THIS DRAFT WILL BE PLACED IN THE COMMITTEE OF COURSES MEETING ON 22-05-2019 FOR DISCUSSION AND THE SUBSEQUENT APPROVAL

Introduction

Content: The learning outcomes-based curriculum framework for a B.Sc degree in Physics is intended to provide a b framework within which Physics programmes that respond to the needs of students and to the evolving nature of Physics as a subject could be developed. The framework is expected to assist in the maintenance of the standard o Physics degrees/programmes across the country and periodic programme review within a broad framework of agree expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The framework, however, does not seek to bring about uniformity in syllabi for a programme of study in Physics, or in teaching-learning process and learning assessment procedures. Instead, the framework is intended t allow for flexibility and innovation in programme design and syllabi development, teaching-learning process, assess of student learning levels.

Learning Outcome based approach to Curriculum Planning
>> Nature and extent of the B.Sc/B.A./B.Com Programme

Content: Physics is normally referred to as the natural science that studies systematically the laws of Nature operat at diverse length scales (from sub-atomic scales to the entire universe) and their consequences. The scope of Physi a subject is very broad. The key areas of study within the disciplinary/subject area of Physics comprise: Classical an Quantum Mechanics, Thermal and Statistical Physics, Nuclear, Atomic and Particle Physics, Optics. Laser and Spectroscopy, Solid State Physics and Materials Science, Electronics, Astrophysics and so on to name a few. Each to area deals with various aspects of nature as evident from their names in great detail with mathematical description understanding.

Degree programmes in Physics cover topics that overlap with the areas outlined above and that address the interfa of Physics with other subjects (such as Biophysics and Chemical Physics) and with applied fields (such as Environme Physics, Materials Physics etc.). The depth and breadth of study of ndividual topics dealt with would vary with the n of specific Physics programmes. As a part of the efforts to enhance the employability of graduates of Physics programmes, the curricula for these programmes are expected to include learning experiences that offer opportunit for a period of study in industry. These may involve both a major work-related Physics project and some guided stu

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Learning Outcome based approach to Curriculum Planning
>> Aims of Bachelor's degree programme in (CBCS) B.SC. PHYSICAL SCIENCE

Content: The overall aims of bachelor's degree programme in Physics are to:

•provide students with learning experiences that help instill deep interests in learning Physics, develop broad and balanced knowledge and understanding of key concepts, principles, and theories related to Physics and equip stude with appropriate tools of analysis to tackle issues and problems in the field of Physics.

•develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in Physics.

•provide students with the knowledge and skill base that would enable them to undertake further studies in Physic related areas or in multidisciplinary areas that involve Physics and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

Graduate Attributes in Subject

>> Disciplinary knowledge

Content: Capable of demonstrating (i) comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings in Physics and its different subfields (Classical and Quantum Mechanics, Therma Statistical Physics, Nuclear, atomic and particle Physics, Optics.Solid State Physics and Materials Science, Electronics, Astrophysics etc.), and other related fields of study, including broader interdisciplinary subfields such as life science, environmental science and material sciences; (ii) ability to use modern instrumentation for analysis and interpretatic

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Graduate Attributes in Subject
>> Communication Skills

Content: Ability to transmit complex technical information relating to Physics in a clear and concise manner in writing oral skills.

Graduate Attributes in Subject
>> Critical thinking

Content: Ability to employ critical thinking in the various basic areas of Physics.

Graduate Attributes in Subject
>> Problem solving

Content: Ability to efficient problem solving skills in the various basic areas of Physics.

Graduate Attributes in Subject
>> Analytical reasoning

Content: Capability for asking relevant/appropriate questions relating to issues and problems in the field of Physics planning, executing and
reporting the results of an experiment or investigation.

Graduate Attributes in Subject
>> Research-related skills

Content: Capability for asking relevant/appropriate questions relating to issues and problems in the field of Physics planning, executing and
reporting the results of an experiment or investigation.

Graduate Attributes in Subject
>> Cooperation/Team work

Content: Capable of working effectively in diverse teams in both classroom, laboratory and in industry and field-bas situations.

Graduate Attributes in Subject
>> Leadership readiness/qualities

Content: Capable of identifying/mobilising appropriate resources required for a project, and manage a project throu completion, while observing responsible and ethical scientific conduct; and safety regulations and practices.

Graduate Attributes in Subject
>> Information/digital literacy

Content: Capable of using computers for Physics simulation and computation and appropriate software for analysis data, and employing modern library search tools to locate, retrieve, and evaluate Physics -related information.

Graduate Attributes in Subject
>> Moral and ethical awareness/reasoning

Content: Avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, and appreciate environmental and sustainability issues.

Graduate Attributes in Subject
>> Lifelong learning

Content: Capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and reskilling.

Qualification Description

Content: The qualification descriptors for a Bachelor's Degree programme in Physics may include the following:

•Demonstrate (i) a fundamental/systematic or coherent understanding of the academic field of Physics, Its different learning areas and applications, and its linkages with related disciplinary areas/subjects; (ii) procedural knowledge creates different types of professionals related to Physics area of study, including research and development, teach and government and public service;
(iii) skills in areas related to specialization area relating the subfields and current developments in the academic fiel Physics.

•Use knowledge, understanding and skills required for identifying problems and issues relating to Physics, collectior relevant quantitative and/or qualitative data drawing on a wide range of sources, and their application, analysis an evaluation using methodologies as appropriate to the subject(s) for formulating evidence-based solutions and arguments

•Communicate the results of studies undertaken accurately in a range of different contexts using the main concepts constructs and techniques of the subject(s)

•Meet one's own learning needs, drawing on a range of current research and development work and professional materials

•Apply one's subject knowledge and transferable skills to new/unfamiliar contexts to identify and analyse problems issues and solve complex problems with well-defined solutions.

•Demonstrate subject-related and transferable skills that are relevant to Physics related job trades and employmer opportunities

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Programme Learning Outcome in course

Content: The programme learning outcomes relating to B.Sc degree programmein Physics may include the following

•Demonstrate(i) a systematic or coherent understanding of the fundamental concepts, principles and processes underlying the academic field of Physics, its different subfields (Classical and Quantum Mechanics, Thermal and Stati Physics, Nuclear, atomic and particle Physics, Optics. Laser and Spectrocopy, Solid State Physics and Materials Scien Electronics, Astrophysics etc.), and its linkages with related disciplinary areas/subjects; (ii) procedural knowledge th creates different types of professionals in the field of Physics and related fields such as pharmaceuticals, chemical industry, teaching, research, environmental monitoring, product quality, consumer goods industry, food products, cosmetics industry, etc.; (iii) skills related to specialisation areas within Physics as well as within subfields of Physics mentioned above), and other related fields of study, including broader interdisciplinary subfields (life, environmental material sciences).

•Apply appropriate methodologies in order to conduct investigations and apply relevant knowledge and skills to see solutions to problems that emerge from the subfields of Physics as well as from broader interdisciplinary subfields relating to Physics.

•Use Physics techniques relevant to academia and industry, generic skills and global competencies, including knowle and skills that enable students to undertake further studies in the field of Physics or a related field, and work in the various related industry sectors.

•Undertake hands on lab work and practical activities which develop problem solving abilities required for successfu career in Physics applications oriented industries, computational and IT industries, teaching, research, environmenta monitoring, space research, product quality, consumer goods industry etc

•Recognize and appreciate the importance of the Physical sciences and its application in an academic, industrial, economic, environmental and social contexts.

Teaching-Learning Process

Content: As a programme of study in Physics is designed to encourage the acquisition of disciplinary/subject knowle understanding, and academic and professional skills required for Physics-based professions and jobs, learning experiences should be designed and implemented to foster active/participative learning. Development of practical sl will constitute an important aspect of the teaching-learning process. A variety of approaches to teaching-learning process, including lectures, seminars, tutorials, workshops, peer teaching and learning, practicum and project-basec learning, field-based learning, substantial laboratory-based practical component and experiments, open-ended proj work, games, technology-enabled learning, internship in industry and research establishments etc. will need to be adopted to achieve this. Problem-solving skills and higher-order skills of reasoning and analysis will be encouraged through teaching strategies.

Assessment Methods

Content: The assessment of students' achievement in Physics will be aligned with the course/programme learning outcomes and the academic and professional skills that the programme is designed to develop. A variety of assessr methods that are appropriate within the disciplinary area of Physics will be used. Learning outcomes will be assess using the following: oral and written examinations, closed-book and open-book tests; problem-solving exercises, ur problems in examinations, practical assignment laboratory reports, observation of practical skills, individual project reports, seminar presentation; viva voce interviews; computerized adaptive testing, literature surveys and evaluati outputs from collaborative work, etc.

Communication Electronics (42514305) Core Course - (CC) Credit:6

Course Objective(2-3)

1. This paper aims to describe the concepts of electronics in communication.
2. Communication techniques based on Analog Modulation, Analog and digital Pulse Modulation including PA PWM, PPM, ASK, PSK, FSK are described in detail.
3. Communication and Navigation systems such as GPS and mobile telephony system are introduced.

Course Learning Outcomes

At the end of this course, students will be able to develop following learning outcomes:
• This paper aims to describe the concepts of electronics in communication. In this course, students will receive an introduction to the principle, performance and applications of communication systems.
• Students will learn the various means and modes of communication. They will gain an understanding of fundamentals of electronic communication system and electromagnetic communication spectrum with an idea of frequency allocation for radio communication system in India.
• They will gain an insight on the use of different modulation and demodulation techniques used in analog communication
• Students will be able to analyze different parameters of analog communication techniques.
• They will learn the need of sampling and different sampling techniques where they can sample analog signal.
• Students will learn the generation and detection of a signal through pulse and digital modulation techniques and multiplexing.
• They will gain an in-depth understanding of different concepts used in a satellite communication system.
• They will study the concept of Mobile radio propagation, cellular system design and understand mobile technologies like GSM and CDMA.
• Students will understand evolution of mobile communication generations 2G, 3G, and 4G with their

characteristics and limitations.
• This paper will essentially connect the text book knowledge with the most popular communication technology in real world.

Unit 1

Electronic communication: Introduction to communication – means and modes. Power measurements (units of power). Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. (4 Lectures)
Analog Modulation: Amplitude Modulation, modulation index and frequency spectrum.Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Single Sideband (SSB) systems, advantages of SSB transmission, Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector),Qualitative idea of Super heterodyne receiver. (12 Lectures)

Unit 2

Analog Pulse Modulation: Channel capacity, Sampling theorem, Basic Principles-PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing (time division multiplexing and frequency division multiplexing). (9 Lectures)

Unit 3

Digital Pulse Modulation: Need for digital transmission, Pulse Code Modulation,Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying(PSK), and Binary Phase Shift Keying (BPSK).(10 Lectures)

Unit 4

Satellite Communication– Introduction, need, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Transponders (C - Band), Uplink and downlink, path loss, Satellite visibility, Ground and earth stations. Simplified block diagram of earthstation. (10 Lectures)

Unit 5

Mobile Telephony System – Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only), GPS navigation system (qualitative idea only). (15 Lectures)

Practical

ELECTRONICS LAB-DSC 1C LAB: COMMUNICATION ELECTRONICS LAB

60 Periods

AT LEAST 05 EXPERIMENTS FROM THE FOLLOWING
1. To design an Amplitude Modulator using Transistor
2. To study envelope detector for demodulation of AM signal
3. To study FM - Generator and Detector circuit
4. To study AM Transmitter and Receiver
5. To study FM Transmitter and Receiver
6. To study Time Division Multiplexing (TDM)
7. To study Pulse Amplitude Modulation (PAM)
8. To study Pulse Width Modulation (PWM)
9. To study Pulse Position Modulation (PPM)
10. To study ASK, PSK and FSK modulators

References

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- Modern Digital and Analog Communication Systems, B.P. Lathi, 4th Edition, 2011, Oxford University Press.
- Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGraw Hill.
- Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
- Communication Systems, S. Haykin, 2006, Wiley India
- Electronic Communication system, Blake, Cengage, 5th edition.
- Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press
- Introduction to Communication systems, U. Madhow, 1st Edition, 2018, Cambridge University Press

Keywords

Electronic communication, Modulation, Channels, base band signals, Analog modulation, Amplitude modulation, modulation index, Demodulation, Frequency modulation, Phase modulation, sampling, Analog Pulse modulation, Digital Pulse Modulation, Shift Keying, satellite communication, mobile communication

Electricity, Magnetism & EMT (42221201) Core Course - (CC) Credit:6

Course Objective(2-3)

Vector Analysis: Review of vector algebra (Scalar and Vector product), Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only (10 Lectures)

Course Learning Outcomes

1. Demonstrate the application of Coulomb’s law for the electric field, and also apply it to systems of point charges as well as line, surface, and volume distributions of charges.

