (energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness), concept of quark model.

Books for Study:

1. Modern Physics- G. Aruldhas and P. Rajagopal, PHI, New Delhi, 2005.
2. Modern Physics by R. Murugesan, S. Chand & Co., Reprint, 2008.
3. Introduction to Elementary particles by David J Griffiths, Wiley, 2008.
4. Concepts of Modern Physics by A. Beiser, Tata McGraw-Hill, New Delhi, 6th edition.

Books for Reference:

1. Introduction to Atomic Spectra, White, McGraw-Hill Inc.
2. Spectroscopy, Volume 3, B. P. Straughan, Stanley D. Walker, Chapman and Hall, 1976.
3. Fundamentals of Molecular Spectroscopy - Banwell (TMH)
4. Nuclear Physics: S.N. Ghoshal, S. Chand & Co.
5. Introductory nuclear Physics: Kenneth S. Krane, Wiley India Pvt. Ltd., 2008.

PC1661.1: ASTRONOMY AND ASTROPHYSICS (54 hours -3 credits)

CO No	On successful completion of the course, students will be able to	Cognitive Level
CO 1	Familiarize and appreciate the field of astronomy	**U**
CO 2	Comprehend astronomical scales and basic concepts of positional astronomy and can understand about stellar parameters and spectral classification.	**U, Ap**
CO 3	Basic information about the formation of stars, their magnitudes and luminosity	**R,U**

CO 4	To understand the structure of sun	**U**
CO 5	Describe the classification of stars, stellar evolution, interstellar matter, galaxies etc.	**Ap**
CO6	To understand the origin of the Planets	**U**
CO7	Explain Earth's motion in space;rotation and revolution,predict seasons using diagram of Earth and sun,Describe what causes seasons	**An**

R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Unit I-Introduction (4 hrs.) (Book 2, Chapter 1, P 1 – 6)

Astronomy and Astrophysics, Importance of Astronomy, Methods of Astronomy and Astrophysics, The Scientific Methods, Scope of Astronomy

Unit 2 - Astronomy (15 hrs.) (Book 1, Chapter 4, 5, P 65-70, 78-101)

Birth of the Universe, Ancient astronomy, Medieval Astronomy, Renaissance Astronomy, Modern Astronomy

Unit 3-The Objects in the Sky (15 hrs.) ((Book 1, Chapter 6, P 102-127)

The Microwave background radiation, The Sun, The Stars, Neutron Stars and Black holes, Supernovae, Galaxies

Unit 4 -The Solar System (15 hrs.) (Book 1, Chapter 7, P 128-154)

Sun and Planets, Formation of the Planets, Comets, Planets and Satellites, Asteroids, Meteorites

Unit 5 -Earth in Space (5 hrs.) (Book 1, Chapter 8, P 155-162)

Motion of the Earth, The Calendar, The Seasons

Books for Study:

1. Planet Earth, Cesare Emiliani , (Cambridge University Press, 1995)
2. Astrophysics - K. D. Abhayankar (University Press,2001)

Books for reference:

1. Fundamentals of Geophysics William Lowrie (Cambridge University Press, 1997)
2. Modern Physics- R. Murugeshan, Kiruthika Sivaprasath (2007), S.Chand & Company Ltd.
3. Introduction to Astrophysics – Baidyanadh Basu
4. Modern Trends in Physics Vol I, C. J. Babu
5. Space Science –Louise K. Harra& Keith O.Mason(Imperial College Press, London, 2004)

PC 1661.2: GENERAL METEOROLOGY (54 hours -3 Credit)

CO. No	Upon completion of this course, students will be able to	Cognitive Level
CO 1	Understand the basic concepts of meteorology	Un
CO 2	Understand the composition of vertical structure of the atmosphere	Un
CO 3	Interpret equations that describe atmospheric processes for various spatial and temporal scales	Un, An
CO 4	Understand the energy transfer phenomenon between earth and atmosphere	Un
CO 5	Apply fundamental physical principles in understanding atmospheric and climate processes	Un, Ap
CO 6	Understand the basic thermodynamic concepts for the atmosphere	Un
CO 7	Describe and quantify the role of greenhouse gases in earth's energy budget and climate system	Un, An
CO 8	Develop skills for interpreting and applying atmospheric observations	Un, Ap

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Unit 1 - (20 hrs.)

