Scheme for UG Syllabus

(Effective from 2016-17)

under

CHOICE BASED CREDIT SYSTEM (CBCS)

In

Bachelor of Science with Physics

Department of Physics

Himachal Pradesh University

Shimla

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform

grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. Elective Course: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

2.1 **Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

2.2 **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

3. Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course: The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based

and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

3.1 **AE Compulsory Course (AECC**): Environmental Science, English Communication/MIL Communication.

3.2 **AE Elective Course (AEEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

Details of Courses Under Undergraduate Program (B.Sc.)

Course	***Credits**	
Theory+ Practical		Theory +Tutorials
I. Core Course	12X4= 48	12X5=60
(12 Papers)		
04 Courses from each of the 03 disciplines of choice		
Core Course Practical / Tutorial*	12X2=24	12X1=12
(12 Practical/ Tutorials*)		
04 Courses from each of the 03 Disciplines of choice		
II. Discipline Specific Course Elective Course	6x4=24	6X5=30
(6 Papers)		
Two papers from each discipline of choice including paper of interdisciplinary nature.		
Discipline Specific Course Practical / Tutorials*	6 X 2=12	6X1=6
(6 Practical / Tutorials*)		
Two Papers from each discipline of choice including paper of interdisciplinary nature		

- **Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester**

III. Ability Enhancement Courses

1**. Ability Enhancement Compulsory**	2 X 4=8	2X4=8
(2 Papers of 4 credits each) **Environmental Science English/MIL Communication**		
2**. Skill Enhancement Course**	4 X 4=16	4 X 4=16
(Skill Based)		
(4 Papers of 4 credits each)		
	Total credit= 132	**Total credit= 132**

Institute should evolve a system/policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.

wherever there is practical there will be no tutorials and vice -versa

HIMACHAL PRADESH UNIVERSITY

SYLLABUS AND SCHEME OF EXAMINATION FOR B.SC. PHYSICS AND PHYSICAL SCIENCE (PHYSICS , CHEMISTRY AND MATHEMATICS)

Sem	Course Type	Course Code	Title of paper	Credits
I	CORE COURSE-I	PHYS101TH PHYS101IA	MECHANICS Theory	**4`**
	CORE COURSE-I	PHYS101PR	MECHANICS Lab	**2**
	CORE COURSE-II	CHEM101TH CHEM101IA CHEM101PR	ATOMIC STRUCTURE----	**6**
	CORE COURSE-III	MATH101TH MATH101IA	DIFFERENTIAL CALCULUS	**6**
	A.E.C. COURSE-I		ENGLISH/MIL COMMUNICATION/EVS	**4**
II	CORE COURSE-IV	PHYS201TH PHYS201IA	ELECTRICITY MAGNETISIM &EMT Theory	**4**
	CORE COURSE-IV	PHYS201PR	ELECTRICITY MAGNETISIM &EMT Lab	**2**
	CORE COURSE-V	CHEM201TH CHEM201IA CHEM201PR	CHEMICAL ENERGETICS---	**6**
	CORE COURSE-VI	MATH201TH MATH201IA	DIFFERENTIAL EQUATIONS	**6**
	A.E.C.COURSE-II		ENGLISH/MIL COMMUNICATION/EVS	**4**
III	CORE COURSE-VII	PHYS301TH PHYS301IA	THERMAL PHYSICS & STATASTICAL MECHANICS	**4**
	CORE COURSE	PHYS301PR	THERMAL PHYSICS & STATASTICAL MECHANICS Lab	**2**
	CORE COURSE-VIII	CHEM301TH CHEM301IA CHEM301PR	SOLUTION------	**6**
	CORE COURSE-IX	MATH101TH MATH101IA	REAL ANALYSIS	**6**

	SEC I	PHYS302TH OR PHYS303TH	PHYSICS WORKSHOP SKILLS OR COMPUTATIONAL PHYSICS SKILLS	**4**
IV	CORE COURSE-X	PHYS401TH	WAVES & OPTICS	**4**
	CORE COURSE-X	PHYS401PR	WAVES & OPTICS	**2**
	CORE COURSE-XI	CHEM401TH CHEM401IA CHEM401PR	COORDINATION CHEM---	**6**
	CORE COURSE-XII	MATH401TH MATH401IA	ALGEBRA	**6**
	SEC II	PHYS402TH OR PHYS403TH	ELECTRICAL CKTS & NETWORK SKILLS OR BASIC INSTRUMENTATION SKILLS	**4**
V	DISCIPLINE SPECIFIC ELECTIVES DSE:1A (CHOOSE ANY ONE FROM GIVEN FOUR)	PHYS501TH PHYS501IA PHYS501PR	ELEMENTS OF MODERN PHYSICS - Theory ELEMENTS OF MODERN PHYSICS – Lab	**4+2**
		PHYS502TH PHYS502IA PHYS502PR	MATHEMATICAL PHYSICS	
		PHYS503TH PHYS503IA PHYS503PR	SOLID STATE PHYSICS	
		PHYS504TH PHYS504IA PHYS504PR	MEDICAL PHYSICS	
	SEC III	PHYS505TH OR PHYS506TH	RADIOLOGY & SAFETY OR APPLIED OPTICS	**4**
	DSE: 2A	CHEMxxxTH		**6**
	DSE 3A	MATHSxxxTH,		**6**
	DISCIPLINE SPECIFIC	PHYS601TH PHYS601IA PHYS601TU	NUCLEAR AND PARTICLE PHYSICS (5+1)	
		PHYS602TH PHYS602IA	QUANTUM MECHANICS	

VI	ELECTIVES DSE:1B (CHOOSE ANY ONE FROM GIVEN FOUR)	PHYS602PR		**4+2**
		PHYS603TH PHYS603IA PHYS603PR	DIGITAL SIGNAL PROCESSING	
		PHYS604TH PHYS604IA PHYS604PR	ASTRONOMY AND ASTROPHYSICS	
	SEC III	PHYS605TH OR PHYS606TH	WEATHER FORECASTING OR RENEWABLE ENERGY AND ENERY HARVESTING	**4**
	DSE: 2B	CHEMxxxTH		**6**
	DSE 3B	MATHSxxxTH,		**6**

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course-I	English/MIL communications/ Environmental Science	4
	Core course-I	Mechanics	4
	Core Course-I Practical/Tutorial	Mechanics Lab	2
	Core Course II	DSC 2A	6
	Core Course III	DSC 3A	6
II	Ability Enhancement Compulsory Course-II	English/MIL communications/ Environmental Science	4
	Core course-IV	Electricity, Magnetism and EMT	4
	Core Course-IV Practical/Tutorial	Electricity, Magnetism and EMT Lab	2
	Core Course V	DSC 2B	6
	Core Course VI	DSC 2B	6
III	Core course-VII	Thermal Physics and Statistical Mechanics	4
	Core Course-VII Practical/Tutorial	Thermal Physics and Statistical Mechanics Lab	2
	Core Course VIII	DSC 2C	6
	Core Course IX	DSC 2C	6
	Skill Enhancement Course -1	SEC-1	4
IV	Core course-X	Waves and Optics	4
	Course-X Practical/Tutorial	Waves and Optics Lab	2
	Core Course XI	DSC 2D	6
	Core Course XII	DSC 2D	6
	Skill Enhancement Course -2	SEC -2	4
V	Skill Enhancement Course -3	SEC -3	4
	Discipline Specific Elective -1	DSE-1A: Physics	6
VI	Skill Enhancement Course -4	SEC -4	4
	Discipline Specific Elective -4	DSE-1B: Physics	6
	Total Credits		**132**