2. Demonstrate an understanding of the relation between electric field and potential, exploit the potential to solve a variety of problems, and relate it to the potential energy of a charge distribution.

3. Apply Gauss’s law of electrostatics to solve a variety of problems.

4. Demonstrate an understanding of the behavior of electric conductors.

5. Demonstrate a working understanding of capacitors.

6. Calculate the magnetic forces that act on moving charges and the magnetic fields due to currents (Biot-Savart and Ampere laws)

7. Understand the concepts of induction and self-induction, to solve problems using Faraday’s and Lenz’s laws.

8. Concept of Maxwell's equations.

Unit 1

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

(10 Lectures)

Unit 2

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.

(24 Lectures)

Unit 3

Magnetism:

Magnetostatics: Biot-Savart's law and 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 4

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)

Unit 5

Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Wave equation in free space (10Lectures)

Practical

At least 06 experiments from the following:
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 & its variation in a Solenoid (Determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study 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

References

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• A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Teaching Learning Process

- Chalk and Blackboard approach
- Group discussion in the class
- PPT presentation on special topics.

Assessment Methods

- Assignments
- Class test
- Semester end examination

Linear and Digital Integrated Circuits (42511201) Core Course - (CC) Credit:6

Course Objective(2-3)

1. This paper aims to provide the basic knowledge of linear and digital electronics.

2. It discusses about the operational amplifier and its applications. It introduces the number systems such a Decimal, Binary, Octal and Hexadecimal number systems along with their applications in arithmetic circuits.
3. Boolean algebra and combinational logic circuits are also discussed.

Course Learning Outcomes

At the end of this course, students will be able to achieve the following learning outcomes:
• To understand Op- Amp basics.
• Become familiar with the characteristics of an ideal and practical OP – AMP.
• To understand the concept of OP – AMP parameters like offset voltage, CMRR, Slew rate, concept of Virtual Ground.

• To become familiar with the operation of OP – AMP in Inverting and Non - Inverting Configurations.
• To understand the applications of OP – AMP as

1. Summing and Difference Amplifier
2. Differentiator and Integrator
3. As Zero crossing Detector, and
4. As active High Pass and Low Pass filters.

• To become familiar with number systems and codes, Logic Gates, Boolean Algebra Theorems.
• To understand the minimization techniques for designing a simplified logic circuit.
• To design a half Adder, Full Adder, Half-Subtractor, Full-Subtractor.
• To understand the working of 4 – bit Binary Adder/Subtractor.
• To understand the working of Data processing circuits Multiplexers, Demultiplexers, Decoders, Encoders.
• To become familiar with the working of sequential circuits like R-S flip flop, D flip flop and J-K Master/ Slave flip flop.
• To understand the Working and Applications of Shift Registers and Counters.
• To understand the working of D to A and A to D Convertors.

Unit 1

Operational Amplifiers (Black box approach): Characteristics of an Ideal and Practical Operational Amplifier (IC 741), Open and closed loop configuration, Frequency Response. CMRR. Slew Rate and concept of Virtual Ground. (5 Lectures)

Applications of Op-Amps:(1) Inverting and non-inverting amplifiers, (2) Summing and Difference Amplifier, (3) Differentiator, (4) Integrator, (5) Wein bridge oscillator, (6) Comparator and Zero-crossing detector, and (7) Active low pass and high pass Butterworth filter (1st order only). (12 Lectures)

Unit 2

Number System and Codes: Decimal, Binary, Octal and Hexadecimal number systems, base conversions. Representation of signed and unsigned numbers, BCD code. Binary, octal and hexadecimal arithmetic; addition, subtraction by 2's complement method, multiplication. (9 Lectures)

Unit 3

Logic Gates and Boolean algebra: Truth Tables of OR, AND, NOT, NOR, NAND, XOR, XNOR, Universal Gates, Basic postulates and fundamental theorems of Boolean algebra. (4 Lectures)

Combinational Logic Analysis and Design: Standard representation of logic functions (SOP and POS), Minimization Techniques (Karnaugh map minimization up to 4 variables for SOP). (5 Lectures)

Unit 4

Arithmetic Circuits: Binary Addition. Half and Full Adder. Half and Full Subtractor, 4-bit binary Adder/Subtractor. (5 Lectures)

Data processing circuits: Multiplexers, De-multiplexers, Decoders, Encoders. (4 Lectures)

Unit 5

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. Master-slave JK Flip-Flop. (6 Lectures)

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). (2 Lectures)

Unit 6

Counters (4 bits):Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. (4 Lectures)
D-A and A-D Conversion: 4 bit binary weighted and R-2R D-A converters, circuit and working. Accuracy and Resolution. A-D conversion characteristics, successive approximation ADC. (Mention of relevant ICs for all). (4 Lectures)

Practical

ELECTRONICS LAB- DSC 1B LAB: LINEARAND DIGITAL INTEGRATED CIRCUITS LAB
60 Periods

At least 04 experiments each from section A, B and C
Section-A: Op-Amp.Circuits (Hardware design)
1. To design an inverting amplifier using Op-amp (741,351)for dc voltage of given gain.
2. (a) To design inverting amplifier using Op-amp (741,351) and study its frequency response.
(b) To design non-inverting amplifier using Op-amp (741,351) and study frequency response.
3. (a) To add two dc voltages using Op-Amp in inverting and non-inverting mode.
(b) To study the zero-crossing detector and comparator.
4. To design a precision Differential amplifier of given I/O specification using Op-Amplifier.
5. To investigate the use of an op-amp as an Integrator.
6. To investigate the use of an op-amp as a Differentiator.
7. To design a Wien bridge oscillator for given frequency using an Op-Amplifier.
8. To design a circuit to simulate the solution of simultaneous equation and 1st/2ndorder differential equation.
9. Design a Butterworth Low Pass active Filter (1st order) and study frequency response.
10. Design a Butterworth High Pass active Filter (1st order) and study frequency response.
11. Design a digital to analog converter (DAC) of given specifications.

Section-B: Digital circuits (Hardware design)
1. (a) To design a combinational logic system for a specified Truth Table.
(b) To convert Boolean expression into logic circuit & design it using logic gate ICs.
(c) To minimize a given logic circuit.
2. Half Adder and Full Adder.
3. Half Subtractorand Full Subtractor.
4. 4 bit binary adder and adder-subtractor using Full adder IC.
5. To design a seven segment decoder.
6. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
7. To build JK Master-slave flip-flop using Flip-Flop ICs.
8. To build a Counter using D-type/JK Flip-Flop ICs and study timing diagram.
9. To make a Shift Register (serial-in and serial-out) using D-type/JK Flip-Flop ICs.

Section-C: SPICE/MULTISIM simulations for electronic circuits and devices
1. To verify the Thevenin and Norton Theorems.
2. Design and analyze the series and parallel LCR circuits.
3. Design the inverting and non-inverting amplifier using an Op-Amp of given gain.
4. Design and Verification of op-amp as integrator and differentiator.
5. Design the 1storder active low pass and high pass filters of given cutoff frequency.
6. Design a Wein`s Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flop`s using NAND Gates.
8. Design 4-bit asynchronous counter using Flip-Flop ICs.
9. Design the CE amplifier of a given gain and its frequency response.

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Keywords

Operational Amplifiers, Frequency response, Op-Amp Applications, Number systems, BCD code, Logic gates, Boolean algebra, Combinational logic analysis, Minimization techniques, Adder, Subtractor, Flip flops, Shift Registers, Counters, D-A convertor, A-D convertor

Mechanics
(42221101)
Core Course - (CC) Credit:6

Course Objective(2-3)

This course begins with the review of Vectors and Differential equations and ends with the Special Theory of Relativity. Students will also appreciate the Gravitation, Rotational Motion and Oscillations. The emphasis of this course is to enhance the basics of mechanics. By the end of this course, students should be able to solv the seen or unseen problems/numericals in vectors, differential equations and mechanics.This course starts providing a physical picture of mathematical topics like vector and Ordinary differential equations and ends c covariant formulation of space-time in special theory of relativity. The emphasis here is to enhance the understanding of laws of mechanics and their application to moving systems. By the end of this course, students should be able to do problems on rectilinear and rotational motion, stability of a system, moment c inertia, simple harmonic motion and special theory of relativity.

Course Learning Outcomes

- In this course students will be able to understand theoretical concepts and their experimental verification.
- This course will make them to gain deep knowledge on the topics like:
- Vectors and Ordinary Differential equations.
- Centre of mass of objects with different symmetries.
- Concept of Potential energy and stability of a system.
- Angular momentum and motion of a spinning top.
- Kepler's laws and satellite motion.
- Concept of space- time, mass variation of a relativistic particle.
- Mass- Energy equivalence.
- Application of the concepts for solving related theoretical and numerical problems.
- Ability to analyze daily life phenomenon in a physical framework.

Unit 1

Vectors: Vector algebra. Derivatives of a vector with respect to a parameter. Scalar and vector products of two, three and four vectors. Gradient, divergence and curl of vectors fields. Polar and Axial vectors. (5 Lectures)

Ordinary Differential Equations: 1st order homogeneous differential equations, exact and non-exact differential equations, 2nd order homogeneous and non-homogenous differential equations with constant coefficients (Operator Method Only). (9 Lectures)

Unit 2

Laws of Motion: Review of Newton's Laws of motion. Dynamics of a system of particles. Concept of Centre of Mass, determination of center of mass for discrete and continuous systems having cylindrical and spherical symmetry (1-D, 2-D, 3-D objects). (6 Lectures)

Work and Energy: Motion of rocket. Work-Energy theorem for conservative forces. Force as a gradient of Potential Energy. Conservation of momentum and energy. Elastic and in-elastic Collisions. (4 Lectures)

Unit 3

Rotational Dynamics: Angular velocity, Angular momentum, Torque, Conservation of angular momentum, Moment of Inertia. Theorem of parallel and perpendicular axes (statements only). Calculation of Moment of

Inertia of discrete and continuous objects (1-D, 2-D and 3-D). Kinetic energy of rotation. Motion involving both translation and rotation. (8 Lectures)

Unit 4

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 (statements only). Satellite in circular orbit and applications. Geosynchronous orbits.

(4 Lectures)

Unit 5

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Compound pendulum. Differential equations of damped oscillations and forced oscillations and their solution. (10 Lectures)

Unit 6

Special Theory of Relativity: Frames of reference. Gallilean Transformations. Inertial and Non-inertial frames. Outcomes of Michelson Morley’s Experiment. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic transformation of velocity. Relativistic variation of mass. Mass-energy equivalence. Transformation of Energy and Momentum. (14 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.

Practical

60 Lectures
At least 06 experiments from the following:
1. Measurements of length (or diameter) using vernier calliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the motion of the spring and calculate (a) Spring constant and, (b) g.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique.
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille’s method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell’s needle.
10. To determine the elastic constants of a wire by Searle’s method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater’s Pendulum.

References

For Theory:

• University Physics. FW Sears, MW Zemansky & HD Young 13/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.

For Practicals:
• 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
• Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
• A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Teaching Learning Process

 Class room teaching with simple demonstration of physical phenomenon.
 Use of IT tools like power point presentation to enhance understanding.
 Use of short videos to provide physical pictures.
 Hands on activities.
 Student teacher interaction in tutorial classes.

Assessment Methods

Assessment methods are the strategies, techniques, tools and instruments for collecting information to determi the extent to which students demonstrate desired learning outcomes. Several methods should be used to asses student learning outcomes.Learning outcomes will be assessed using the following: oral and written examinations, closed-book and open-book tests; problem-solving exercises, practical assignment laboratory reports, observation of practical skills, individual project reports, seminar presentation; viva voce interviews computerised adaptive testing, literature surveys and evaluations, outputs from collaborative work etc.