Introduction to Meteorology-The Atmosphere-Solar Energy-Global Circulation – Climatology-Tropical Weather-Global climate system. Atmospheric composition-primary Gases-Greenhouse gases-reactive gas species-aerosols- Temporal and spatial variation of atmosphere. Mass of atmosphere-total pressure and vapour pressure. Standard Atmosphere-Vertical Structure of earth's atmosphere-Troposphere, Stratosphere, Above Stratosphere, The Energy Balance- Black body radiation -Radiation laws-The atmosphere and solar radiation –Reflection, Scattering, absorption and Transmission. The Greenhouse effect Earth's surface and solar energy-the steady state systems

Unit 2 - (20 hrs.)

Atmospheric temperatures-daily temperature changes –day time heating-Night time cooling-Factors influencing the vertical distribution of temperature-horizontal distribution of temperature-Moisture in the atmosphere-changes of states-Hydrological cycle-relative humidity-evaporation and transpiration-precipitation regional variation in precipitation –water balance –inter annual variation in the climate-El-Nino and La-Nina.

Unit 3 - (6 hrs.)

Concepts of equilibrium, atmospheric equilibrium, adiabatic process of temperature changes, adiabatic lapse rate, atmospheric stability and lapse rate, atmospheric equilibrium in saturated air.

Unit 4 - (8 hrs.)

Theory of global warming-Evidence for global warming. Changes in Temperature record. Changing levels of atmospheric carbon dioxide- Rising sea levels-The other contributions to global warming-Theory of ozone depletion-Ozone chemistry-CFC and ozone hole.

Books for Reference:

1. Atmosphere, weather and climate (8e), Roger G Barry and Richard J Chorley
2.Climatology: D S Lal
3. Global Warming: A complete Guide John Houghton
4. Atmospheric Science: An Introductory Survey, John M Wallace & Peter V Hobbs
5.Physical Meteorology, H. G. Houghton,
6. Atmosphere weather and climate K. Siddhartha, Kisalaya Publications.

PC 1661.3: SPACE SCIENCE (54 hrs. -3 credits)

CO. No	Upon completion of this course, students will be able to	Cognitive Level
CO 1	Acquire knowledge on the physical universe, its evolution, and the tabulation of the positioning of astronomical objects.	Un, An
CO 2	Understand the evolution, classification, formation of stars, stellar phenomena, and theories of the interstellar medium.	Un, An
CO 3	Understand various solar radiation and phenomena related to the sun	Un, An
CO 4	Understand different layers of atmosphere and analysis of their temperature, pressure, and density profiles.	Un, An
CO 5	Understand the earth's magnetic field and various magnetic phenomena associated with it.	Un, An

R:

Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create

Unit 1 - Universe (12 hrs.)

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

Ref; Introduction to Cosmology- J. V. Narlikar (1993), Cambridge University Press, Art. 1.1 to 1.8 (Pages 1 to 26)

Unit 2 - The evolution of Stars (9 hrs.)

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.

Ref; Modern Physics- R. Murugeshan, Kiruthika Sivaprasath, S.Chand & Company Ltd. (2007), Art. 78.1 to 78.15(Pages 963 to 976)

Unit 3 - The active Sun (10 hrs.)

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.

Ref; Earth's Proximal Space- Chanchal Uberoi (2000), Universities Press (India) Limited, Art. 3.1 to 3.6 (Pages 36 to 55)

Unit 4 - The earth's Atmosphere (15 hrs.)

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.

Ref; Introduction to Space Science- Robert C. Haymes (1971) John Wiley & Sons Art. 3.1 to 3.9 and 3.12 to 3.17 (Pages 54 to 65 and 69 to 78)

Unit 5 - Magnetosphere (8 hrs.)

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.

Ref; Earth's Proximal Space- Chanchal Uberoi (2000), Universities Press(India) Limited, Art. 4.1 to 4.6 and 4.8 to 4.8.3 (Pages 56 to 67 and 71 to 74)

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)

PC 1661.4: PHOTONICS (54 hours -3 Credits)

CO. No	Upon completion of this course, students will be able to	Cognitive Level
CO 1	Understand the basics of semiconductor physics	Un
CO 2	Illustrate the working of simple devices based on semiconductor physics	Un, An
CO 3	Extend the knowledge of working of semiconductor to its device applications	An, Ap
CO 4	Understand and illustrate the working of various semiconductor diodes	Un, An
CO 5	Understand various electrooptic effects and its applications	Un, Ap
CO 6	Understanding the basics of non-linear optics	Un
CO 7	Understanding and analyzing advanced device applications of photonic devices	Un, An

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Unit 1 - (7 hrs.)