*** Wherever there is a practical there will be no tutorial and vice versa. The size of group for practical papers is recommended to be maximum of 12 to 15 students.**

B.Sc. Program with Physics as one subject

Core papers Physics (Credit: 06 each) (CP 1-4):

PHYS101 Mechanics (4) + Lab (2)
PHYS201 Electricity and Magnetism (4) + Lab (2)
PHYS301 Thermal Physics and Statistical Mechanics (4) + Lab (2)
PHYS401 Waves and Optics (4) + Lab (2)

Discipline Specific Elective papers (Credit: 06 each) (DSE 1, DSE 2):
Choose two courses, one for each semester V and VI.
Semester V: DSE -1 A (Choose one course only)

PHYS501 Elements of Modern Physics (4) + Lab (2)
PHYS502 Mathematical Physics (4) + Lab (2)
PHYS503 Solid State Physics (4) + Lab (2)
PHYS504 Medical Physics (4) + Lab (2)

Semester VI: DSE -1 B (Choose one course only)

PHYS601 Nuclear and particle Physics (5) + Tut (1)
PHYS602 Quantum Mechanics (4) + Lab (2)
PHYS603 Digital Signal Processing (4) + Lab (2)
PHYS604 Astronomy and Astrophysics (5) + Tutorials (1)

Skill Enhancement Course (any four) (Credit: 02 each)- SEC 1 to SEC 4
SEC- 1
PHYS302 Physics Workshop Skills or
PHYS303 Computational Physics Skills
SEC- 2
PHYS402 Electrical circuits and Network Skills or
PHYS403 Basic Instrumentation Skills
SEC- 3
PHYS505 Radiology and Safety or
PHYS506 Applied Optics
SEC- 4
PHYS605 Weather Forecasting or
PHYS606 Renewable Energy and Energy Harvesting
Important:

1. **Each University/Institute should provide a brief write-up about each paper outlining the salient features, utility, learning objectives and prerequisites.**
2. **University/Institute can add/delete some experiments of similar nature in the Laboratory papers.**
3. **The size of the practical group for practical papers is recommended to be 12-15 students.**
4. **University/Institute can add to the list of reference books given at the end of each paper.**

Semester –I

MECHANICS

Name of the Course	**PHYSICS-DSC 1A: MECHANICS (Credits: Theory-04) Theory: 60 Lectures**
Code	PHYS101 TH
Semester Term End Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit* I*), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each question from section B,C,D and E will carry 09 marks. Question Number 1. (Section A), will consist of nine sub-questions each of 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.*
2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A.(Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit-I

Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. **(4 Lectures)**
Ordinary Differential Equations: 1^{st} order ho=mogeneous differential equations. 2^{nd} order homogeneous differential equations with constant coefficients. **(6 Lectures)**
Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. **(10 Lectures)**

Unit-II

Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. **(6 Lectures)**
Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum. **(5 Lectures)**

Unit-III

Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). **(8 Lectures)**
Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic

and Potential Energy, Total Energy and their time averages. Damped oscillations.

(6 Lectures)

Unit-IV

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and $\sigma$by Searles method

(8 Lectures)

Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities. **(7) Lectures**

Note: *Students are not familiar with vector calculus. Hence all examples involve differentiation either in one dimension or with respect to the radial coordinate.*

Reference Books:

- University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison-Wesley
- Mechanics Berkeley Physics course,v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill.
- Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
- Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Mechanics Lab

Name of the Course	**PHYSICS-DSC 2A LAB: Mechanics (Credits: -02)**
Code	PHYS 101 (PR)
Semester Term End Examination	**30 marks (3 Hrs)**
Distribution of Marks: Experiment = **10 Marks**, Written/ Skills= **10 Marks** Viva Voce = **5 Marks**, Practical Record Book= **5 Marks**	

PHYSICS LAB: DSC 1A LAB: MECHANICS

60 Lectures

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater's Pendulum.
9. To determine **g** and velocity for a freely falling body using Digital Timing Technique
10. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g

11. To find the moment of inertia of an irregular body about an axis through its C.G with the torsional pendulum.
12. To compare the moment of inertia of a solid sphere and hollow sphere or solid disc of same mass with the torsional pendulum.

Reference Books:

- Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers.
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
- A Text Book of Practical Physics, Indu Pra..kash and Ramakrishna, 11^{th} Edition, 2011, Kitab Mahal, New Delhi.
- B.Sc Practical Physics C.L. Arora, S. Chand and company Ltd.

Semester-II

ELECTRICITY AND MAGNETISM

Name of the Course	**PHYSICS-DSC 1A: ELECTRICITY AND MAGNETISM** **(Credits: Theory-04)** **Theory: 60 Lectures**
Code	PHYS201 TH
Semester Term End Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each question from section B,C,D and E will carry 09 marks. Question Number 1. (Section A), will consist of nine sub-questions each of 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A.(Compulsory question number 1). The duration of the examination will be 3 hours.

Unit-I

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

(12 Lectures)

Unit-II

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric. **(22 Lectures)**

Unit-III

Magnetism:

Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law.

Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro-magnetic materials.

(10 Lectures)

Unit-IV

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

(6 Lectures)

Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization. **(10 Lectures)**

Reference Books:

- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education..
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.

ELECTRICITY AND MAGNETISM LAB

Name of the Course	**PHYSICS-DSC 2A LAB: ELECTRICITY AND MAGNETISM** **(Credits: -02)**
Code	PHYS 201 (PR)
Semester Term End Examination	**30 marks (3 Hrs)**
Distribution of Marks: Experiment = **10 Marks**, Written/ Skills= **10 Marks** Viva Voce = **5 Marks**, Practical Record Book= **5 Marks**	

PHYSICS LAB- DSC 2A LAB: ELECTRICITY AND MAGNETISM

60 Lectures

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer:

(i) Measurement of charge and current sensitivity

(ii) Measurement of CDR

(iii) Determine a high resistance by Leakage Method

(iv) To determine Self Inductance of a Coil by Rayleigh's Method.

3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and

(b) Quality factor Q

8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorem
10. To verify the Superposition, and Maximum Power Transfer Theorem
11. To determine unknown capacitance by flashing and quenching method

Reference Books

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

Semester-III

THERMAL PHYSICS AND STATISTICAL MECHANICS

Name of the Course	**PHYSICS-DSC 1A: THERMAL PHYSICS AND STATISTICAL MECHANICS MAGNETISM** **(Credits: Theory-04)** **Theory: 60 Lectures**
Code	PHYS301 TH
Semester Term End Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each question from section B,C,D and E will carry 09 marks. Question Number 1. (Section A), will consist of nine sub-questions each of 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A.(Compulsory question number 1). The duration of the examination will be 3 hours.

Unit-I

Laws of Thermodynamics:

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_P & C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero. **(22 Lectures)**

Unit-II

Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for ($C_P – C_V$), C_P/C_V, TdS equations. **(10 Lectures)**

Unit-III

Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

(10 Lectures)

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

(6 Lectures)

Unit-IV

Statistical Mechanics: Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics. **(12 Lectures)**

Reference Books:

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.
- Thermal Physics Brij Lal Subramanium

Name of the Course	**PHYSICS-DSC 3A LAB: THERMAL PHYSICS AND STATISTICAL MECHANICS** **(Credits: -02)**
Code	PHYS 301 (PR)
Semester Term End Examination	**30 marks (3 Hrs)**
Distribution of Marks: Experiment = **10 Marks**, Written/ Skills= **10 Marks** Viva Voce = **5 Marks**, Practical Record Book= **5 Marks**	

PHYSICS LAB-DSC 3A LAB: THERMAL PHYSICS AND STATISTICAL MECHANICS

60 Lectures

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.