Keywords

Gradient, divergence and curl of a vector, ordinary differential equations, Newton's laws of motion, Centre of Mass, Conservative forces, conservation of linear and angular momentum, central forces, Geosynchronous orbits, Simple Harmonic oscillator, Galilean transformation, Mass- Energy equivalence.

Microprocessor and Microcontroller (42514413) Core Course - (CC) Credit:6

Course Objective(2-3)

1. This paper introduces students with the architecture of microprocessor 8085 and microcontroller 8051.
2. Here, students will learn about the 8085 programming, subroutines, Timing and control circuitry.
3. Also, students will gain an exposure of 8051 I/O port programming and their addressing modes.
4. By the end of syllabus, students will have an introductory knowledge of embedded systems.

Course Learning Outcomes

This is a course to familiarize/ introduce students to designing and developing embedded systems. It provides the students with an introductory coverage of embedded systems. The learning outcomes of the course are:
• Knowledge of the major components that constitute an embedded system.
• Study the architecture of a 8085 Microprocessor
• Assembly language programming essentials
• Understand what is a microcontroller, microcomputer embedded system.
• Description of the architecture of a 8051 microcontroller.
• Write simple programs for 8051 microcontroller in C language.
• Understand key concepts of 8051 microcontroller systems like I/O operations, interrupts, programming of timers and counters.
• Interfacing of 8051 microcontroller with peripherals
• Understand and explain concepts and architecture of embedded systems
• Implement small programs to solve well-defined problems on an embedded platform.

Unit 1

Microcomputer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. (5 Lectures)

8085 Microprocessor Architecture: Main features of 8085. Block diagram. Pin-out diagram of 8085. Data and address buses. Registers. ALU. Stack memory. Program counter. (8 Lectures)

Unit 2

8085 Programming : Instruction classification, Instructions set (Data transfer including stacks. Arithmetic, logical, branch, and control instructions). Subroutines, delay loops. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. Hardware and software interrupts. (10 Lectures)

Unit 3

8051 microcontroller: Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Data types and directives, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions. (12 Lectures)

8051 I/O port programming: Introduction of I/O port programming, pin out diagram of 8051 microcontroller, I/O port pins description & their functions, I/O port programming in 8051 (using assembly language), I/O programming: Bit manipulation. (5 Lectures)

Unit 4

8051 Programming: 8051 addressing modes and accessing memory locations using various addressing modes, assembly language instructions using each addressing mode, arithmetic and logic instructions, 8051 programming in C: for time delay and I/O operations and manipulation, for arithmetic and logic operations, for ASCII and BCD conversions.(15 Lectures)

Unit 5

Introduction to embedded system: Embedded systems and general purpose computer systems. Architecture of embedded system. Classifications, applications and purpose of embedded systems.(5 Lectures)

Practical

ELECRONICS LAB-DSC 1D LAB: MICROPROCESSOR AND MICROCONTROLLER LAB
60 Periods

At least 06 experiments each from Section-A and Section-B
Section-A: Programs using 8085 Microprocessor
1. Addition and subtraction of numbers using direct addressing mode
2. Addition and subtraction of numbers using indirect addressing mode
3. Multiplication by repeated addition.
4. Division by repeated subtraction.
5. Handling of 16-bit Numbers.
6. Use of CALL and RETURN Instruction.
7. Block data handling.
8. Other programs (e.g. Parity Check, using interrupts, etc.).

Section-B: Experiments using 8051 microcontroller:
1. To find that the given numbers is prime or not.
2. To find the factorial of a number.
3. Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number.
4. Use one of the four ports of 8051 for O/P interfaced to eight LED’s. Simulate binary counter (8 bit) on LED’s .
5. Program to glow the first four LEDs then next four using TIMER application.
6. Program to rotate the contents of the accumulator first right and then left.

7. Program to run a countdown from 9-0 in the seven segment LED display.
8. To interface seven segment LED display with 8051 microcontroller and display 'HELP' in the seven segment LED display.
9. To toggle '1234' as '1324' in the seven segment LED display.
10. Interface stepper motor with 8051 and write a program to move the motor through a given angle in clock wise or counter clockwise direction.
11. Application of embedded systems: Temperature measurement& display on LCD

References

- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.
- Embedded Systems:Architecture, Programming & Design, Raj Kamal, 2008, Tata McGraw Hill
- The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.
- Microprocessor and Microcontrollers, N. Senthil Kumar, 2010, Oxford University Press
- 8051 microcontrollers, Satish Shah, 2010, Oxford University Press.
- Embedded Systems: Design & applications, S.F. Barrett, 2008, Pearson Education India
- Introduction to embedded system, K.V. Shibu, 1st edition, 2009, McGraw Hill
- Embedded Microcomputer systems: Real time interfacing, J.W.Valvano 2011, Cengage Learning
- Microprocessors and Microcontrollers, Krishna Kant, 2nd Edition, 2016, PHI learning Pvt. Ltd.

Keywords

Microprocessor, Architecture, Data transfer, Subroutine, Timing circuitry, Control circuitry, Microcontroller, I/O port programming, addressing modes, embedded systems

Network Analysis and Analog Electronics (42511101) Core Course - (CC) Credit:6

Course Objective(2-3)

1. This course offers the basic knowledge to students to design and analyze the network circuit analysis and analog electronics.

2. It gives the concept of voltage, current sources and various electrical network theorems. Physics of Semiconductor devices including Junction diode, Bipolar junction Transistors, Unipolar devices and their applications are discussed in detail.
3.This also develops the understanding of amplifier and its applications.

Course Learning Outcomes

At the end of this course, students will be able to achieve the following learning outcomes:
- To understand the concept of voltage and current sources, Kirchhoff's current and voltage laws, Mesh and Node Analysis.
- To understand the concept of Network theorems.
- To be able to determine h, y and z parameters.
- To understand the formation of Depletion layer in P N Junction diode.
- To develop an understanding of the basic operation and characteristics of a diode, dc load line Q point.
- Become familiar with working and applications of ZENER DIODE.
- Become familiar with Half-wave, Full-wave center tapped and bridge rectifiers. To be able to calculate ripple factor and efficiency.

- To understand the working of filters in power supply, working of Zener diode as voltage regulator.
- Be able to understand line and load regulation.
- To be able to recognize and explain the characteristics of a PNP or NPN transistor.
- To be able to define the active, cutoff and saturation regions.
- Be able to apply the proper biasing to insure operation in active region.
- Become familiar with the load-line analysis of the BJT configurations.
- To understand the hybrid model (h- parameters) of the BJT transistors.
- To be able to perform small signal analysis of CE Amplifier. To be able to classify class A, B and C amplifiers.
- To be able to perform analysis of two stage R-C coupled Amplifier.
- To understand the concept of positive and negative feedback along with applications of each type of feedback.
- To understand the working of Oscillators.
- To become familiar with construction, working and characteristics of JFET and UJT.

Unit 1

Circuit Analysis: Concept of Voltage and Current Sources. Kirchhoff's Current Law, Kirchhoff's Voltage Law. Mesh Analysis Node Analysis. Star and Delta networks, Star-Delta Conversion. Principal of Duality. Superposition Theorem. Thevenin's Theorem. Norton's Theorem. Reciprocity Theorem. Maximum Power Transfer Theorem. Two Port Networks: h, y and z parameters and their conversion. (14 Lectures)

Unit 2

Junction Diode and its applications: PN junction diode (Ideal and practical)-constructions, Formation of Depletion Layer, Diode Equation and I-V characteristics. Idea of static and dynamic resistance, dc load line analysis, Quiescent (Q) point. Zener diode, Reverse saturation current, Zener and avalanche breakdown. Qualitative idea of Schottky diode. Rectifiers-Half wave rectifier, Full wave rectifiers (center tapped and bridge), circuit diagrams, working and waveforms, ripple factor and efficiency. Filter- Shunt capacitor filter, its role in power supply, output waveform, and working. Regulation- Line and load regulation, Zener diode as voltage regulator, and explanation for load and line regulation.(18 Lectures)

Unit 3

Bipolar Junction Transistor: Review of the characteristics of transistor in CE and CB configurations, Regions of operation (active, cut off and saturation), Current gains α and β. Relations between α and β. dc load line and Q point. (5 Lectures)

Amplifiers: Transistor biasing and Stabilization circuits- Fixed Bias and Voltage Divider Bias. Thermal runaway, stability and stability factor S. Transistor as atwo port network, h-parameter equivalent circuit. Small signal analysis of single stage CE amplifier. Input and Output impedance, Current and Voltage gains. Class A, B and C Amplifiers. (10 Lectures)

Unit 4

Cascaded Amplifiers: Two stage RC Coupled Amplifier and its Frequency Response. (2 Lectures)

Feedback in Amplifiers: Concept of feedback, negative and positive feedback, advantages of negative feedback (Qualitative only). (2 Lectures)

Sinusoidal Oscillators: Barkhausen criterion for sustained oscillations. Phase shift and Colpitt's oscillator. Determination of Frequency and Condition of oscillation. (5 Lectures)

Unipolar Devices: JFET. Construction, working and I-V characteristics (output and transfer), Pinchoff voltage. UJT, basic construction, working, equivalent circuit and I-V characteristics.
(4 Lectures)

Practical

ELECTRONICS LAB: DSC 1A LAB: NETWORK ANALYSIS AND ANALOG ELECTRONICS LAB
60 Periods

AT LEAST 06 EXPERIMENTS FROM THE FOLLOWING BESIDES #1
1. To familiarize with basic electronic components (R, C, L, diodes, transistors), digital Multimeter, Function Generator and Oscilloscope.

2. Measurement of Amplitude, Frequency & Phase difference using Oscilloscope.
3. Verification of (a) Thevenin’s theorem and (b) Norton’s theorem.
4. Verification of (a) Superposition Theorem and (b) Reciprocity Theorem.
5. Verification of the Maximum Power Transfer Theorem.
6. Study of the I-V Characteristics of (a) p-n junction Diode, and (b) Zener diode.
7. Study of (a) Half wave rectifier and (b) Full wave rectifier (FWR).
8. Study the effect of (a) C- filter and (b) Zener regulator on the output of FWR.
9. Study of the I-V Characteristics of UJT and design relaxation oscillator..
10. Study of the output and transfer I-V characteristics of common source JFET.
11. Study of Fixed Bias and Voltage divider bias configuration for CE transistor.
12. Design of a Single Stage CE amplifier of given gain.
13. Study of the RC Phase Shift Oscillator.
14. Study the Colpitt`s oscillator.

References

- Electric Circuits, S. A. Nasar, Schaum’s outline series, Tata McGraw Hill (2004)
- Electrical Circuits, M. Nahvi & J. Edminister, Schaum’s Outline Series, Tata McGraw-Hill (2005)
- Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press
- Network,Lines and Fields, J.D.Ryder, Prentice Hall of India.
- Electronic Devices and Circuits, David A. Bell, 5th Edition 2015, Oxford University Press.
- Electronic Circuits: Discrete and Integrated, D.L. Schilling and C. Belove, Tata McGraw Hill
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill (2001)
- J. J. Cathey, 2000 Solved Problems in Electronics, Schaum’s outline Series, Tata McGraw Hill (1991)
- Allen Mottershead, Electronic Devices and Circuits, Goodyear Publishing Corporation.
- Basic Electronics: Principles and Applications, C.Saha, A.Halder, D.Ganguli, 2018, Cambridge University Press
- Electronic Principles, A. Malvino, D.J. Bates, 7th Edition, 2018, Tata Mc-Graw Hill Education.

Keywords

Kirchoff's laws, Superposition theorem, Thevenin's theorems, Norton's, theorems, two port networks, pn junction, diode equation, load line, Q point, Zener diode, Schottky diode, Rectifiers, BJT, transistor biasing, amplifiers, stability factor, Feedback, Oscillators, JFET, UJT

Thermal Physics and Statistical Mechanics (42224303) Core Course - (CC) Credit:6

Course Objective(2-3)

This course will introduce Thermodynamics, Kinetic theory of gases and Statistical Mechanics to the students The primary goal is to understand the fundamental laws of thermodynamics and it’s applications to various thermo dynamical systems and processes . This coursework will also enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behavior of atom and molecules through statistical mechanics.