Photons in semiconductors-semiconductors-energy band and charge carriers-semi conducting materials-electron and hole concentrations-generation, recombination and injection-junctions-hetero junctions-quantum wells and super lattices.

Unit 2 - (6 hrs.)

Semiconductor photon sources-light emitting diodes-injection-electroluminescence- LED characteristics internal photon flux-output photon flux and efficiency-responsivity- spectral distribution-materials-response time-device structures.

Unit 3 - (8 hrs.)

Semiconductor laser amplifiers-gain-amplifier band width-optical pumping-electrical current pumping-hetero structures-semiconductor injection lasers-amplification-feedback and oscillators-resonator losses-gain condition-internal photon flux-output photon flux and efficiency-spectral distribution-spatial distribution-single frequency operation-quantum well lasers (qualitative).

Unit 4 - (8 hrs.)

Semiconductor photon detectors-The external photo effect-photo electron emission-The internal photo effect-semiconductor photo detection-quantum efficiency-responsivity- devices with gain-response time-photoconductors- photo diodes-PIN photo diodes-heterostructure photo diode-Schottky barrier photodiodes- array detectors-avalanche photodiodes-gain and responsivity-response time.

Unit 5 - (8 hrs.)

Electro optic, Pockels and Kerr effects- electro optic modulators and switches-scanners-directional couplers-spatial light modulators-electro optics of liquid crystals-wave retarders and modulators-spatial light modulators.

Unit 6 - (7 hrs.)

Nonlinear optics-second order and third order optical non-linearity-intensity dependent refractive index-optical Kerr effect-self focusing.

Unit 7 - (10 hrs.)

Photonic switching and computing-opto mechanical, electro optic, acousto optic and magneto optic switches-all optical switches- bistable systems-principle of optical bistability- bistable optical devices-optical inter connectors-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, Prentice Hall of India.
2. Optics and Photonics- An introduction: F. Graham Smith and Terry A. King, John Wiley & Sons, Inc.
3. Lasers and Nonlinear Optics: B. B. Laud, New Age International Pvt Ltd.

PC1661.5: NANOSCIENCE ANTECHNOLOGY (54 hours, 3 credits)

CO No	On successful completion of the course, students will be able to	Cognitive Level
CO 1	Explain the electrical, optical, magnetic, thermal, mechanical properties of nanomaterials	**An**
CO 2	Have a good idea on the applications of nanomaterials and nanotechnology	**U, Ap**
CO 3	Gather required knowledge on the synthesis of nanomaterials using bottom-up or top-down approach	**R,U**
CO 4	Characterize nanomaterials using different analysis tools	**Ap**
CO 5	Understand the Synthesis, properties, applications and importance of carbon nanostructures	**U,Ap**
CO6	Understand the different nanomachines and nanodevices	**U,Ap**

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Unit 1 - Introduction to Nanoscience and Nanotechnology (10 hrs.)

Nanoscience and nanotechnology- Definition-Historical development, scope and applications

[Book 1, Chapter 1].

Comparison of bulk and nanomaterials-, classification of nanostructured materials: one-, two- and three-dimensional confinement, size and dimensionality effects - size effects, conduction electrons and dimensionality, Fermi gas and density of states, Potential wells, Partial confinement, Properties dependent on density of states, excitons.

[Book 2 Chapter 9.1, 9.3, 9.4]

Unit 2 - Properties of nanomaterials and scaling laws (6 hrs.)

Introduction, size dependent properties, Properties of nanomaterials-chemical reactivity, solubility, melting points, electronic energy levels, electrical conductivity, Super-paramagnetism, Electron confinement, Integrated optics, Optical properties, Mechanical properties, Thermodynamic properties, scaling laws.

[Book 1 Chapter 3.1 to 3.4]

Unit 3 - Synthesis and characterization (16 hrs.)