2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge
11. To prove the law of probability by using one coin, two coins and 10 or more coins.
12. To determine the coefficient of increase of volume of air at constant pressure.
13. To determine the coefficient of increase of pressure of air at constant volume.

Reference Books:

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

Semester-IV

WAVES AND OPTICS

Name of the Course	**PHYSICS-DSC 1A: WAVES AND OPTICS** **(Credits: Theory-04)** **Theory: 60 Lectures**
Code	PHYS401 TH
Semester Term End Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each question from section B,C,D and E will carry 09 marks. Question Number 1. (Section A), will consist of nine sub-questions each of 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A.(Compulsory question number 1). The duration of the examination will be 3 hours.

Unit-I

Superposition of Two Collinear Harmonic oscillations: Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). **(4 Lectures)**

Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

(2 Lectures)

Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity. **(7 Lectures)**

Unit-II

Fluids: Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. Viscosity: Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of a liquid with temperature lubrication. Physics of low pressure - production and measurement of low pressure - Rotary pump - Diffusion pump - Molecular pump - Knudsen absolute gauge - penning and pirani gauge – Detection of leakage. **(6 Lectures)**

Sound: Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria. **(6 Lectures)**

Unit-III

Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. **(3 Lectures)**

Interference: Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. **(10 Lectures)**

Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of

wavelength, Wavelength difference, Refractive index and Visibility of fringes.
(3 Lectures)

Unit-IV

Diffraction: Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **(14 Lectures)**

Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization. **(5 Lectures)**

Reference Books:

- Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
- Principles of Optics, B.K. Mathur, 1995, Gopal Printing
- Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
- University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986. Addison-Wesley

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Name of the Course	**PHYSICS-DSC 4A LAB: WAVES AND OPTICS** **(Credits: -02)**
Code	PHYS 401 (PR)
Semester Term End Examination	**30 marks (3 Hrs)**
Distribution of Marks: Experiment = **10 Marks**, Written/ Skills= **10 Marks** Viva Voce = **5 Marks**, Practical Record Book= **5 Marks**	

PHYSICS LAB-DSC 4A LAB: WAVES AND OPTICS
60 Lectures

1. To investigate the motion of coupled oscillators
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ^2 – T Law.
3. To study Lissajous Figures
4. Familiarization with Schuster`s focussing; determination of angle of prism.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a given Prism using Mercury Light
8. To determine the value of Cauchy Constants of a material of a prism.
9. To determine the Resolving Power of a Prism.
10. To determine wavelength of sodium light using Fresnel Biprism.
11. To determine wavelength of sodium light using Newton's Rings.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium & (2) spectrum of Mercury light using plane diffraction Grating
14. To determine the Resolving Power of a Plane Diffraction Grating.
15. To measure the intensity using photosensor and laser in diffraction patterns of single and

double slits.

16. To find the refractive index of glass slab using travelling microscope
17. To find the refractive index of water using travelling microscope
18. To determine the magnifying power of a telescope

Reference Books:

- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Semester-V

Discipline Specific Elective

Select two papers

Name of the Course	**PHYSICS-DSC 1A: ELEMENTS OF MODERN PHYSICS** **(Credits: Theory-04)** **Theory: 60 Lectures**
Code	PHYS501 TH
Semester Term End Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit* I*), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each question from section B,C,D and E will carry 09 marks. Question Number 1. (Section A), will consist of nine sub-questions each of 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.*
2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A.(Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit-I

Planck’s quantum, Planck’s constant and light as a collection of photons; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. **(8 Lectures)**

Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra. **(4 Lectures)**

Unit-II

Position measurement- gamma ray microscope thought duality, Heisenberg uncertainty principle- impossibility trajectory; Estimating minimum energy of a confined principle; Energy-time uncertainty principle. Experiment; Wave-particle of a particle following a particle using uncertainty

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave function, probabilities and normalization; Probability and probability current densities in one dimension. (**11 Lectures)**

Unit-III

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier. **(12 Lectures)**

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy.

(6 Lectures)

Unit-IV

Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life; α decay; β decay - energy released, spectrum and Pauli's prediction of neutrino; γ-ray emission.

(11 Lectures)

Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions.

(4 Lectures)

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
- Modern Physics, John R. Taylor, Chris D. Zafiratos, Michael A.Dubson,2009, PHI Learning
- Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill
- Quantum Physics, Berkeley Physics Course Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
- Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning
- Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill

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Name of the Course	**PHYSICS-DSC 5A LAB: ELEMENTS OF MODERN PHYSICS (Credits: -02)**
Code	PHYS 501 (PR)
Semester Term End Examination	**30 marks (3 Hrs)**
Distribution of Marks: Experiment = **10 Marks**, Written/ Skills= **10 Marks** Viva Voce = **5 Marks**, Practical Record Book= **5 Marks**	

PRACTICALS -DSE-1 LAB: ELEMENTS OF MODERN PHYSICS
60 Lectures

1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
2. To determine work function of material of filament of directly heated vacuum diode.
3. To determine value of Planck's constant using LEDs of at least 4 different colours.
4. To determine the ionization potential of mercury.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the absorption lines in the rotational spectrum of Iodine vapour.
7. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photosensor and compare with incoherent source – Na light.
8. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
9. To determine the value of e/m by magnetic focusing.
10. To setup the Millikan oil drop apparatus and determine the charge of an electron.
11. To verify the inverse square law by using photovoltaic cell.
12. To measure the DC voltage by using CRO
13. To display the action of junction Diode as (a) Half wave rectifier and (b) Full wave rectifier using CRO

Reference Books:

- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Semester-V

Mathematical Physics

Name of the Course	**PHYSICS-DSE: MATHEMATICAL PHYSICS** **(Credits: Theory-04)** **Theory: 60 Lectures**
Code	PHYS502 TH
Semester Term End Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each question from section B,C,D and E will carry 09 marks. Question Number 1. (Section A), will consist of nine sub-questions each of 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A.(Compulsory question number 1). The duration of the examination will be 3 hours.

Unit-I

The emphasis of the course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. **(6 Lectures)**

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. **(10 Lectures)**

Unit-II

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations.

Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Orthogonality. Simple recurrence relations. **(16 Lectures)**

Unit-III

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). **(4 Lectures)**

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. **(10 Lectures)**

Unit-IV

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. **(14 Lectures)**

Reference Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- An Introduction to Ordinary Differential Equations, Earl A Coddington, 1961, PHI Learning.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Essential Mathematical Methods, K.F. Riley and M.P. Hobson, 2011, Cambridge University Press
- Partial Differential Equations for Scientists and Engineers, S.J. Farlow, 1993, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Books.