Course Learning Outcomes

At the end of the course, students will be able to :

- Explain the Laws of Thermodynamics and its application to various physical processes
- Understand the concept of entropy, reversible and Irreversible processes.
- Understand the Blackbody radiation
- Apply the Kinetic theory of gases for calculating the transport properties of gases.
- the concept of classical and quantum statistics

Unit 1

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 and C_v, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law, Entropy, Carnot's cycle & theorem, Entropy changes in reversible and irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero. (22 lectures)

Unit 2

Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thomson Effect, Clausius Clapeyron Equation, Expression for (C_p – C_v), C_p/C_v, TdS equations. (10 lectures)

Unit 3

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)

Unit 4

Theory of Radiation: Blackbody radiation, Spectral distribution, 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 5

Statistical Mechanics: Macrostate and Microstate, Phase space, Entropy and Thermodynamic probability, Maxwell-Boltzmann law, Quantum statistics, Fermi-Dirac distribution law, Bose-Einstein distribution law, comparison of three statistics (12 lectures)

Practical

.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 Cu by Searle's Apparatus.
. 5. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
6. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
7. To study the variation of thermo emf across two junctions of a thermocouple with temperature.

References

For Theory

- 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.
- • Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill
- • Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and 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

For Practical

- 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, KitabMahal, New Delhi.
- • A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal, 1985, Vani Publication.

Teaching Learning Process

- Chalk and Blackboard approach
- Group discussion in the class
- PPT presentation on special topics.

Assessment Methods

- Assignments
- Class test
- Semester end examination

Keywords

Laws of Thermodynamics, entropy, Maxwell relations, Kinetic theory of gases, Black body radiation, M-B, B-E and FD distribution

Waves and Optics
(42224412)
Core Course - (CC) Credit:6

Course Objective(2-3)

The physics and mathematics of wave motion underlie many important phenomena. The water wave on the se the vibration of a violin string, etc. can all be described in a similar way. Light too, often displays properties that are wave-like.

The course is aimed at equipping the students with the general treatment of waves. This begins with explainin ideas of oscillations and simple harmonic motion and go on to look at the physics of travelling and standing waves. This understanding applies to have a more elaborate analysis for sound waves and this further considers a number of phenomena in which the wave properties of light are important such as interference, diffraction, and polarization with emphasis of examples as seen in daily life.

Teaching Learning Process

- Chalk and Blackboard approach
- Group discussion in the class
- PPT presentation on special topics.

Assessment Methods

- Assignments
- Class test
- Semester end examination

Antenna Theory and wireless Network (42517616) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This course gives an overview of wireless communication elements and networks.

2. Students will develop an understanding of basics of antenna, its various parameters, its usage as a transmitter and receiver.
3. Cellular concept and system design fundamentals are described and the evolution of current wireless systems in real world such as 2G, 3G, 4G and LTE networks is discussed.

Course Learning Outcomes

At the end of this course, students will be able to achieve the following learning outcomes:

- Identify basic antenna parameter (Radiating wire Structures).
- Determine directions of maximum signal radiations and the nulls in the radiation patterns.
- Design array antenna systems from specifications.
- Identify the characteristics of radio-wave propagation.
- Identify Wireless Networks 4G and LTE, and 5G.
- Design Cellular Systems

Unit 1

ANTENNA THEORY:
Introduction: Antenna as an element of wireless communication system, Antenna radiation mechanism, Types of Antennas, Fundamentals of EMFT: Maxwell's equations and their applications to antennas. (7 Lectures)

Antenna Parameters: Antenna parameters: Radiation pattern (polarization patterns, Field and Phase patterns), Field regions around antenna, Radiation intensity, Beam width, Gain, Directivity, Polarization, Bandwidth, Efficiency and Antenna temperature. (9 Lectures)

Unit 2

Antenna as a Transmitter/Receiver: Effective Height and Aperture, Power delivered to antenna, Input impedance. Radiation from an infinitesimal small current element, Radiation from an elementary dipole (Hertzian dipole), Reactive, Induction and Radiation fields, Power density and radiation resistance for small current element and half wave dipole antenna. (12 Lectures)

Unit 3

Radiating wire Structures (Qualitative idea only): Monopole, Dipole, Folded dipole, Loop antenna and Biconical broadband Antenna. Basics of Patch Antenna and its design. Examples of Patch antenna like bowtie, sectoral, fractal, etc. (6 Lectures)

Propagation of Radio Waves: Different modes of propagation: Ground waves, Space waves, Space Wave propagation over flat and curved earth, Optical and Radio Horizons, Surface Waves and Troposphere waves, Ionosphere, Wave propagation in the Ionosphere. Critical Frequency, Maximum usable frequency (MUF), Skips distance. Virtual height. Radio noise of terrestrial and extraterrestrial origin. Elementary idea of propagation of waves used in terrestrial mobile communications. (9 Lectures)

Unit 4

WIRELESS NETWORKS:
Introduction: History of wireless communication, Wireless Generation and Standards, Cellular and Wireless Systems, Current Wireless Systems, Cellular Telephone Systems, Wide Area Wireless Data Services, Broadband Wireless Access, Satellite Networks, Examples of Wireless Communication Systems. Idea about Global Mobile communication system. (10 Lectures)

Unit 5

Modern Wireless Communication Systems: Second Generation (2G) Cellular Networks, Third Generation (3G) Wireless Networks, Wireless Local Loop (WLL), Wireless Local Area Networks (WLANs), Bluetooth and Personal Area Networks (PANs). Idea about Wi-Fi, 4G and LTE, and 5G. (10 Lectures)

Unit 6

Cellular Concept and System Design Fundamentals: Cellular Concept and Cellular System Fundamentals, Frequency Reuse, Channel Assignment Strategies, Handoff strategies, Interference and System Capacity, Trunking and Grade of Service. Improving Coverage & Capacity in Cellular Systems. Cell Splitting and Sectoring. Cellular Systems design Considerations (Qualitative idea only). (12 Lectures)

References

- Ballanis, Antenna Theory, John Wiley & Sons, (2003) 2nd Ed.
- Jordan and Balmain, E. C., Electro Magnetic Waves and Radiating Systems, PHI, 1968 Reprint (2003) 3rd Ed.
- Andrea Goldsmith, Wireless communications, (2015) Cambridge University Press
- D. Tse and P. Viswanathan, Fundamentals of Wireless Communication, (2014) Cambridge University Press
- Wireless communication and Networks, UpenaDala, 2015, Oxford University Press.
- Haykin S. & Moher M., Modern Wireless Communication, Pearson, (2005) 3rd Ed.
- Lee, William C.Y., Mobile Communication Design and Fundamentals, (1999) 4th Ed

Keywords

Wireless communication, Antenna, radiation mechanism, EMFT, Antenna Parameters, Power delivered to antenna, Hertzian dipole, Radiating wire Structures, Propagation of Radio Waves, Second and third Generation (2G, 3G) Cellular Networks, Wireless Local Loop (WLL), Wireless Local Area Networks (WLANs), Bluetooth and Personal Area Networks (PANs), Wi-Fi, Cellular System Fundamentals

Applied Dynamics (42227536) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

Most processes encountered in nature are inherently nonlinear. This course introduces the main topics of lo dimensional nonlinear systems, with applications to a wide variety of disciplines, including physics, engineering, mathematics, chemistry, and biology. Specific topics include maps and flows in one and two dimensions, phase portraits, bifurcations, chaos, fractals and elementary fluid dynamics. Students will obtai familiarity with concepts and methods in the field of dynamical systems, apply those concepts and methods analyze dynamic models analytically and computationally, and will learn how to interpret and critically evalu the results of those analyses.This course begins with the first order dynamical system and the idea of phas space, flows and trajectories and ends with the elementary fluid dynamics. Students will also appreciate the introduction to chaos and fractals. The emphasis of this course is to enhance the understanding of the basi of applied dynamics. By the end of this course, students should be able to solve the seen or unseen problems/numericals in applied dynamics.

Course Learning Outcomes

Upon successful course completion, a student will be able to:
- Demonstrate understanding of the concepts that underlay the study of dynamical systems.
- Use the analytical and computational methods covered in this course to analyze dynamical systems models.

- Analyze the behavior of dynamical systems (e.g. find periodic orbits and assess their stability, draw phase portraits, etc.)
- Apply the techniques of nonlinear dynamics to physical processes drawn from a variety of scientific and engineering disciplines.

- Analyze uniform and nonuniform oscillators (flows on circle)
- Draw phase portraits and interpret them in several applications from biology, physics, chemistry and engineering.

- Define a fractal and give several examples of fractals in nature
- Understand the basics of different kind of fluid motion.

Unit 1

Introduction to Dynamical systems: Definition of a continuous first order dynamical system. The idea of phase space, flows and trajectories. Simple mechanical systems as first order dynamical systems: simple and damped harmonic oscillator. Sketching flows and trajectories in phase space. Fixed points, attractors, stability of fixed points, basin of attraction, notion of qualitative analysis of dynamical systems.

Examples of dynamical systems –
Population models e.g. exponential growth and decay, logistic growth, predator-prey dynamics. Rate equations for chemical reactions e.g. auto catalysis, bistability.
(22 Lectures)

Unit 2

Introduction to Chaos and Fractals: Chaos in nonlinear equations - Logistic map and Lorenz equations: Dynamics from time series. Parameter dependence- steady, periodic and chaotic states.Cobweb iteration.Fixed points. Defining chaos- aperiodic, bounded, deterministic and sensitive dependence on initial conditions. Period- Doubling route to chaos.

Self-similarity and fractal geometry: Fractals in nature – trees, coastlines, earthquakes, etc. Need for fractal dimension to describe self-similar structure. Deterministic fractal vs. self-similar fractal structure.
(18 Lectures)

Unit 3

Elementary Fluid Dynamics: Importance of fluids: Fluids in the pure sciences, fluids in technology. Study of fluids: Theoretical approach, experimental fluid dynamics, computational fluid dynamics. Basic physics of fluids: The continuum hypothesis-concept of fluid element or fluid parcel; Definition of a fluid- shear stress; Fluid properties- viscosity, thermal conductivity, mass diffusivity, other fluid properties and equation of state; Flow phenomena- flow dimensionality, steady and unsteady flows, uniform and non-uniform flows, viscous and inviscid flows, incompressible and compressible flows, laminar and turbulent flows, rotational and irrotational flows, separated and unseparated flows. Flow visualization - streamlines, pathlines, Streaklines.
(20 Lectures)

Practical

60 Lectures
Computing and visualizing trajectories using software such as Scilab, Maple, Octave, XPPAUT based on Applied Dynamics problems like (at least 06 experiments)
1. To determine the coupling coefficient of coupled pendulums.
2. To determine the coupling coefficient of coupled oscillators.
3. To determine the coupling and damping coefficient of damped coupled oscillator.
4. To study population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuits.
5. To study rate equations for chemical reactions e.g. auto catalysis, bistability.
6. To study examples from game theory.
7. Computational visualization of trajectories in the Sinai Billiard.
8. Computational visualization of trajectories Electron motion in mesoscopic conductors as a chaotic billiard problem.
9. Computational visualization of fractal formations of Deterministic fractal.
10. Computational visualization of fractal formations of self-similar fractal.
11. Computational visualization of fractal formations of Fractals in nature – trees, coastlines, earthquakes.
12. Computational Flow visualization - streamlines, pathlines, Streaklines.

References

For Theory:

• Nonlinear Dynamics and Chaos, S.H. Strogatz, Levant Books, Kolkata, 2007
• Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
• An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge Univ. Press, 2002
• Fluid Mechanics, 2nd Edition, L. D. Landau and E. M. Lifshitz, Pergamon Press, Oxford, 1987.