Synthesis of nanoscale materials and structures, Zero Dimensional Materials-Inert gas condensation, Inert gas expansion, Sono chemical processing, Sol-gel deposition, Molecular self-assembly, 1D and 2D- Foil beating, Electro-deposition, PVD, CVD, 3D- Rapid solidification, Equiangular extrusion, Milling and Mechanical alloying, Micromachining, Consolidation of nanoclusters and milled powders, Methods for nano profiling.

[Book 3 chapter 8.1]

Electron microscopy, Scanning probe microscopy, Optical microscopy, XRD

[Book 4, Chapter 2.1 to 2.4, 2.6]

IR and Raman Spectroscopy, Photoemission and X-ray spectroscopy

[Book 2 Chapter 3.4]

Unit 4 - Carbon nanostructures (10 hrs.)

Carbon nanostructures-carbon molecules, carbon clusters, Fullerene-structure of C-60 and its crystal larger and smaller fullerenes-other bucky balls. Carbon nanotubes-fabrication-structure-electrical properties vibrational properties-mechanical properties. Applications of carbon nano tubes-Field Emission and shielding-computers-fuel cells-chemical sensors-catalysis-mechanical reinforcement.

[Book 2, Chapter 5]

Unit 5 - Nanomachines and nanodevices (12 hrs.)

Resonant Tunneling diode, quantum cascade lasers, single electron transistors- operating principles and applications.

[Book 5, Chapter 9.1 to 9.4]

Books for study:

1 Nanotechnology, An Introduction to synthesis, Properties and Applications of Nanomaterials, Thomas Varghese and KM Balakrishna, Atlantic Publishers and Distributors (P) Ltd, New Delhi

2 Introduction to Nanotechnology, Charles P. Poole Jr and Frank J Ovens, Wiley Interscience, USA

3 Nanomaterials, Nanotechnologies and design, Michael F Ashby, Paulo J Ferreira and Daniel L Schodek, Elsevier Publishers, UK

4 Nano, The Essentials, T. Pradeep, Tata Mc Graw Hill, New Delhi

5 Nanotechnology and Nanoelectronics, W.R. Fahrner, Springer, Newyork.

Books for Reference:

1 Encyclopedia of Nanoscience and Nanotechnology, H. S. Nalwa (Ed),American Scientific Publishers, Los Angels
2 Nanotubes and Nanowires, C.N.R. Rao and Govindraj, RSC Publishing
3 Nanotehnology, An Introduction, Jeremy J Ramsden, Elsevier Publishers,UK
4 Nanotechnology, Mick Wilson, Kamali Kannagara, Geoff Smith, Michelle Simmons and Burkhard Raguse, Overseas Press, New Delhi.

PRACTICALS

Students must be given a brief description of units, errors, significant figures and graphs. They must be familiarised with screw gauge, Vernier calipers, travelling microscope etc. using simple experiments.

SEMESTER 1 & 2

PC1242- MECHANICS, PROPERTIES OF MATTER, HEAT AND ACOUSTICS

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO1	Familiarize with the precautions and steps of systematic recording of an experiment.	**U, Ap**
CO2	Understand multiple experimental techniques for determining physical quantities.	**U, Ap**
CO3	Develop skill in setting up of apparatus for accurate measurement of physical quantities.	**U, Ap**
CO4	Apply and illustrate the concepts of mechanics, heat and acoustic experiments	**U, Ap**

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List of Experiments (Minimum 16 experiments to be done)

1. Fly Wheel – To determine the moment of inertia of a fly wheel about its axle.
2. Symmetric Compound Bar Pendulum – Determination of g, radius of gyration and hence moment of inertia
3. Asymmetric Compound Bar Pendulum – Determination of g, radius of gyration and hence moment of inertia
4. Uniform Bending—Determination of Young's Modulus using pin and microscope
5. Uniform bending— Determination of Young's Modulus using optic lever and telescope
6. Non-uniform bending- Determination of Young's Modulus using optic lever and telescope