PRACTICALS -DSE LAB: MATHEMATICS PHYSICS 60 Lectures

Name of the Course	**PRACTICALS –DSE LAB: MATHEMATICAL PHYSICS (Credits: -02)**
Code	PHYS 501 (PR)
Semester Term End Examination	**30 marks (3 Hrs)**
Distribution of Marks: Experiment = **10 Marks**, Written/ Skills= **10 Marks** Viva Voce = **5 Marks**, Practical Record Book= **5 Marks**	

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlights the use of computational methods to solve physical problems*
- *Use of computer language as a tool in solving physics problems (applications)*

- *The course will consist of lectures (both theory and practical) in the Computer Lab*
- *Evaluation done not on the programming but on the basis of formulating the problem*
- *Aim at teaching students to construct the computational problem to be solved*
- *Students can use anyone operating system Linux or Microsoft Windows*

Topics	**Description with Applications**
Introduction and Overview	Computer architecture and organization, memory and Input/output devices
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (*If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement Unconditional and Conditional Looping. While-Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops*), Arrays (*1D&2D*) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs: using C/C++ language	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending-descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of pi (**π**)
Solution of Algebraic and Transcendental equations by Bisection, Newton Raphsonand Secant methods	Solution of linear and quadratic equation, solving � � ��□� �$\propto = \tan \propto$; $I = I_0 \left(\frac{\sin \propto}{\propto}\right)^2$ � in optics.
Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear	Evaluation of trigonometric functions e. g. $sin\,\theta, cos\,\theta, tan\,\theta$, *etc.*

interpolation	
Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal a n d Simpson rules), Monte Carlo method	Given Position with equidistant time data to calculate velocity and acceleration and vice-versa. Find the area of B-H Hysteresis loop
Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Attempt following problems using RK 4 order method: • Solve the coupled differential equations $\frac{dx}{dt} = y + x - \frac{x^3}{3}$; $\frac{dy}{dx} = -x$ for four initial conditions x(0) = 0, y(0) = -1, -2, -3, -4. Plot x vs y for each of the four initial conditions on the same screen for $0 \le t \le 15$ The differential equation describing the motion of a pendulum is $\frac{d^2\vartheta}{dt^2} = -\sin(\vartheta)$. The pendulum is released from rest at an angular displacement α, i. e. $\vartheta(0) = \alpha$ and $\vartheta' = 0$. Solve the equation for α = 0.1, 0.5 and 1.0 and plot ϑ as a function of time in the range $0 \le t \le 8\pi$. Also plot the analytic solution valid for small ϑ $\sin(\vartheta) = \vartheta$.

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J.Hubbard, 2000, McGraw-Hill Publications.
- Numerical Recipes in C++ : The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.
- A first course in Numerical Methods, Uri M. Ascher and Chen Greif, 2012, PHI Learning
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
- Numerical Methods for Scientists and Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to Computational Physics, T. Pang, 2nd Edn., 2006, Cambridge Univ. Press

Semester –V

SOLID STATE PHYSICS

Name of the Course	**PHYSICS-DSE: SOLID STATE PHYSICS** **(Credits: Theory-04)** **Theory: 60 Lectures**
Code	PHYS503 TH
Semester Term End Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit* I*), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each question from section B,C,D and E will carry 09 marks. Question Number 1. (Section A), will consist of nine sub-questions each of 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.*
2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A.(Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit-I

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor. **(12 Lectures)**

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law **(10 Lectures)**

Unit-*II*

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. **(12 Lectures)**

Unit-III

Dielectric Properties of Materials: 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 **(10 Lectures)**

Unit-IV

Elementary band theory: Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient. **(10 Lectures)**

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect.

(6 Lectures)

Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, Neil W. Ashcroft and N. David Mermin, 1976, Cengage Learning
- Solid State Physics, Rita John, 2014, McGraw Hill
- Solid-state Physics, H. Ibach and H Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications

Name of the Course	**PRACTICALS –DSE LAB: SOLID STATE PHYSICS (Credits: -02)**
Code	PHYS 503 (PR)
Semester Term End Examination	**30 marks (3 Hrs)**
Distribution of Marks: Experiment = **10 Marks**, Written/ Skills= **10 Marks** Viva Voce = **5 Marks**, Practical Record Book= **5 Marks**	

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (from room temperature to 150 ^{o}C) and to determine its band gap.

10. To determine the Hall coefficient of a semiconductor sample.
11. To study the characteristics of FET
12. To find energy gap of a semiconductor.
13. To study the characteristics of Zener diode.
14. To study the voltage regulation using Zener diode
15. To study the characteristics of NPN transistor
16. To study the characteristics of PNP transistor

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal, New Delhi
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India

Semester- V

MEDICAL PHYSICS

Name of the Course	**PHYSICS-DSE: Medical Physics (Credits: Theory-04) Theory: 60 Lectures**
Code	PHYS504 TH
Semester Term End Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit* I*), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each question from section B,C,D and E will carry 09 marks. Question Number 1. (Section A), will consist of nine sub-questions each of 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.*
2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A.(Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit-I

PHYSICS OF THE BODY-I

Basic Anatomical Terminology: Standard Anatomical Position, Planes. Familiarity with terms like- Superior, Inferior, Anterior, Posterior, Medial, Lateral, Proximal and Distal. **Mechanics of**

the body: Skeleton, forces, and body stability. Muscles and dynamics of body movement. Physics of Locomotors Systems: joints and movements, Stability and Equilibrium. **Energy household of the body:** Energy balance in the body, Energy consumption of the body, Heat losses of the body, Thermal Regulation. **Pressure system of body:** Physics of breathing, Physics of cardiovascular system. **(8 Lectures)**

PHYSICS OF THE BODY-II

Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound. **Optical system of the body:** Physics of the eye. **Electrical system of the body:** Physics of the nervous system, Electrical signals and information transfer. **(10 Lectures)**

Unit-II

PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-I

X-RAYS: Electromagnetic spectrum, production of x-rays, x-ray spectra, Brehmsstrahlung, Characteristic x-ray. **X-ray tubes & types**: Coolidge tube, x-ray tube design, tube cooling stationary mode, Rotating anode x-ray tube, Tube rating, quality and intensity of x-ray. X-ray generator circuits, half wave and full wave rectification, filament circuit, kilo voltage circuit, types of X-Ray Generator, high frequency generator, exposure timers and switches, HT cables, HT generation.

RADIATION PHYSICS: Radiation units exposure, absorbed dose, units: rad, gray, relative biological effectiveness, effective dose, inverse square law. Interaction of radiation with matter Compton & photoelectric effect, Rem & Sievert, linear attenuation coefficient. **Radiation Detectors**: Thimble chamber, condenser chambers, Geiger Muller counter, Scintillation counters and Solid State detectors, ionization chamber, Dosimeters, survey methods, area monitors, TLD, Semiconductor detectors. **(7 Lectures)**

Unit-III

MEDICAL IMAGING PHYSICS: Evolution of Medical Imaging, X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR), NMR imaging, MRI Radiological imaging, Ultrasound imaging, Physics of Doppler with applications and modes, Vascular Doppler. Radiography: Filters, grids, cassette, X-ray film, film processing, fluoroscopy. **Computed tomography scanner-** principle & function, display, generations, mammography. Thyroid uptake system and Gamma camera (Only Principle, function and display). **(9 Lectures)**

RADIATION ONCOLOGY PHYSICS: External Beam Therapy (Basic Idea): Telecobalt, Conformal Radiation Therapy (CRT), 3DCRT, IMRT, Image Guided Radiotherapy, EPID, Rapid Arc, Proton Therapy, Gamma Knife, Cyber Knife. Contact Beam Therapy (Basic Idea): Brachytherapy-LDR and HDR, Intra Operative Brachytherapy. Radiotherapy, kilo voltage machines, deep therapy machines, Telecobalt machines ,Medical linear accelerator. Basics of Teletherapy units, deep x-ray, Telecobalt units, medical linear accelerator, Radiation protection, external beam characteristics, dose maximum and build up – bolus, percentage depth dose, tissue maximum ratio and tissue phantom ratio, Planned target Volume and Gross Tumour Volume **(9 Lectures)**

Unit-IV

RADIATION AND RADIATION PROTECTION: Principles of radiation protection ,protective materials-radiation effects , somatic, genetic stochastic and deterministic effect. Personal monitoring devices: TLD film badge , pocket dosimeter, OSL dosimeter. Radiation dosimeter. Natural radioactivity, Biological effects of radiation, Radiation monitors**.** Steps to reduce radiation to Patient, Staff and Public. Dose Limits for Occupational workers and Public. AERB: Existence and Purpose. **(5 Lectures)**

PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-II

Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography. Therapeutic nuclear medicine: Interaction between radiation and matter Dose and isodose in radiation treatment.