For Practicals:

• Nonlinear Dynamics and Chaos, Steven H. Strogatz, Levant Books, Kolkata, 2007

- Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
- An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge Univ. Press, 2002
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer

Teaching Learning Process

Teaching learning process should include appropriate methods to make classroom teaching more effective, encouragement to students for active participation, collaborative learning and effective laboratory practices. Teaching methods should develop interest in the students by choosing appropriate method which cater individuals need, scientific ways of thinking, problem solving ability, student understanding, critical & quantitative thinking and experimental & data analysis skills. Students should Learn to use scientific apparatus, estimate statistical errors & recognize errors and develop reporting skills in laboratory practices.

Assessment Methods

Assessment methods are the strategies, techniques, tools and instruments for collecting information to determ the extent to which students demonstrate desired learning outcomes. Several methods should be used to asses student learning outcomes.Learning outcomes will be assessed using the following: oral and written examinations, closed-book and open-book tests; problem-solving exercises, practical assignment laboratory reports, observation of practical skills, individual project reports, seminar presentation; viva voce interviews computerised adaptive testing, literature surveys and evaluations, outputs from collaborative work etc.

Keywords

Phase space, First order dynamical systems, attractors, Chaos, Logistic map, route to chaos, Fractals, Self-similarity, fractal geometry, Autocorrelation, Lyapunov component, Fluid Dynamics, viscosity.

Astronomy and Astrophysics (42227642) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

The objective of this course is to introduce an undergraduate student to the basic concepts of modern astrophysics such as stellar classification, stellar evolution, properties and components of solar system, origin and evolution of galaxies and large scale structures of the Universe. The student should be able to apply physical principles studied in other physics subjects to astrophysical phenomena and should develop a broad problem solving skills.

Course Learning Outcomes

After completing the course on Astronomy and Astrophysics, the student should be able to,

- Differentiate between various astrophysical objects and should be able to understand and apply scientific models governing their origin and evolution.
- Understand the differences between competing astrophysical models based on physical and observational constraints.

Unit 1

Introduction to Astronomy and Astronomical Scales: Night sky, diurnal and yearly motions of the Sun, stars and constellations, Size, Mass, Density and Temperature of astronomical objects, Scale and structure of the Universe, Basic concepts of positional astronomy: Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Spherical Trignometric identities and applications, Astronomical Coordinate Systems, Horizon System, Equatorial System, Ecliptic System, Conversion of Coordinates. Rising and Setting Times, Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Astronomical Time Systems (LMT, UT, UTC) (15 Lectures)

Unit 2

Basic Parameters of Stars: Determination of Distance by ParallaxMethod; Aberration, Proper Motion, Cluster Parallax, Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Interstellar Extinction, Determination of Temperature and Radius of a star; Stellar Spectra, Atomic Spectra Revisited, Boltzman's and Saha's Equations, Balmer Lines of H, H and K lines of Ca, Spectral Types and Their Temperature Dependence, Black Body Approximation, Luminosity Classification, H R Diagram, Relations between stellar parameters

(12 Lectures)

Unit 3

Observational Tools and Physical Principles: Observing through the atmosphere (Scintillation, Seeing , Atmospheric Windows and Extinction) Basic Optical Definitions for Telescopes: Magnification, Light Gathering Power, Limiting magnitude, Resolving Power, Diffraction Limit, Maximum and Minimum magnifications, Types of Telescope Foci. Telescope Mountings, Radio telescopes, Observations at other wavelengths, Space telescopes, detection of gravitational radiation (LIGO), Current Indian Observatories.

Virial theorem for N particle systems, applications in astrophysics, General Relativity effects: event horizon, density of black holes, gravitational radiation, Systems in Thermodynamic Equilibrium, Radiative Transfer, Equations for Hydrostatic and Thermal Equilibria (15 Lectures)

Unit 4

Sun and Stars: Solar Parameters, Sun's Internal Structure, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Helioseismology

Temperature Gradient in Stars, Mean molecular weight of stellar gas, Stellar Energy Sources, Stellar Models, Stellar Life Cycle, Compact Objects, Chandrasekhar Mass limit, Oppenheimer-Volkhoff Mass (12 Lectures)

Unit 5

Milky Way, Galaxies and Astrochemistry: 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), Star Clusters of the Milky Way, Gas and Dust in the Milky Way, Properties of and around the Galactic Nucleus. Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies, Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo)

Molecular Spectroscopy, Interstellar molecules, Organic compounds interstellar medium and Solar system (11 lectures)

Unit 6

Large Scale Structure of the Universe, Cosmology and Astrobiology: Cosmic Distance Ladder, Groups, Clusters and Superclusters of galaxies, Olber's Paradox, Hubble's Expansion, History of the Universe, Chemistry of Life, origin of life, chances of life in the solar system, Exoplanets, SETI (10)

References

1. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer

2. Astrophysics Stars and Galaxies K D Abhyankar, Universities Press

3. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.

4. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B.

Bhatia, Narosa Publication.

5. The Physical Universe: An Introduction to Astronomy, F H Shu, University Science Books

6. Baidyanath Basu, An introduction to Astrophysics, Second printing, Prentice -

Hall of India Private limited, New Delhi,2001.

7. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th
Edition, Saunders College Publishing.

8. Explorations: Introduction to Astronomy, Thomos Arny and Stephen Schneider, 2014, 7th edition, McGraw Hill

9. The Molecular Universe, A.G.G.M. Tielens, Reviews of Modern Physics, Vol 85, July September, 2013

Additional Resources:

1) Introduction to Astrophysics by Baidyanath Basu, PHI publisher, 2nd edition

2) Conceptual Astronomy: A Journey of Ideas by Michael Zeilik, John Wiley & Sons, Inc., 1993

3) Universe by William J. Kaufmann, W. H. Freeman and Company, 1985

4) Principles of Stellar Dynamics, S Chandrasekhar, Dover Books

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Teaching Learning Process

1. The main mode of instruction will be class room lectures. Audio visual media involving documentaries, and Web based resources on latest discoveries will also be used.

2. Students will learn problem solving skills in tutorials. A list of problems should be distributed before every tutorial to let student solve them before solutions are discussed.

3. Students will get hands on experience of handling telescopes in coordination with institute's astronomy club. Outdoor excursions can be organised for viewing sky at night.

4. Students will be encouraged to form teams and participate in analysis of observational data available on the net.

Assessment Methods

1. Continuous evaluation of tutorial work.

2. Student Projects

3. Semester end exam.

Atmospheric Physics
(42227643)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

This paper aims to describe the characteristics of earth's atmosphere and also its dynamics.

Course Learning Outcomes

Atmospheric waves along with the basic concepts of atmospheric Radar and Lidar are discussed in detail

Unit 1

General features of Earth's atmosphere: Thermal structure of the Earth's Atmosphere, Composition of atmosphere, Hydrostatic equation, Potential temperature, Atmospheric Thermodynamics, Greenhouse effect, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze. Instruments for meteorological observations including RS/RW, meteorological processes and convective systems, fronts, Cyclones and anticyclones, thunderstorms.
(12 Lectures)

Unit 2

Atmospheric Dynamics: Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Quasi biennial oscillation, annual and semi-annual oscillations, Mesoscale circulations, The general circulations, Tropical dynamics.
(12 Lectures)

Unit 3

Atmospheric Waves: Surface water waves, wave dispersion, acoustic waves, buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a nonhomogeneous medium, Lamb wave, Rossby waves and its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration
(12 Lectures)

Unit 4

Atmospheric Radar and Lidar: Radar equation and return signal, Signal processing and detection, Various type of atmospheric radars, Applications of radars to study atmospheric phenomena, Lidar and its applications, Application of Lidar to study atmospheric phenomenon. Data analysis tools and techniques.
(12 Lectures)

Unit 5

Atmospheric Aerosols: Spectral distribution of the solar radiation, Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Radiative and health effects, Observational techniques for aerosols, Absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Bouguert-Lambert law, Principles of radiometry, Optical phenomena in atmosphere,

Aerosol studies using Lidars.
(12 Lectures)

Practical

Scilab/C ++ / Fortran/ Matlab based simulations experiments based on Atmospheric Physics problems like (at least 05 experiments)
1. Numerical Simulation for atmospheric waves using dispersion relations
(a) Atmospheric gravity waves (AGW)
(b) Kelvin waves
(c) Rossby waves and mountain waves
2. Offline and online processing of radar data
(a) VHF radar,
(b) X-band radar, and
(c) UHF radar
3. Offline and online processing of LIDAR data
4. Radiosonde data and its interpretation in terms of atmospheric parameters using vertical profiles in different regions of the globe.
5. Handling of satellite data and plotting of atmospheric parameters using different techniques such as radio occultation technique
6. Time series analysis of temperature using long term data over metropolitan cities in India – an approach to understand the climate change
7. PM 2.5 measurement using compact instruments
8. Field visits to National center for medium range weather forecasting, India meteorological departments, and ARIES Nainital to see onsite radiosonde balloon launch, simulation on computers and radar operations on real time basis.

References

• Fundamental of Atmospheric Physics, M.L Salby; Academic Press, Vol 61, 1996
• The Physics of Atmosphere – John T. Houghton; Cambridge University press; 3 rd edn. 2002.
• An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
• Radar for meteorological and atmospheric observations – S Fukao and K Hamazu, Springer Japan, 2014

Biological physics
(42227645)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

The Biological Physics course introduces the emerging inter-disciplinary field on the interface of Physics and Biology.

Course Learning Outcomes

It makes use of concepts from Physics and discusses their application in Biology. This course helps the students to develop a system level perspective of Biology and equips them with the required mathematical and computational skills.

Unit 1

Overview:
(6 Lectures)
The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction,

evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales. Allometric scaling laws.

Unit 2

Molecules of life:
(18 Lectures)
Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling.
Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell.
Simplified mathematical models of transcription and translation, small genetic circuits and signaling pathways to be studied analytically and computationally.

Unit 3

Molecular motion in cells:
(22 Lectures)
Random walks and applications to biology: Diffusion; models of macromolecules.
Entropic forces: Osmotic pressure; polymer elasticity.
Chemical forces: Self assembly of amphiphiles.
Molecular motors: Transport along microtubules.
Flagellar motion: bacterial chemotaxis.

Unit 4

The complexity of life:
(20 Lectures)
At the level of a cell: The numbers of distinct metabolites, genes and proteins in a cell. Metabolic, regulatory and signaling networks in cells. Dynamics of metabolic networks; the stoichiometric matrix. The implausibility of life based on a simplified probability estimate, and the origin of life problem.

At the level of a multicellular organism: Numbers and types of cells in multicellular organisms. Cellular differentiation and development.
Brain structure: neurons and neural networks. Brain as an information processing system.

At the level of an ecosystem and the biosphere: Foodwebs. Feedback cycles and self-sustaining ecosystems.

Unit 5

References

•
Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman &Co, NY, 2004)
• Physical Biology of the Cell (2nd Edition); Rob Phillips et al (Garland Science, Taylor & Francis Group, London & NY, 2013)
• An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special Indian Edition, 2013)
• Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition

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Communication System (42227533) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This paper aims to describe the concepts of electronics in communication.

2. Communication techniques based on Analog Modulation, Analog and digital Pulse Modulation including PA PWM, PPM, ASK, PSK, FSK are described in detail.
3. Communication and Navigation systems such as GPS and mobile telephony system are introduced.

Course Learning Outcomes

At the end of this course, students will be able to develop following learning outcomes:
• This paper aims to describe the concepts of electronics in communication. In this course, students will receive an introduction to the principle, performance and applications of communication systems.
• Students will learn the various means and modes of communication. They will gain an understanding of fundamentals of electronic communication system and electromagnetic communication spectrum with an idea of frequency allocation for radio communication system in India.
• They will gain an insight on the use of different modulation and demodulation techniques used in analog communication
• Students will be able to analyze different parameters of analog communication techniques.
• They will learn the need of sampling and different sampling techniques where they can sample analog signal.
• Students will learn the generation and detection of a signal through pulse and digital modulation techniques and multiplexing.
• They will gain an in-depth understanding of different concepts used in a satellite communication system.
• They will study the concept of Mobile radio propagation, cellular system design and understand mobile technologies like GSM and CDMA.
• Students will understand evolution of mobile communication generations 2G, 3G, and 4G with their characteristics and limitations.
• This paper will essentially connect the text book knowledge with the most popular communication technology in real world.