7. Non- Uniform bending –Determination of Young's Modulus using pin and microscope
8. Cantilever - Determination of Young's Modulus using Angle between tangents.
9. Cantilever - Determination of Young's Modulus using pin and microscope.
10. Torsion pendulum- Determination of rigidity modulus of a given wire.
11. Kater's pendulum- Determination of acceleration due to gravity
12. Melde's string - Frequency of tuning fork
13. Viscosity of a liquid - Stokes method
14. Viscosity-Continuous flow method using constant pressure head.
15. Viscosity-Variable pressure head arrangement
16. Surface Tension-Capillary rise method
17. Sonometer-frequency of A.C
18. Kundt's tube-determination of velocity of sound.
19. Lee 's disc- Thermal conductivity of a bad conductor
20. Phase transition-determination of M.P of wax.
21. Determination of thermal conductivity of rubber

Books for Reference:

1. Practical Physics: R. K. Shukla, Anchal Srivastava, New Age International (P) Ltd, Publishers
2. B. Sc Practical Physics: C L Arora, S. Chand Publications
3. Yarwood and Wittle; Experimental Physics for Students, Chapman & Hall Publishers.
4. An advanced course in practical physics, Chathopadhyaya, Rakshit and Saha, New central agency, Kolkata.
5. A text book of practical physics, S. Viswanathan & Co., Chennai
6. Advanced Practical Physics, B.L. Worsnop and H.T.Flint, Khosla Publishers, Delhi

SEMESTER 3 & 4

PC1443- ELECTRICITY AND MAGNETISM

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO1	Understand and differentiate between different circuit elements and their use in a circuit	**U, Ap**
CO2	Familiarize with the precautions and steps of systematic and accurate recording of an experiment.	**U, Ap**
CO3	Understand multiple experimental techniques for determining physical quantities.	**U, Ap**

CO4	Develop skill in setting up apparatus for accurate measurement of physical quantities.	**U, Ap**
CO5	Develop skill in identifying and rectifying the errors in a circuit connection	**An , Ap**
CO6	Apply and illustrate the concepts of electricity and magnetism experiments.	**U, Ap**

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List of Experiments (Minimum 14 experiments to be done)

1. Maxwell's bridge - To determine the self-inductance of a coil
2. Anderson's Bridge – To determine the self-inductance of a coil
3. To study the frequency response of a series RC circuit
4. To study the response curve of a series LCR circuit and determine its (a) Resonant frequency (b) Impedance at resonance (c) quality factor (d) band width
5. To study the response curve of a parallel LCR circuit and determine its antiresonance frequency and Quality factor
6. Potentiometer- To determine the Resistivity of a given wire.
7. Potentiometer-Calibration of ammeter
8. Potentiometer –Calibration of low range voltmeter
9. Potentiometer – Calibration of high range voltmeter
10. Potentiometer –determine the Reduction factor of T.G and hence verify the value of Bh
11.. Carey Foster's bridge- To determine the Resistivity of a given wire
12. Carey Foster's bridge- To study the temperature coefficient of resistance
13. Tangent Galvanometer- Calibration of Ammeter
14. Mirror galvanometer-figure of merit.
15. BG- Absolute capacity of a condenser
16. Current sensitivity of a galvanometer
17. Conversion of galvanometer into ammeter and calibration using digital Multimeter
18. Conversion of galvanometer into voltmeter and calibration using digital Voltmeter.
19. Circular coil-dipole moment
20. Circular coil-Study of earth's magnetic field using compass box.

Circular coil - Calibration of ammeter

21. Study of network Theorems-Superposition Theorem, Thevenin's & Norton's theorems and maximum power transfer theorem.
22. Absolute determination of m and Bh using box type magnetometer
23. Searle's vibration magnetometer-comparison of magnetic moments and determination of Bh.

Books for Reference:

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
5. A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Edn.,2011, Kitab Mahal

SEMESTER 5 & 6

PC 1643 OPTICS AND BASIC ELECTRONICS

CO No	On successful completion of the course, students will be able to	Cognitive Level
CO 1	Understand how to use a spectrometer	**U**
CO 2	Obtain a practical understanding of the refraction of light by a prism	**U, Ap**
CO 3	Use basic laws to study the spectral and optical properties of the given prism and grating	**U, Ap**
CO 4	Apply the knowledge to understand the working of PN junction diode and Zener diode	**U, Ap**
CO 5	Apply basic laws and theories to construct basic circuits involving diodes and transistors	**Ap**

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List of Experiments (Minimum 16 experiments to be done)