Medical Instrumentation: Basic Ideas of Endoscope and Cautery, Sleep Apnea and Cpap Machines, Ventilator and its modes. **(5 Lectures)**

References:

- Medical Physics, J.R. Cameron and J.G. Skofronick, Wiley (1978)
  Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
- Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
- Physics of Radiation Therapy: F M Khan - Williams and Wilkins, Thirdedition (2003)
- Physics of the human body, Irving P. Herman, Springer (2007).
  The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
  Handbook of Physics in Diagnostic Imaging: R.S. Livingstone: B.I. Publication Pvt Ltd.
- The Physics of Radiology-H E Johns and Cunningham.

Medical Physics Lab

<table>
<tr><td>Name of the Course</td><td>PRACTICALS –DSE LAB: Medical Physics (Credits: -02)</td></tr>
<tr><td>Code</td><td>PHYS 504 (PR)</td></tr>
<tr><td>Semester Term End Examination</td><td>30 marks (3 Hrs)</td></tr>
<tr><td colspan="2">Distribution of Marks: Experiment = 10 Marks, Written/ Skills= 10 Marks Viva Voce = 5 Marks, Practical Record Book= 5 Marks</td></tr>
</table>

PRACTICALS -DSE LAB: Medical Physics 60 Lectures

1. Understanding the working of a manual Hg Blood Pressure monitor and measure the Blood Pressure.
2. Understanding the working of a manual optical eye-testing machine and to learn eye-testing.
3. Correction of Myopia (short sightedness) using a combination of lenses on an optical bench/breadboard.
4. Correction of Hypermetropia/Hyperopia (long sightedness) using a combination of lenses on an optical bench/breadboard.
5. To learn working of Thermoluminescent dosimeter (TLD) badges and measure the background radiation.
6. Familiarization with Geiger-Muller (GM) Counter and to measure background radiation.
7. Familiarization with Radiation meter and to measure background radiation.

8. Familiarization with the Use of a Vascular Doppler.

References:

- Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
- Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
- Physics of Radiation Therapy: F M Khan - Williams and Wilkins, Third edition (2003)
- The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
- The Physics of Radiology-H E Johns and Cunningham.
- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- Handbook of Physics in Diagnostic Imaging: Roshan S. Livingstone: B. I. Publications Pvt Ltd.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Semester –VI

QUANTUM MECHANICS

Name of the Course	**PHYSICS-DSE: QUANTUM MECHANICS** **(Credits: Theory-04)** **Theory: 60 Lectures**
Code	PHYS602 TH
Semester Term End Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each question from section B,C,D and E will carry 09 marks. Question Number 1. (Section A), will consist of nine sub-questions each of 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.*
2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A.(Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit-I

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. **(6 Lectures)**

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to the spread of Gaussian wavepacket for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle. **(10 Lectures)**

Unit-II

General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method. **(12 Lectures)**

Unit-III

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for the second order partial differential equation; angular momentum operator and quantum numbers; Radial wave functions from Frobenius method; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells (idea only) **(10 Lectures)**

Atoms in Electric and Magnetic Fields:- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **(8 Lectures)**

Unit-IV

Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect. **(4 Lectures)**

Many electron atoms:- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J-J couplings. **(10 Lectures)**

Reference Books:

- A Text book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2ndEdn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Additional Books for Reference

- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4thEdn., 2001, Springer

Semester- VI (Quantum Mechanics Lab)

Name of the Course	**PRACTICALS –DSE LAB: QUANTUM MECHANICS (Credits: -02)**
Code	PHYS 602 (PR)
Semester Term End Examination	**30 marks (3 Hrs)**
Distribution of Marks: Experiment = **10 Marks**, Written/ Skills= **10 Marks** Viva Voce = **5 Marks**, Practical Record Book= **5 Marks**	

PRACTICAL-DSE LAB: QUANTUM MECHANICS 60 Lectures

Use C/C^{++}/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom

$$\frac{d^2y}{dt^2} = A(r)u(r), \quad A(r) = \frac{2m}{\hbar^2}[V(r) - E] = -\frac{e^2}{r}$$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 (eVÅ)$^{1/2}$,ħc = 1973 (eV Å) and m = 0.511x10^{6}eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}[V(r) - E]$$

Here m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -\frac{e^2}{r}e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits, Also, plot the corresponding wave function. Take e = 3.795 (eVÅ)$^{1/2}$,m=0.511x10^{6}eV/c^2, and a = 3 Å. In these Units hc =1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}[V(r) - E]$$

for the ground state energy (in MeV) of the particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3} In theseħ=197units,30MeV fm^{-3}. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2\mu}{h^2}[V(r) - E]$$

Where is the reduced mass of the two atom system for the Morse potential

$$V(r) = D(\, e^{-2\propto r'} e^{-\propto r'}), \qquad r' = \frac{r - r_0}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant edigits. Also plot the corresponding wave function.

Take: m = 940 x10^6e V/C^2, D= 0.755501 eV, ∝= 1.44, r_0= 0.131349 Å

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency

6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting

7. To study the quantum tunnelling effect with solid state device, e.g. tunnelling current in backward diode or tunnel diode.

Reference Books:

- Schaum's Outline of Programming with C++. J.Hubbard, 2000, McGraw-Hill Publications.
- Numerical Recipes in C: The Art of Scientific Computing, W.H.Press et al., 3rd Edn., 2007, Cambridge University Press.
- Elementary Numerical Analysis, K.E.Atkinson, 3rd Edn., 2007, Wiley India Edition.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf2012ISBN: 978-1479203444
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand and Company, New Delhi ISBN: 978-8121939706
- Scilab Image Processing: Lambert M. Surhone. 2010Betascript Publishing ISBN: 978-6133459274A
- Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
- Quantum Mechanics, Bruce Cameron Reed, 008, Jones and Bartlett Learning.