Unit 1

Electronic communication: Introduction to communication – means and modes. Power measurements (units of power). Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. (4 Lectures)
Analog Modulation: Amplitude Modulation, modulation index and frequency spectrum.Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Single Sideband (SSB) systems, advantages of SSB transmission, Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector),Qualitative idea of Super heterodyne receiver. (12 Lectures)

Unit 2

Analog Pulse Modulation: Channel capacity, Sampling theorem, Basic Principles-PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing (time division multiplexing and frequency division multiplexing). (9 Lectures)

Unit 3

Digital Pulse Modulation: Need for digital transmission, Pulse Code Modulation,Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying(PSK), and Binary Phase Shift Keying (BPSK).(10 Lectures)

Unit 4

Satellite Communication– Introduction, need, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Transponders (C - Band), Uplink and downlink, path loss, Satellite

visibility, Ground and earth stations. Simplified block diagram of earthstation.
(10 Lectures)

Unit 5

Mobile Telephony System – Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only), GPS navigation system (qualitative idea only). (15 Lectures)

Practical

PHYSICS LAB-DSE LAB: COMMUNICATION SYSTEM LAB
60 Periods

AT LEAST 05 EXPERIMENTS FROM THE FOLLOWING
1. To design an Amplitude Modulator using Transistor
2. To study envelope detector for demodulation of AM signal
3. To study FM - Generator and Detector circuit
4. To study AM Transmitter and Receiver
5. To study FM Transmitter and Receiver
6. To study Time Division Multiplexing (TDM)
7. To study Pulse Amplitude Modulation (PAM)
8. To study Pulse Width Modulation (PWM)
9. To study Pulse Position Modulation (PPM)
10. To study ASK, PSK and FSK modulators

References

- Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
- Advanced Electronics Communication Systems- Tomasi, 6thEdn. Prentice Hall.
- Modern Digital and Analog Communication Systems, B.P. Lathi, 4th Edition, 2011, Oxford University Press.
- Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGraw Hill.
- Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
- Communication Systems, S. Haykin, 2006, Wiley India
- Electronic Communication system, Blake, Cengage, 5th edition.
- Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press
- Introduction to Communication systems, U. Madhow, 1st Edition, 2018, Cambridge University Press

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Keywords

Electronic communication, Modulation, Channels, base band signals, Analog modulation, Amplitude modulation, modulation index, Demodulation, Frequency modulation, Phase modulation, sampling, Analog Pulse modulation, Digital Pulse Modulation, Shift Keying, satellite communication, mobile communication

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Digital Signal Processing
(42517513)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This paper describes the discrete-time signals and systems, Fourier Transform Representation of Aperiodi Discrete-Time Signals.
2. This paper also highlights the concept of filters and realization of Digital Filters.
3. At the end of the syllabus, students will develop an understanding of Discrete and fast Fourier Transform.

Course Learning Outcomes

In this course, students will be able to develop a thorough understanding of the central elements of discrete time signal processing theory and correlate this theory with the real-world signal processing applications. At the end of this course, students will be able to develop following learning outcomes:
• Students will learn basic discrete-time signal and system types, convolution sum, impulse and frequency response concepts for linear time-invariant (LTI) systems.
• The student will be in position to understand use of different transforms and analyze the discrete time signals and systems. They will learn to analyze a digital system using z-transforms and discrete time Fourier transforms, region of convergence concepts, their properties and perform simple transform calculations,.
• The student will realize the use of LTI filters for filtering different real world signals. The concept of transfer Function and difference-Equation System will be introduced. Also, they will learn to solve Difference Equations.
• Students will develop an ability to analyze DSP systems like linear-phase, FIR, IIR, All-pass, averaging and notch Filter etc.
• Students will be able to understand the discrete Fourier transform (DFT) and realize its implementation using FFT techniques.
• Students will be able to learn the realization of digital filters, their structures, along with their advantages and disadvantages. They will be able to design and understand different types of digital filters such as finite & infinite impulse response filters for various applications.

Unit 1

Discrete-Time Signals and Systems: Classification of Signals, Transformations of the Independent Variable, Periodic and Aperiodic Signals, Energy and Power Signals, Even and 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)

Unit 2

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 3

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 4

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)

Unit 5

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.
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)

Practical

PRACTICAL-DSE LAB: DIGITAL SIGNAL PROCESSING LAB
60 Periods

At least 06 experiments from the following using Scilab/Matlab. Introduction to Numerical computation software Scilab/Matlab be introduced in the lab.
1. Write a program to generate and plot the following sequences: (a) Unit sample sequence δ(n) , (b) unit step sequence u(n), (c) ramp sequence r(n) , (d) real valued exponential sequence x(n)=(0.8)^n u(n) for 0≤n≤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(n/2N)=Π(n/2N)={█(1 -N≤n≤N@0 otherwise)┤

3. An LTI system is specified by the difference equation
y(n)=0.8y(n-1)+x(n)
(a) Determine H(e^jw)
(b) Calculate and plot the steady state response y_ss (n) to
x(n)=cos(0.5πn)u(n)

4. Given a casual system
y(n)=0.9y(n-1)+x(n)
(a) Find H(z) and sketch its pole-zero plot
(b) Plot the frequency response |H(e^jw) | and ∠H(e^jw)

5. Design a digital filter to eliminate the lower frequency sinusoid of x(t)=sin7t+sin200t. The sampling frequency is f_s=500 Hz. 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})¦↑={█(1 0≤n≤3@0 otherwise)┤
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)=({1,2,2,1})¦↑
h(n)=({1,-1,-1,1})¦↑
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=2 KHz
stopband edge F_s=5 KHz
Passband attenuation A_p=2 dB
Stopband attenuation A_s=42 dB
Sampling frequency F_s=20 KHz

10. The frequency response of a linear phase digital differentiator is given by
H_d (e^jw)=jwe^(-jτw) |w|≤π
Using a Hamming window of length M = 21, design a digital FIR differentiator. Plot the amplitude response.

References

• Digital Signal Processing, Tarun Kumar Rawat, 2015, Oxford University Press, India
• Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
• Principles of Signal Processing and Linear Systems, B.P. Lathi, 2009, 1st 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 Processing, A. Anand Kumar, 2nd Edition, 2016, PHI learning Private Limited.
• Digital Signal Processing, Paulo S.R. Diniz, Eduardo A.B. da Silva, Sergio L .Netto, 2nd Edition, 2017, Cambridge University Press
• A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
• Getting started with MATLAB, Rudra Pratap, 2010, Oxford University Press.

Keywords

Signals, Periodic signals, Aperiodic signals, Discrete time systems, Impulse response, Convolution, Discrete time fourier transform (DTFT), z-transform, LTI system, Difference equation, Filters, Frequency domain sampling, Discrete fourier transform (DFT), Fast fourier transform, Digital filters, FIR filter, IIR filter, Frequency response, Kaiser window

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Digital Signal processing (42227641) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This paper describes the discrete-time signals and systems, Fourier Transform Representation of Aperiodi Discrete-Time Signals.

2. This paper also highlights the concept of filters and realization of Digital Filters.
3. At the end of the syllabus, students will develop an understanding of Discrete and fast Fourier Transform.

Course Learning Outcomes

In this course, students will be able to develop a thorough understanding of the central elements of discrete time signal processing theory and correlate this theory with the real-world signal processing applications. At the end of this course, students will be able to develop following learning outcomes:
• Students will learn basic discrete-time signal and system types, convolution sum, impulse and frequency response concepts for linear time-invariant (LTI) systems.
• The student will be in position to understand use of different transforms and analyze the discrete time signals and systems. They will learn to analyze a digital system using z-transforms and discrete time Fourier transforms, region of convergence concepts, their properties and perform simple transform calculations,.
• The student will realize the use of LTI filters for filtering different real world signals. The concept of transfer Function and difference-Equation System will be introduced. Also, they will learn to solve Difference Equations.
• Students will develop an ability to analyze DSP systems like linear-phase, FIR, IIR, All-pass, averaging and notch Filter etc.
• Students will be able to understand the discrete Fourier transform (DFT) and realize its implementation using FFT techniques.
• Students will be able to learn the realization of digital filters, their structures, along with their advantages and disadvantages. They will be able to design and understand different types of digital filters such as finite & infinite impulse response filters for various applications.

Unit 1

Discrete-Time Signals and Systems: Classification of Signals, Transformations of the Independent Variable, Periodic and Aperiodic Signals, Energy and Power Signals, Even and 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)

Unit 2

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 3

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 4

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)

Unit 5

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.
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)

Practical

PRACTICAL-DSE LAB: DIGITAL SIGNAL PROCESSING LAB
60 Periods

At least 06 experiments from the following using Scilab/Matlab. Introduction to Numerical computation software Scilab/Matlab be introduced in the lab.
1. Write a program to generate and plot the following sequences: (a) Unit sample sequence δ(n) , (b) unit step sequence u(n), (c) ramp sequence r(n) , (d) real valued exponential sequence x(n)=(0.8)^n u(n) for 0≤n≤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(n/2N)=Π(n/2N)={█(1 -N≤n≤N@0 otherwise)┤

3. An LTI system is specified by the difference equation
$y(n)=0.8y(n-1)+x(n)$
(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
$y(n)=0.9y(n-1)+x(n)$
(a) Find $H(z)$ and sketch its pole-zero plot
(b) Plot the frequency response $|H(e^{jw})|$ and $\angle H(e^{jw})$

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

6. Let x(n) be a 4-point sequence:
$x(n)=\{1,1,1,1\}_{\uparrow}=\begin{cases}1 & 0\le n\le 3\\ 0 & \text{otherwise}\end{cases}$
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,
$x(n)=\{1,2,2,1\}_{\uparrow}$
$h(n)=\{1,-1,-1,1\}_{\uparrow}$
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 $F_p=2$ KHz
stopband edge $F_s=5$ KHz
Passband attenuation $A_p=2$ dB
Stopband attenuation $A_s=42$ dB
Sampling frequency $F_s=20$ KHz

10. The frequency response of a linear phase digital differentiator is given by
$H_d(e^{jw})=jwe^{-j\tau w}\quad |w|\le\pi$
Using a Hamming window of length M = 21, design a digital FIR differentiator. Plot the amplitude response.

References

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- Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
- Principles of Signal Processing and Linear Systems, B.P. Lathi, 2009, 1st 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 Processing, A. Anand Kumar, 2nd Edition, 2016, PHI learning Private Limited.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press.
- Getting started with MATLAB, Rudra Pratap, 2010, Oxford University Press.
- Digital Signal Processing, Paulo S.R. Diniz, Eduardo A.B. da Silva, Sergio L .Netto, 2nd Edition, 2017, Cambridge University Press

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Keywords

Signals, Periodic signals, Aperiodic signals, Discrete time systems, Impulse response, Convolution, Discrete time fourier transform (DTFT), z-transform, LTI system, Difference equation, Filters, Frequency domain sampling, Discrete fourier transform (DFT), Fast fourier transform, Digital filters, FIR filter, IIR filter, Frequency response, Kaiser window

Digital, Analog and Instrumentation (42227530) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This paper aims to cover the basic digital and analog electronic systems. The concept of Boolean algebra i discussed in detail and arithmetic circuits are described.

2. Students will learn the physics of semiconductor devices such as p-n junction, rectifier diodes and bipolar junction transistors.
3. By the end of the syllabus, students will also have an understanding of operational amplifiers and instrumentation including CRO, power supply etc.

Course Learning Outcomes

At the end of this course, students will be able to develop following learning outcomes:
• To differentiate between Analog and Digital circuits, acquire knowledge of the concepts of binary numbers, their addition, subtraction and conversion into decimal numbers.
• To explains the concepts of logic states and logic gates AND, OR, NOT, NAND, NOR, XOR and XNOR as fundamental, universal and derived gates with its utility.
• To learn how to write logical Boolean statements using the truth table, its simplification using Boolean Algebra, De-Morgan's Theorem and Karnaugh Maps specially the Sum of Products method and realize the corresponding logic circuit.
• To realize addition and subtraction of binary numbers using electronic circuits.
• To introduce the structure and operation of PN junction diodes and Bipolar Junction transistors. Also understand characteristics of different configurations, various current components and related parameters.
• To learn about the DC load line, quiescentpoint and biasing of voltage divider circuit.
• To analyze CE transistor amplifier using h-parameter model of the transistor.
• To distinguish ideal and practical op-amps and their electrical parameters.
• To understand various operating modes of Op-amps and its linear and non-linear application and acquire skill to design circuits for different OP-amp applications.
• To comprehend the criterion for sustained oscillations and its application in frequency determination for RC phase shift oscillator.
• To impart understanding of working of CRO and its usage in measurements of voltage, current, frequency and phase measurement.
• To describe working of rectifier circuits and quantitatively explain effect of capacitance filter, line and load regulation
• To explain the working of timer circuits using IC 555 and use them to develop multivibrators.