1. Spectrometer – Determination of the refractive index of the material of a prism
2. Spectrometer – Determination of the dispersive power of the material of the prism for different pairs of lines of the mercury spectrum
3. Spectrometer – Determination of Cauchy's constants of the given prism
4. Spectrometer – Measurement of the angles of deviation (*d*) corresponding to various angles of incidence (*i*), and calculation of the refractive index of the material of the prism by drawing *i-d* curve
5. Spectrometer – Determination of the refractive index of the material of a small angled prism by finding the angle of the small angled prism by supplementary angle method and its angle of deviation corresponding to normal incidence
6. Spectrometer – Determination the refractive index of the given liquid using hollow prism
7. Spectrometer – Standardise the grating using green line of mercury spectrum and hence to find the wavelength of other prominent lines of the mercury spectrum by normal incidence method

8. Spectrometer – Determination of the wavelengths of the prominent spectral lines of mercury spectrum by adjusting the grating for minimum deviation
9. Spectrometer – Determination of the dispersive power of a grating
10. Liquid lens – Determination of the optical constants of a convex lens and refractive index of the given liquid
11. Newton's Rings – Determination of the wavelength of sodium light using the reflected system of Newton's rings
12. Air wedge – Determination of the diameter of a thin wire by the air wedge arrangement
13. Standardisation of meter using He-Ne Laser
14. PN junction Diode (Ge & Si) characteristics – Determination of ac and dc forward resistances of a PN junction diode by drawing the characteristic curve
15. Full wave (centre tapped) rectifier – Construction of a full wave rectifier using junction diode and calculation of the ripple factor with and without shunt filter (10 readings for R_L 100 to 5000)
16. Full wave (centre tapped) rectifier – Construction of a full wave rectifier using junction diode and hence to study the effect of L, C, and LC filters on the ripple factor (for different R_L)
17. Bridge rectifier – Construction of a bridge rectifier using junction diodes and calculation of the ripple factor with and without shunt filter (10 readings for R_L 100 to 5000)
18. Bridge rectifier (Dual power supply) – Construction of a dual power supply using bridge rectifier and measurement of the output voltages for different pair of identical load resistors
19. Zener diode characteristics – Determination of the break down voltage and the dynamic resistance of a Zener diode by drawing the V-I characteristics
20. Zener diode as a voltage regulator – Construction of a voltage regulator using Zener diode and hence to study the output voltage variation (i) for different R_L and (ii) for different input voltage with same R_L
21. Transistor characteristics (CE) – Determination of the current gain, input impedance and output impedance of a transistor in CE configuration by drawing the characteristic curves
22. Transistor characteristics (CB) – Determination of the current gain, input impedance and output impedance of a transistor in CB configuration by drawing the characteristic curves
23. Single stage CE amplifier – Construction of a single stage CE transistor amplifier and hence to study its frequency response

Books for Reference:

1. B.Sc. Practical Physics, Harnam Singh and Dr. P. S. Hemne, S. Chand & Co.
2. Electronics Lab Manual – Volume I – Fifth Edition, K.A. Navas, PHI
3. Principles of Electronics, V.K. Mehta, S. Chand & Co.
4. Basic Electronics Solid State, B.L. Theraja, S. Chand & Co.

PC 1644: Digital Electronics, Computational Physics and Project work (core)

CO No	On successful completion of the course, students will be able to	Cognitive Level
CO 1	Understand the working of gates and verify their operation	**U**
CO 2	Design and construct basic combinational circuits	**U, Ap**
CO 3	Design and construct basic sequential circuits	**U, Ap**
CO 4	Basic understanding of python programming	**U**
CO 5	Apply python programming skills to solve computational physics problems	**Ap**
CO 6	Be initiated into the basics of research	**U**
CO 7	Imbibe sound moral and ethical values	**Ap**

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Unit I: Digital Electronics

List of Experiments (Minimum 08 experiments to be done)

1. AND, OR and NOT Gates using IC - Verify truth tables of AND (IC 7408), OR (IC 7432) and NOT (IC 7404) gates.
2. NAND, NOR and XOR Gates using IC - Verify truth tables of NAND (IC 7400), NOR (IC 7402) and XOR (IC 7486) gates.
3. SR flip-flop - Construct (i) active-high and (ii) active-low SR flip-flops using NAND gates and verify truth tables.
4. Clocked SR flip-flop - Construct a clocked SR flip-flop using NAND gates and verify the truth table.
5. D flip-flop - Construct a D flip-flop using NAND gates and verify the truth table.
6. JK flip-flop - Construct a JK flip-flop using NAND gates and verify the truth table.
7. Half-Adder - From the truth table, obtain the logic expression for the output of half-adder in terms of its input, construct a logic circuit to implement it using appropriate logic gates and verify the truth table.