Semester –VI

NUCLEAR AND PARTICALE PHYSICS

Name of the Course	**PHYSICS-DSE:NUCLEAR AND PARTICLE PHYSICS (Credits: Theory-04) Theory: 60 Lectures**
Code	PHYS601 TH
Semester Term End Examination	**80 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit* I*), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question no. one will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each questions from B,C,D and E will carry 16 marks. Question number 1. (Section A), will consist of nine sub-questions each 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.*
2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and Eight sub-questions from section A(Compulsory question number 1.). The duration of the examination will be 3 hours.*

Unit-I

General Properties of Nuclei: 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, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states. **(10 Lectures)**

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability. Two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. **(12 Lectures)**

Unit-II

Radioactivity decay:(a) Alphaα decay: basics of -decay processes, theory of α-emission, Gamowα factor, Geiger Nuttall law, -decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. **(10 Lectures)**

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **(8 Lectures)**

Unit-III

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation, Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.
(8 Lectures)

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si & Ge) for charge particle and photon detection (concept of charge carrier and mobility). **(8 Lectures)**

Unit-IV

Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. **(5 Lectures)**

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quarkmodel, color quantum number and gluons. **(14 Lectures)**

Reference Books:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004)
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)

SEMESTER- VI

DIGITAL SIGNAL PROCESSING

Name of the Course	**PHYSICS-DSE:DIGITAL SIGNAL PROCESSING** **(Credits: Theory-04)** **Theory: 60 Lectures**
Code	PHYS603 TH
Semester Term End Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each question from section B,C,D and E will carry 09 marks. Question Number 1. (Section A), will consist of nine sub-questions each of 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A.(Compulsory question number 1). The duration of the examination will be 3 hours.

Unit-I

Discrete-Time Signals and Systems: Classification of Signals, Transformations of theIndependent Variable, Periodic and Aperiodic Signals, Energy and Power Signals, Evenand Odd Signals, Discrete-Time Systems, System Properties. Impulse Response, Convolution Sum; Graphical Method; Analytical Method, Properties of Convolution; Commutative; Associative; Distributive; Shift; Sum Property System Response to Periodic Inputs, Relationship Between LTI System Properties and the Impulse Response; Causality; Stability; Invertibility, Unit Step Response. **(10 Lectures)**

Discrete-Time Fourier Transform: Fourier Transform Representation of Aperiodic Discrete-Time Signals, Periodicity of DTFT, Properties; Linearity; Time Shifting; Frequency Shifting; Differencing in Time Domain; Differentiation in Frequency Domain; Convolution Property. **The *z*-Transform:** Bilateral (Two-Sided) *z*-Transform, Inverse *z*-Transform, Relationship Between *z*-Transform and Discrete-Time Fourier Transform, *z*-plane, Region-of-Convergence; Properties of ROC, Properties; Time Reversal; Differentiation in the *z*-Domain; Power Series Expansion Method (or Long Division Method); Analysis and Characterization of LTI Systems; Transfer Function and Difference-Equation System. Solving Difference Equations. **(15 Lectures)**

Unit-II

Filter Concepts: Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter,Simple FIR Digital Filters, Simple IIR Digital Filters, All pass Filters, Averaging Filters, Notch Filters. **(5 Lectures)**

Discrete Fourier Transform: Frequency Domain Sampling (Sampling of DTFT), The Discrete Fourier Transform (DFT) and its Inverse, DFT as a Linear transformation, Properties; Periodicity; Linearity; Circular Time Shifting; Circular Frequency Shifting; Circular Time Reversal; Multiplication Property; Parseval's Relation, Linear Convolution Using the DFT (Linear Convolution Using Circular Convolution), Circular Convolution as Linear Convolution with aliasing. **(10 Lectures)**

Unit-III

Fast Fourier Transform: Direct Computation of the DFT, Symmetry and Periodicity Properties of the Twiddle factor (*WN*), Radix-2 FFT Algorithms; Decimation-In-Time (DIT) FFT Algorithm; Decimation-In-Frequency (DIF) FFT Algorithm, Inverse DFT Using FFT Algorithms. **(5 Lectures)**

Realization of Digital Filters: Non Recursive and Recursive Structures, Canonic and Non Canonic Structures, Equivalent Structures (Transposed Structure), FIR Filter structures; Direct-Form; Cascade-Form; Basic structures for IIR systems; Direct-Form I.

Unit-IV

Finite Impulse Response Digital Filter: Advantages and Disadvantages of Digital Filters, Types of Digital Filters: FIR and IIR Filters; Difference Between FIR and IIR Filters, Desirability of Linear-Phase Filters, Frequency Response of Linear-Phase FIR Filters, Impulse Responses of Ideal Filters, Windowing Method; Rectangular; Triangular; Kaiser Window, FIR Digital Differentiators.

Infinite Impulse Response Digital Filter: Design of IIR Filters from Analog Filters, IIR Filter Design by Approximation of Derivatives, Backward Difference Algorithm, Impulse Invariance Method. **(15 Lectures)**

Reference Books:

- Digital Signal Processing, Tarun Kumar Rawat, 2015, Oxford University Press, India
- Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
- Modern Digital and Analog Communication Systems, B.P. Lathi, 1998, 3rd Edn. Oxford University Press.
- Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L.Harris, 2005, Cengage Learning.
- Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.
- Digital Signal Processing Principles Algorithm & Applications, J.G. Proakis and D.G. Manolakis, 2007, 4th Edn., Prentice Hall.

DIGITAL SIGNAL PROCESING LAB

Name of the Course	**PRACTICALS –DSE LAB: DIGITAL SIGNAL PROCESSING** **(Credits: -02)**
Code	PHYS 603 (PR)
Semester Term End Examination	**30 marks (3 Hrs)**
Distribution of Marks: Experiment = **10 Marks**, Written/ Skills= **10 Marks** Viva Voce = **5 Marks**, Practical Record Book= **5 Marks**	

Scilab based simulations experiments based problems like

1. Write a program to generate and plot the following sequences: (a) Unit sample sequence $\delta(n)$, (b) unit step sequence $u(n)$, (c) ramp sequence (n), (d) real valued exponential sequence $x(n) = (0.8)^n$ for $0 \le n \le 50$.

2. Write a program to compute the convolution sum of a rectangle signal (or gate function) with itself for $N = 5$

$X(n) = rect\left(\frac{n}{2n}\right) \Pi\left(\frac{n}{2n}\right) = \begin{cases} 1 & -N \le n \le N \\ 0 & otherwise \end{cases}$

3. An LTI system is specified by the difference equation
$y(n) = 0.8\, y(n-1) + x(n)$
(a) Determine $H(e^{jw})$
(b) Calculate and plot the steady state response $Y_{ss}(n)$ to $x(n) = \cos(0.5\pi n)u(n)$

4. Given a casual system y(n) = 0.9 y(n-1)+x(n)

(a) Find $H(z)$ and sketch its pole − zero plot
(b) Plot the frequency response $|H(e^{jw})|$ and

5. Design a digital filter to eliminate the lower frequency sinusoid of $\sin 7t + \sin 200t$. The sampling frequency is $f_s = 500$. Plot its pole zero diagram, magnitude response, input and output of the filter.

6. Let $x(n)$ be a 4 − point sequence:

$x(n) = (1,1,1,1) = \begin{cases} 1 & 0 \le n \le 3 \\ 0 & \text{other wise} \end{cases}$

Compute the DTFT $X(e^{jw})$ and plot its magnitude
(a) Compute and plot the 4 point DFT of $x(n)$
(b) Compute and plot the 8 point DFT of $x(n)$ (by appending 4 zeros)
(c) Compute and plot the 16 point DFT of $x(n)$ (by appending 12 zeros)

7. Let $x(n)$ and $h(n)$ be the two 4 − point sequences,

$x(n) = \left\{\frac{1,2,2,1}{|}\right\}$ h(n) $\left\{\frac{1-1,-1,1}{|}\right\}$

Write a program to compute their linear convolution using circular convolution.