Unit 1

UNIT-1: Digital Circuits
Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates. NAND and NOR. Gates as Universal Gates. XOR and XNOR Gates. (5 Lectures)
De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Minterms and Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. (6 Lectures)
Binary Addition. Binary Subtraction using 2's Complement Method). Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor. (4 Lectures)

Unit 2

UNIT-2: Semiconductor Devices and Amplifiers:
Semiconductor Diodes: P and N type semiconductors. PN junction and its characteristics. Static and dynamic Resistance. (2 Lectures)

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Active, Cutoff & Saturation regions. Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line & Q-point. Voltage Divider Bias Circuit for CE Amplifier. h-parameter Equivalent Circuit of transistor. Analysis of single-stage CE amplifier using hybrid Model. Input and output Impedance. Current and Voltage gains. (12 Lectures)

Unit 3

UNIT-3: Operational Amplifiers (Black Box approach):
Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop and closed-loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator,(5) Integrator, (6) Zero crossing detector. (14 Lectures)
Sinusoidal Oscillators: Barkhausen's Criterion for Self-sustained Oscillations. Determination of Frequency of RC Phase-shift Oscillator. (5 Lectures)

Unit 4

UNIT-4: Instrumentations:
Introduction to CRO: Block diagram of CRO. Applications of CRO: (!) Study of waveform, (2) Measurement of voltage, current, frequency, and phase difference. (3 Lectures)
Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, Zener Diode and Voltage Regulation. (6 Lectures)
Timer IC: IC 555 Pin diagram and its application as Astable and Monostable Multivibrator. (3 Lectures)

Practical

PRACTICALS - DSE LAB: DIGITAL AND ANALOG CIRCUITS AND INSTRUMENTS

60 Lectures
AT LEAST 06 EXPERIMENTS FROM THE FOLLOWING
1. To measure (a) Voltage, and (b) Frequency of a periodic waveform using a CRO
2. To minimize a given (a) logic circuit and (b) Boolean equation.
3. Half adder, Full adder and 4-bit Binary Adder.
4. To design an astable multivibrator of given specifications using 555 Timer.
5. To design a monostable multivibrator of given specifications using 555 Timer.
6. To study IV characteristics of (a) PN diode, (b) Zener diode and (c) LED
7. To study the characteristics of a Transistor in CE configuration.
8. To design a CE amplifier of a given gain (mid-gain) using voltage divider bias.
9. (a) To design an inverting amplifier of given gain using Op-amp 741 and study its frequency response.
(b) To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.
10. To study a precision Differential Amplifier of given I/O specification using Op-amp.
11. To investigate the use of an op-amp as a Differentiator
12. To design a Wien Bridge Oscillator using an op-amp

References

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Fundamentals of Digital Circuits, Anand Kumar, 4nd Edn, 2018, PHI Learning Pvt. Ltd.
- Electronic devices & circuits, S. Salivahanan & N.S. Kumar, 2012, Tata Mc-Graw Hill
- Microelectronic Circuits, M.H. Rashid, 2nd Edn., 2011, Cengage Learning.
- Modern Electronic Instrumentation and Measurement Tech., Helfrick and Cooper,1990, PHI Learning.
- Digital Principles and Applications, A.P.Malvino, D.P.Leach and Saha, 8th Ed., 2018, Tata McGraw Hill Education.
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- OP-AMP & Linear Digital Circuits, R.A. Gayakwad, 2000, PHI Learning Pvt. Ltd.
- Electronic Devices and circuits, B. Kumar, S.B. Jain, 2nd Edition, 2015, PHI Learning Pvt. Ltd.
- Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1994, Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.

Keywords

Logic gates, Boolean Algebra, Adder, Subtractor, Semiconductor diode, Transistor, Amplifier, Oscillators, CRO, Rectifiers, Zener diode,Voltage regulation, Multivibrator

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Dissertation (42517617) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

It emphasizes the specific skills which the student shall be learning during the course of dissertation, for example, some computational skill or literature survey, etc.

Course Learning Outcomes

The dissertation work should not be a routine experiment or project at the under graduate level. It should involve more than text book knowledge. Referring text books for preparation and making concept, is allowed, however one component of the dissertation must include study of research papers or equivalent research material.

Unit 1

The total number of dissertations in Physics should be limited to 5% of the total strength of the students (Hons. and B.Sc. Programme) in the subject However, students having national scholarships like NTSE, KVPY, INSPIRE, etc. can be considered above this quota. The selection criterion is at the discretion of the college. The student should not have any academic backlog (ER). The sole/single supervisor must have a Ph.D. degree. Not more than two candidates would be enrolled under same supervisor.

Unit 2

At the time of submission of teaching- work load of the teachers by the college to the Department (Department of Physics and Astrophysics, Delhi University), the supervisor shall submit the proposal (200-300 words; not more than full one A4 page) of the proposed dissertation. Along with that four names of the external examiners from any college of Delhi University (other than the own college of the supervisor) or any department of Delhi University can be suggested. The committee of courses of the department may appoint any one teacher as an external examiner from the proposed list of external examiners.

Unit 3

No topic would be repeated from the topics allotted by the supervisor in the previous years, so that the work or dissertation could be distinct every time.

The 'proposal' should include the topic, plan of work, and clearly state the expected deliverables. The topic must be well defined. The abstract should clearly explain the significance of the suggested problem. It must emphasize the specific skills which the student shall be learning during the course of dissertation, for example, some computational skill or literature survey, etc. Both Internal (supervisor) and external examiners will assess the student at the end of the semester and award marks jointly, according to the attached scheme.

Unit 4

Other than the time for pursuing dissertation work, there must be at least 2 hours of interaction per week, of the student with the supervisor.

The student has to maintain a "Log Book" to summarize his/ her weekly progress which shall be duly signed by the supervisor.

Experimental work should be carried out in the parent college or any other college or the Department in Delhi University with consent of a faculty member there. Unsupervised work carried out at research institutions / laboratories is to be discouraged.

Unit 5

The dissertation work should not be a routine experiment or project at the under graduate level. It should involve more than text book knowledge. Referring text books for preparation and making concept, is allowed, however one component of the dissertation must include study of research papers or equivalent research material.

The dissertation report should be around 30 pages. It must have minimum three chapters namely Introduction, Main work including derivations / experimentation and Results, Discussion and Conclusion. At the end, adequate references must be included. Plagiarism must be checked.

Unit 6

It is left to the discretion of the college if it can allow relaxation of two teaching periods (at the most two periods per week to the supervisor, irrespective of the number of students enrolled under him / her for dissertation).

The evaluation/presentation of the dissertation must be done within two weeks after the exams are over.

For the interest of the students it is advised that college may organize a workshop for creating awareness amongst students. Any teacher who is not Ph.D. holder can be Co-supervisor with the main supervisor.

Assessment Methods

MARKING SCHEME for Dissertation in B.Sc. (Hons) and Programme courses in Physics

30 marks: I**nternal assessment based on performance like sincerity, regularity, etc.** *Checking by : Supervisor*
40 marks: **Written Report (including content and quality of work done)** *Checking by: Supervisor and Extern Examiner*
30 marks: **Presentation*** *Checking by: Supervisor and External Examiner*

**All Dissertation presentations should be open. Other students / faculty should be encouraged to attend.*

Electronic Instrumentation (42517512) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This course aims to cover the basics of measurement and instrumentation.
2. Various measurement instruments such as power supply, oscilloscope, multivibrators, signal generators a discussed in detail.
3. At the end of syllabus, Students will develop an understanding of virtual instrumentation and transducer

Course Learning Outcomes

This course aims to provide an exposure to students on various aspects of instruments and their usage through hands-on mode. At the end of this course, students will be able to achieve the following learning outcomes:

- Course learning begins with the basic understanding of the measurement and errors in measurement. It then familiarizes about specifications of basic Measurement instruments and their significance with hands on mode.
- Students learn principles of voltage measurement. Students should be able to understand the advantages of electronic voltmeter over conventional multimeter in terms of sensitivity etc. Types of AC milivoltmeter should be covered.
- Students learn the measurement of impedance using bridges with hands-on mode.
- Covers explanation of Power supply, Filters, IC regulators and Load and line regulation.
- Explanation of the Specifications of CRO and their significance. Complete explanation of CRT.
- Students learn the use of CRO for the measurement of voltage (dc and ac), frequency and time period. Covers the Digital storage Oscilloscope and its principle of working.
- Students learn about the Multivibrators and able to make working circuits of Astable and monostable multivibrators.
- Covers Phase Locked Loop (PLL), Voltage controlled oscillators and lock-In amplifier.
- Covers the explanation and specifications of Signal and pulse Generators. Students should be familiarized with testing and specifications.
- Students learn about the Interfacing techniques, Audrino microcontroller & interfacing software.
- Hands-on mode Understanding and usage of Transducers.

Unit 1

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Shielding and grounding. Electromagnetic Interference. (3 Lectures)

Basic Measurement Instruments: DC measurement-ammeter, voltmeter, ohm meter, AC measurement, Digital voltmeter systems (integrating and non-integrating). Digital Multimeter; Block diagram principle of measurement of I, V, C. Accuracy and resolution of measurement. Measurement of Impedance- A.C. bridges, Measurement of Self Inductance (Anderson's bridge), Measurement of Capacitance (De Sauty's bridge), Measurement of frequency (Wien's bridge). (12 Lectures)

Unit 2

Power supply: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators (78XX and 79XX), Line and load regulation, Short circuit protection. Idea of switched mode power supply (SMPS) & uninterrupted power supply (UPS). (4 Lectures)

Oscilloscope: Block Diagram, CRT, Vertical Deflection, Horizontal Deflection. Screens for CRT, Oscilloscope probes, measurement of voltage, frequency and phase by Oscilloscope. Digital Storage Oscilloscope. LCD display for instruments. (10 Lectures)

Unit 3

Multivibrators (IC 555): Block diagram, Astable & Monostable multivibrator circuits.
Phase Locked Loop (PLL): Basic Principles, Phase detector (XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor), lock and capture. Basic idea of PLL IC (565 or 4046). Lock-in-amplifier (qualitative only). (11 Lectures)

Signal Generators: Function generator, Pulse Generator(qualitative only). (3 Lectures)

Unit 4

Virtual Instrumentation: Introduction, Interfacing techniques (RS 232, GPIB, USB). Idea about Audrino microcontroller & interfacing software like lab View). (5 Lectures)

Transducers: Classification of transducers, Basic requirement/characteristics of transducers, Active and Passive transducers, Resistive (Potentiometer- Theory, temperature compensation and applications), Capacitive (variable air gap type), Inductive (LVDT) and piezoelectric transducers. Measurement of temperature (RTD, semiconductor IC sensors), Light transducers (photo resistors & photovoltaic cells). (12

Lectures)

Practical

PRACTICALS -DSE LAB: ELECTRONIC INSTRUMENTATION LAB
60 Periods

AT LEAST 06 EXPERIMENTS FROM THE FOLLOWING
1. Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity.
2. Measurement of Capacitance by De Sauty's bridge
3. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement of Strain using half and full bridge.)
4. To determine the Characteristics of LVDT.
5. To determine the Characteristics of Thermistors and RTD.
6. Measurement of temperature by Thermocouples.
7. Design a regulated power supply of given rating (5 V or 9V).
8. To design an Astable Multivibrator of given specification using IC 555 Timer.
9. To design a Monostable Multivibrator of given specification using IC 555 Timer.
10. To design and study the Sample and Hold Circuit.
11. To plot the frequency response of a microphone.
1. Glow an LED via USB port of PC.
12. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

References

• W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall (2005).
• E.O.Doebelin, Measurement Systems: Application and Design, McGraw Hill Book - fifth Edition (2003).
• David A. Bell, Electronic Devices and Circuits, Oxford University Press (2015).
• Alan S. Morris, "Measurement and Instrumentation Principles", Elsevier (Butterworth Heinmann-2008).
• S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata McGraw Hill(1998).
• Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1990, Mc-Graw Hill

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Keywords

Measurements, Digital multimeter, AC bridges, measurement of impedance, Oscilloscope, CRT, Multivibrators Phase locked loop, Signal generators, Virtual instrumentation, Interfacing techniques, Audrino microcontrolle transducers

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Elements of Modern Physics (42227929) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

This course introduces modern development in Physics that ushered in relativity and quantum physics which

not only revolutionized mankind's understanding of time, space, atomic and sub-atomic structures that make up the matter

around us, but also led to

fascinating developments in technology that are being witnessed all around us.