8. Full-Adder - From the truth table, obtain the logic expression for the output of full-adder in terms of its input, construct a logic circuit to implement it using appropriate logic gates and verify the truth table.
9. Half-Subtractor - From the truth table, obtain the logic expression for the output of half-subtractor in terms of its input, construct a logic circuit to implement it using appropriate logic gates and verify the truth table.
10. Full-Subtractor - From the truth table, obtain the logic expression for the output of full-subtractor in terms of its input, construct a logic circuit to implement it using appropriate logic gates and verify the truth table.

Unit 2: Computational Physics using Python

List of Experiments (Minimum 08 experiments to be done)

1. Familiarization with Math, Numpy and Matplotlib modules - (Not for Evaluation)
    a. Math module - importing math module, functions provided by math.
    b. Numerical Python (numpy) - importing numpy module, numpy arrays, arange() and linspace() functions, operations on arrays, array functions.
    c. Matplotlib - importing matplotlib module, the plot function and options.
    d. Python Interfaces - Jupyter Notebook, Google Colaboratory.
2. Plotting Functions - Define a python function of one variable and plot it using matplotlib function pyplot.plot().
3. Matrix Multiplication - Define two matrices, of compatible dimensions for multiplication, as numpy.arrays and use the numpy.dot() function to find their product.
4. Projectile Motion - Program to plot the trajectory (height versus horizontal distance) of an object that is given an initial vertical velocity, at a given angle with the horizontal, from a given initial height. The program should accept the initial velocity, angle and height as inputs and, in addition to plotting the trajectory, should, also, compute the maximum height, the horizontal range and the time of flight of the projectile.
5. Root Finding: Bisection Method
    a. Root-Bracketing - Write a python function to find a range [a, a + d] of a given width d that contains a root of a function f (x), using the method of bisection.
    b. Write a python program to find the root, if any, of function f (x), within a specified range [a, b], precise up to a specified tolerance, using the method of bisection.
6. Root Finding: Newton-Raphson Method - Write a python program to find the root, if any, of function f (x), within a specified range [a, b], precise up to a specified tolerance, using the Newton-Raphson method.
7. Linear Regression - Write a python function that will accept two arrays corresponding to x-data and y-data, fit it to a straight line y = m x + c and return the values of parameters m and c. Write a program that calls this function to fit the data and plot the data and the fitted line in the same figure using pyplot.plot() function from matplotlib.

8. Integration: Trapezoidal Rule - Write a python function that integrates a given function fx) over the range x ∈ [a, b] using 2k intervals, where k in a positive integer. Write a program that uses this function to integrate f (x) over [a, b] up to a desired precision.
9. Integration: Simpson 1/3 Rule - Write a python function that takes as input a function f(x) and an even number n > 2, and integrate it via Simpson 1/3 rule, over a range [a, b] using n intervals. Write a program that uses this function to integrate the user-defined function f(x) over [a, b].
10. Integration: Simpson 3/8 Rule - Write a python function that takes as input a function f(x) and a number n > 2, and integrate it via Simpson 3/8 rule, over a range [a, b] using 3n intervals. Write a program that uses this function to integrate the user-defined function f(x) over [a, b].
11. Ordinary Differential Equations: Ruge - Kutta Method - Python program to solve the initial value problem of n coupled first-order differential equations using fourth-order Runge-Kutta method.
12. Find the roots of the quadratic equation.

Books for Reference:

1. Electronics Lab Manual - Volume I - Fifth Edition, K. A. Navas, PHI
2. Numerical Methods in Engineering with Python
3. J. Kiusalaas, Cambridge University Press, 2013.
4. Taming Python By Programming - First edition, Jeeva Jose, Khanna Books
5. Fundamentals of Python: First Programs-Second Edition, Kenneth A Lambert, Martin Osborne, Cengage Publications.