8. *Using a rectangular window, design a FIR low − pass filter with a pass − band gain of unity, cut off frequency of* 1000 *Hz and working at a sampling frequency of* 5 *KHz. Take the length of the impulse response as* 17.

9. *Design an FIR filter to meet the following specifications*:

passband edge $F_p = 2KH_z$

stopband edge $F_s = 5KH_z$

Passband attenuation $A_p = 2dB$

Stopband attenuation $A_s = 42dB$

Sampling frequency $F_s = 20KH_z$

10. *The frequency response of a linear phase digital differentiator is given by*

$H_d\left(e^{jw}\right)$ =jwe^{-jtw} 1w1$\leq \pi$

Using a Hamming window of length M = 21, design a digital FIR differentiator.

Plot the amplitude response.

Reference Books:

1. Digital Signal Processing, Tarun Kumar Rawat, Oxford University Press, India.
2. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rdEdn., Cambridge University Press
3. Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling andS.L. Harris, 2005, Cengage Learning.
4. Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
5. Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007 Cambridge University Press.
6. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
7. Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444
8. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978- 6133459274

SEMESTER –VI

ASTRONOMY AND ASTROPHYSICS

Name of the Course	**PHYSICS-DSE:ASTRONOMY AND ASTROPHYSICS** **(Credits: Theory-06)** **Theory: 60 Lectures**
Code	PHYS604 TH
Semester Term End Examination	**80 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**20 marks**
CCA: Based on midterm exam, class test/seminar/assignments/quiz and attendance. Midterm Exam=**10 marks,** Class test/seminar/assignments/quiz =**05 marks, Attendance=05 marks; a) >=75% to 80% : 3 marks b) >= 80% to 90%= 4 marks c) >= 90% and above = 5 Marks**	

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I*), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question no. one will be compulsory and selecting two questions each from Units I, II, III and unit IV respectively. Each questions from B,C,D and E will carry 16 marks. Question number 1. (Section A), will consist of nine sub-questions each 2 marks of types: Multiple Choice Questions(MCQ)/fill in the blanks and/or short answer type questions.*

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and Eight sub-questions from section A(Compulsory question number 1.). The duration of the examination will be 3 hours.

Unit-I

Astronomical Scales: Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature. **Basic concepts of positional astronomy:** Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Astronomical Coordinate Systems, Geographical Coordinate Systems, Horizon System, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates. Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star; Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram. **(24 Lectures)**

Unit-II

Astronomical techniques: Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical

Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes).

Physical principles: Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium. **(9 Lectures)**

Unit-III

The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology).
The solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets.
Stellar spectra and classification Structure (Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification) **(11 Lectures)**

Unit-IV

The milky way: Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus. **(14 Lectures)**

Galaxies: Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms. **(7 Lectures)**
Large scale structure & expanding universe: Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance-Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter). **(10 Lectures)**

Reference Books:

- Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
- Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4thEdition, Saunders College Publishing.
- The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
- Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
- K.S. Krishnasamy, 'Astro Physics a modern perspective,' Reprint, New Age International (p) Ltd, New Delhi,2002.
- Baidyanath Basu, 'An introduction to Astro physics', Second printing, Prentice - Hall of India Private limited, New Delhi,2001.
- Textbook of Astronomy and Astrophysics with elements of cosmology, V.B.Bhatia, Narosa Publication.
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Skill Enhancement Course (any four) (Credit: 02 each)- SEC1 to SEC4

PHYSICS WORKSHOP SKILL (Credits: 04) 30 Lectures	Maximum Marks: 100 Theory Exam: 50 Skill Exam: 50
Maintain project file or Dissertation to check Analytic skill/problem solving in skill exam	

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,*
2. *The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.*

The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode

Introduction: Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc. **(4 Lectures)**

Mechanical Skill: Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet. **(10 Lectures)**

Electrical and Electronic Skill: Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, Electronic switch using transistor and relay. **(10 Lectures)**

Introduction to prime movers: Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment. **(6 Lectures)**

Reference Books:

- A text book in Electrical Technology - B L Theraja – S. Chand and Company.
- Performance and design of AC machines – M.G. Say, ELBS Edn.
- Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.
- Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes [ISBN: 0750660732]
- New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN: 0861674480]

COMPUTATIONAL PHYSICS (Credits: 04) Theory: 30 Lectures	Maximum Marks: 100 Theory Exam: 50 Skill Exam: 50
Maintain project file or Dissertation to check Analytic skill/problem solving in skill exam	

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,*
2. *The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.*

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlights the use of computational methods to solve physical problems*
- *Use of computer language as a tool in solving physics problems (applications)*
- *Course will consist of hands on training on the Problem solving on Computers.*

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution**.** Usage of linux as an Editor. **Algorithms and Flowcharts:** Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin (x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal. **(4 Lectures)**

Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

(5 Lectures)

Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical **IF**, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

Programming:

1. Exercises on syntax on usage of Object oriented C++/FORTRAN

2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using exp(x) series evaluated at x=1 **(6 Lectures)**

Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. **Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors. **(6 Lectures)**

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization.

(9 Lectures)

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
- LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
- A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.

ELECTRICAL CIRCUITS AND NETWORK SKILLS (Credits: 04) Theory: 30 Lectures	Maximum Marks: 100 Theory Exam: 50 Skill Exam: 50
Maintain project file or Dissertation to check Analytic skill/problem solving in skill exam	

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,*
2. *The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.*

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity.

Familiarization with multimeter, voltmeter and ammeter. **(3 Lectures)**

Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. **(4 Lectures)**

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. **(4 Lectures)**

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. **(3 Lectures)**

Components in Series or in shunt. Response of inductors and capacitors with DC or AC

Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)

(4 Lectures)

Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board. **(5 Lectures)**

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja
- Performance and design of AC machines - M G Say ELBS Edn.

BASIC INSTRUMENTATION SKILLS (Credits: 04) Theory: 30 Lectures	Maximum Marks: 100 Theory Exam: 50 Skill Exam: 50
Maintain project file or Dissertation to check Analytic skill/problem solving in skill exam	

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,*
2. *The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.*

This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. **(4 Lectures)**

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. **AC millivoltmeter:** Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter**,** specifications and their significance. **(4 Lectures)**

Cathode Ray **Oscilloscope:** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. **(6 Lectures)**

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working. **(3 Lectures)**

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis. **(4 Lectures)**

Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges. **(3 Lectures)**

Digital Instruments: Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. **(3 Lectures)**

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution. **(3 Lectures)**

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand and Co.
- Performance and design of AC machines - M G Say ELBS Edn.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

RENEWABLE ENERGY AND ENERGY HARVESTING (Credits: 04) **Theory: 30 Lectures**	**Maximum Marks: 100** **Theory Exam: 50** **Skill Exam: 50**
Maintain project file or Dissertation to check Analytic skill/problem solving in skill exam	

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,*
2. *The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.*

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

Fossil fuels and Alternate Sources of energy: Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. **(3 Lectures)**

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. **(6 Lectures)**

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. **(3 Lectures)**

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. **(3 Lectures)**

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. **(2 Lectures)**

Geothermal Energy: Geothermal Resources, Geothermal Technologies. **(2 Lectures)**

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. **(2 Lectures)**

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power **(4 Lectures)**

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications **(2 Lectures)**

Carbon captured technologies, cell, batteries, power consumption **(2 Lectures)**

Environmental issues and Renewable sources of energy, sustainability. **(1 Lecture)**

Demonstrations and Experiments

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials

3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books:

- Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
- Solar energy - M P Agarwal - S Chand and Co. Ltd.
- Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
- Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
- Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
- J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- http://en.wikipedia.org/wiki/Renewable_energy

TECHNICAL DRAWING (Credits: 04) **Theory: 30 Lectures**	**Maximum Marks: 100** **Theory Exam: 50** **Skill Exam: 50**
Maintain project file or Dissertation to check Analytic skill/problem solving in skill exam	

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,*
2. *The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.*

Introduction: Drafting Instruments and their uses. lettering: construction and uses of various scales: dimensioning as per I.S.I. 696-1972. Engineering Curves: Parabola: hyperbola: ellipse: cycloids, involute: spiral: helix and loci of points of simple moving mechanism.2D geometrical construction. Representation of 3D objects. Principles of projections.
(4 Lectures)

Projections: Straight lines, planes and solids. Development of surfaces of right and oblique solids. Section of solids. **(6 Lectures)**

Object Projections: Orthographic projection. Interpenetration and intersection of solids. Isometric and oblique parallel projection of solids. **(4 Lectures)**

CAD Drawing: Introduction to CAD and Auto CAD, precision drawing and drawing aids, Geometric shapes, Demonstrating CAD- specific skills (graphical user interface.Create, retrieve, edit, and use symbol libraries. Use inquiry commands to extract drawing data). Control entity properties. Demonstrating basic skills to produce 2-D and 3-Ddrawings. 3D modeling with Auto CAD (surfaces and solids), 3D modeling with sketch up, annotating in Auto CAD with text and hatching, layers, templates & design center, advanced plotting (layouts, viewports), office standards, dimensioning, internet and collaboration, Blocks, Drafting symbols, attributes, extracting data. basic printing, editing tools, Plot/Print drawing to appropriate scale. **(16 Lectures)**

Reference Books:

- K. Venugopal, and V. Raja Prabhu. Engineering Graphic, New Age International
- AutoCAD 2014 & AutoCAD 2014/Donnie Gladfelter/Sybex/ISBN:978-1-118-57510-9
- Architectural Design with Sketchup/Alexander Schreyer/John Wiley & Sons/ISBN: 978-1-118-12309-6

Radiation Safety **Credits: 04)** **Theory: 30 Lectures**	**Maximum Marks: 100** **Theory Exam: 50** **Skill Exam: 50**
Maintain project file or Dissertation to check Analytic skill/problem solving in skill exam	

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,*
2. *The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.*

The aim of this course is for awareness and understanding regarding radiation hazards and safety. The list of laboratory skills and experiments listed below the course are to be done in continuation of the topics

Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission. **(6 Lectures)**

Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, **Interaction of Photons -** Photo-electric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, **Interaction of Charged Particles:** Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), **Interaction of Neutrons-** Collision, slowing down and Moderation. **(7 Lectures)**

Radiation detection and monitoring devices: Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). **Radiation detection:** Basic concept and working principle of *gas detectors* (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), *Scintillation Detectors* **(**Inorganic and Organic Scintillators), *Solid States Detectors* and *Neutron Detectors, Thermo luminescent Dosimetry*.
(7 Lectures)

Radiation safety management: *Biological effects of ionizing radiation*, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International

Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management. **(5 Lectures)**

Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. *Industrial Uses:* Tracing, Gauging, Material Modification, Sterization, Food preservation. **(5 Lectures)**

Experiments:

1. Study the background radiation levels using Radiation meter

Characteristics of Geiger Muller (GM) Counter:

2) Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
3) Study of counting statistics using background radiation using GM counter.
4) Study of radiation in various materials (e.g. KSO4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.
5) Study of absorption of beta particles in Aluminum using GM counter.
6) Detectionαparticlesofusing reference source & determining its half life using spark counter
7) Gamma spectrum of Gas Light mantle (Source of Thorium)

Reference Books:

1. W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
2. G.F.Knoll, Radiation detection and measurements
3. Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)
4. W.J. Meredith and J.B. Massey, "Fundamental Physics of Radiology". John Wright and Sons, UK, 1989.
5. J.R. Greening, "Fundamentals of Radiation Dosimetry", Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
6. Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
7. A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.
8. NCRP, ICRP, ICRU, IAEA, AERB Publications.
9. W.R. Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc. London, 1981

Applied Optics **(Credits: 04)** **Theory: 30 Lectures**	**Maximum Marks: 100** **Theory Exam: 50** **Skill Exam: 50**
Maintain project file or Dissertation to check Analytic skill/problem solving in skill exam	

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,*
2. *The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.*

Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections.

(i) Sources and Detectors (9 Periods)

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers.

Experiments on Lasers:

a. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
b. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
c. To find the polarization angle of laser light using polarizer and analyzer
d. Thermal expansion of quartz using laser

Experiments on Semiconductor Sources and Detectors:

a. V-I characteristics of LED
b. Study the characteristics of solid state laser
c. Study the characteristics of LDR
d. Photovoltaic Cell
e. Characteristics of IR sensor

(ii) Fourier Optics (6 Periods)

Concept of Spatial frequency filtering, Fourier transforming property of a thin lens

Experiments on Fourier Optics:

a. Fourier optic and image processing

1. Optical image addition/subtraction
2. Optical image differentiation
3. Fourier optical filtering
4. Construction of an optical 4f system

b. Fourier Transform Spectroscopy

Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

Experiment:

To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done.

(iii) Holography (6 Periods)

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition

Experiments on Holography and interferometry:

1. Recording and reconstructing holograms
2. Constructing a Michelson interferometer or a Fabry Perot interferometer
3. Measuring the refractive index of air
4. Constructing a Sagnac interferometer
5. Constructing a Mach-Zehnder interferometer
6. White light Hologram

(iv) Photonics: Fibre Optics (9 Periods)

Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating

Experiments on Photonics: Fibre Optics

a. To measure the numerical aperture of an optical fibre

b. To study the variation of the bending loss in a multimode fibre

c. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern

d. To measure the near field intensity profile of a fibre and study its refractive index profile

e. To determine the power loss at a splice between two multimode fibre

Reference Books:

- Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.

- LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill
- Fibre optics through experiments,M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
- Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
- Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
- Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4th Edn., 1996, Cambridge Univ. Press

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Weather Forecasting **(Credits: 04)** **Theory: 30 Lectures**	**Maximum Marks: 100** **Theory Exam: 50** **Skill Exam: 50**
Maintain project file or Dissertation to check Analytic skill/problem solving in skill exam	

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,*
2. *The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.*

The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques

Introduction to atmosphere: Elementary idea of atmosphere: physical structure andcomposition; compositional layering of the atmosphere; variation of pressure and

Measuring the weather: Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws. **(4 Periods)**

Weather systems: Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.
(3 Periods)

Climate and Climate Change: Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate. **(6 Periods)**

Basics of weather forecasting: Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts. **(8 Periods)**

Demonstrations and Experiments:

1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data:

(a) To calculate the sunniest time of the year.

(b) To study the variation of rainfall amount and intensity by wind direction.

(c) To observe the sunniest/driest day of the week.

(d) To examine the maximum and minimum temperature throughout the year.

(e) To evaluate the relative humidity of the day.

(f) To examine the rainfall amount month wise.

3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.

4. Formats and elements in different types of weather forecasts/ warning (both aviation and non aviation)

Reference books:

1. Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
2. The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.
3. Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
4. Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.
5. Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.
6. Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.