Beginning with technological marvels like electronics, spectroscopy, semiconductor based devices,

IC chips, lasers, harnessing of nuclear energy, satellite communication, atomic clocks, GPS, space travel, scanning tunneling

microscope, nano-materials, nano- technology, CCDs, etc. modern physics brought forth useful tools

in our daily lives like laptop computers, mobile phones, laser pointers, LEDs, LCD screens, so on and so fort Therefore,

the objective of this course is to teach the physical and mathematical foundations necessary for learning various topics in modern

physics.

Starting from Planck's law, this course introduces Planck spectrum, photo-electric effect, idea of wave-parti duality, Heisenberg's

uncertainty principle, Bohr model of atoms and then, develops the formulation of

Schrodinger equation and the idea of probability interpretation associated with wave-functions.

It also introduces basic underlying concepts involved in laser physics as well as that in nuclear physics, so crucial for high energy

physics, nuclear technology and astrophysics.

Course Learning Outcomes

This course will prepare the students to appreciate and comprehend the following aspects:

1. Understand historical basis of quantum mechanics.

2. Explain how quantum mechanical concepts answer some of unanswered questions of Classical mechanics such as photoelectric effect, Compton scattering etc.

3. Explain inadequacy of Rutherford model, discrete atomic spectra from hydrogen like atoms and its explanation on quantum mechanical basis.

4. Demonstrate ability to apply wave-particle duality and uncertainty principle to solve physics problems.

5. Explain two slit interference experiment with photons, atoms and particles establishing non-deterministic nature of QM.

6. Set up Schrodinger equation for behavior of a particle in a field of force for simple potential and find wave solutions establishing wave-like nature of particles.

7. Demonstrate ability to solve 1-D quantum problems including the quantum particle in a box, a well and the transmission and reflection of waves.

8. Explain nuclear structure, binding energy, nuclear models and impossibility of an electron being in the nucleus as a consequence of the uncertainty principle.

9. Understand radioactivity, radioactive decays, apply radioactive laws to solve related physics problems and Pauli's prediction of neutrino, and the subsequent discovery.

Unit 1

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.
Problems with Rutherford model : Instability of atoms and observation of discrete atomic spectra; Bohr's quantisation rule and atomic stability; calculation of energy levels for hydrogen-like atoms and their spectra. (14 Lectures)

Unit 2

Unit 3

Position measurement : gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle - impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle. (6 Lectures)

Unit 4

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

Unit 5

One dimensional infinitely rigid box : energy eigenvalues, eigenfunctions and their normalization; Quantum dot as an example; Quantum mechanical scattering and tunneling 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 & binding energy.
(6 Lectures)

Unit 6

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay: energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. Fission and fusion: mass deficit, relativity and generation of energy; Fission : nature of

fragments and emission of neutrons. (11 Lectures)

Practical

Radioactivity: stability of nucleus; Law of radioactive decay; Mean life and half-life;

 decay; decay - energy released, spectrum and Pauli's prediction of neutrino; -ray

emission. (11 Lectures)

References

 Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.

 Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill

 Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.

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 Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill

 Modern Physics, John R.Taylor, Chris D.Zafiratos and M.A. Dubson, 2009, PHI Learning

 Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning

Additional Resources:

 Six Ideas that Shaped Physics:Particle Behave like Waves, T.A.Moore,2003, McGraw Hill

Thirty years that shook physics: the story of quantum theory, George Gamow, Garden City, NY : Doubleday, 1966

 New Physics, ed. Paul Davies, Cambridge University Press (1989)

 One, Two, Three, ..., Infinity: Facts and Speculations in Science, George Gamow, Dover publications, 1947

 Quantum Theory, David Bohm, Dover Publications, 1979

 Lectures on Quantum Mechanics: Fundamentals and Applications, eds. A. Pathak and Ajoy Ghatak, Viva Books Pvt. Ltd., 2019

Teaching Learning Process

1. Power-point Lecture and Board work
2. Tutorials followed by discussion
3. Question and Answer
4. Laboratory exercise
5. Demonstration experiments
6. Computer simulations
7. Problem Solving

Assessment Methods

1. Written and Oral Tests
2. Assignments
3. Class room presentations
4. Final Semester examination

Embedded System: Introduction to microcontroller (42227638)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This paper gives a review of microprocessor and introduces microcontroller 8051.
2. Here, students will learn about the 8051 I/O port programming and various addressing modes.
3. They will obtain a thorough understanding of Timer and counter programming, Serial port programming w and without interrupt and interfacing 8051 microcontroller to peripherals.

Course Learning Outcomes

This is a course to familiarize/ introduce students to designing and developing embedded systems. It provides the students with an introductory coverage of embedded systems. The learning outcomes of the course are:
• Knowledge of the major components that constitute an embedded system.
• Understand what is a microcontroller, microcomputer embedded system.
• Description of the architecture of a 8051 microcontroller.
• Write simple programs for 8051 microcontroller in C language.
• Understand key concepts of 8051 microcontroller systems like I/O operations, interrupts, programming of timers and counters.
• Interfacing of 8051 microcontroller with peripherals
• Understand and explain concepts and architecture of embedded systems
• Implement small programs to solve well-defined problems on an embedded platform.
• Develop familiarity with tools used to develop an embedded environment

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Unit 1

Embedded system introduction: Introduction to embedded systems and general purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, challenges and design issues in embedded system, operational & non-operational quality attributes of embedded system, elemental description of embedded processors and microcontrollers. (6 Lectures)

Review of microprocessors: Organization of Microprocessor based system, 8085µp pin diagram and architecture, Data bus and address bus, 8085 programming model, instruction classification, subroutines, stacks and its implementation, delay subroutines, hardware and software interrupts. (4 Lectures)

Unit 2

8051 microcontroller: Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Data types and directives, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions. (12 Lectures)

8051 I/O port programming: Introduction of I/O port programming, pin out diagram of 8051 microcontroller, I/O port pins description & their functions, I/O port programming in 8051 (using Assembly Language), I/O programming: Bit manipulation. (4 Lectures)

Unit 3

Programming of 8051: 8051 addressing modes and accessing memory using various addressing modes, assembly language instructions using each addressing mode, arithmetic and logic instructions, 8051 programming: for time delay and I/O operations and manipulation, for arithmetic and logic operations, for ASCII and BCD conversions. (12 Lectures)

Timer and counter programming: Programming 8051 timers, counter programming.
(3 Lectures)

Unit 4

Serial port programming with and without interrupt: Introduction to 8051 interrupts, programming timer interrupts, programming external hardware interrupts and serial communication interrupt, interrupt priority in the 8051. (6 Lectures)

Interfacing 8051 microcontroller to peripherals: Parallel and serial ADC, DAC interfacing, LCD interfacing. (2 Lectures)

Unit 5

Programming Embedded Systems: Structure of embedded program, infinite loop, compiling, linking and locating, downloading and debugging. (3 Lectures)

Embedded system design and development: Embedded system development environment, file types generated after cross compilation, disassembler/decompiler, simulator, emulator and debugging, embedded product development life-cycle, trends in embedded industry. (8 Lectures)

Practical

PRACTICALS- DSE LAB: EMBEDDED SYSTEM:INTRODUCTION TO MICROCONTROLLERS
60 Lectures

Following experiments (at least 06 using 8051:
1. To find that the given numbers is prime or not.
2. To find the factorial of a number.
3. Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number.
4. Use one of the four ports of 8051 for O/P interfaced to eight LED's. Simulate binary counter (8 bit) on LED's.
5. Program to glow first four LED then next four using TIMER application.
6. Program to rotate the contents of the accumulator first right and then left.
7. Program to run a countdown from 9-0 in the seven segment LED display.
8. To interface seven segment LED display with 8051 microcontroller and display 'HELP' in the seven segment LED display.
9. To toggle '1234' as '1324' in the seven segment LED.
10. Interface stepper motor with 8051 and write a program to move the motor through a given angle in clock wise or counter clockwise direction.
11. Application of embedded systems: Temperature measurement, some information on LCD display, interfacing a keyboard.

References

• Embedded Systems: Architecture, Programming & Design, Raj Kamal, 2008, Tata McGraw Hill
• The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A.Mazidi, J.G. Mazidi and R.D. McKinlay, 2nd Edition, 2007, Pearson Education
• Embedded Systems and Robots, Subrata Ghoshal, 2009, Cengage Learning
• Introduction to embedded system, K.V. Shibu, 1st Edition, 2009, McGraw Hill
• Embedded Microcomputer systems: Real time interfacing, J.W.Valvano 2011, Cengage Learning
• Microprocessors and Microcontrollers, Krishna Kant, 2nd Edition, 2016. PHI learning Pvt. Ltd.
• Embedded System, B.K. Rao, 2011, PHI Learning Pvt. Ltd.

Keywords

Embedded systems, 8051, Microcontroller, Architecture, Memory map, Addressing modes, Timers, Counter Programming, Interrupts, LCD interfacing

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Mathematical Physics
(42227531)
Discipline Specific Elective - (DSE) Credit:6

Unit 1

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. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series.
(10 Lectures)

Unit 2

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 Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Orthogonality. Simple recurrence relations.
(16 Lectures)

Unit 3

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. (4 Lectures)
Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular geometry. Solution of 1D wave equation. (10 Lectures)

Unit 4

Complex Analysis: Brief revision of Complex numbers & 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. Integration of a function of a complex variable. Cauchy’s Integral formula. (14 Lectures)

Practical

PRACTICALS -DSE LAB: MATHEMATICAL PHYSICS

60 Lectures

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

- *• The course will consist of lectures(both theory and practical) in the Lab*
- *• Evaluation done on the basis of formulating the problem*
- *• Aim at teaching students to construct the computational problem to be solved*
- *• At least two programs must be attempted from each programming section.*

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 and overflow - emphasize the importance of making equations in terms of dimensionless variables, Iterative methods

Errors and error Analysis: Truncation and roundoff 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, cin and cout ,Manupulators for data formatting, Control statements (decision making and looping statements) (if-statement, if-else statement, nested if statement, else-if statement, ternary operator, goto statement, switch statement, unconditional and conditional looping, while and do while loop, for loop,nested loops, break and continue statements). Arrays (1D and 2D)and strings, user defined functions, Structures and Unions, Idea of classes and objects

Programs: using C/C++ language: Sum and 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

Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods: Solution of linear and quadratic equation, solving in optics, 20sin;tan□□□□□□==□□□□II

Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation: Evaluation of trigonometric functions e.g. sin□, cos□, tan□ etc

Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method: Given Position with equidistant time data calculate velocity and acceleration and vice versa. Find the area of BH 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 – (i)Radioactive decay (ii) Current in RC, LC circuits with DC source (iii) Newton's law of cooling (iv) Classical equations of motion

Attempt following problems using RK 4 order method: (i) Solve the coupled differential equations

References

- 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, E.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
- Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt. Ltd.

• Schaum'sOutlineofProgrammingwithC++. J.Hubbard, 2000, McGraw-HillPub.
• NumericalRecipesinC++:TheArtofScientificComputing, W.H.Presset.al.,2ndEdn., 2013, CambridgeUniversityPress.
• A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
• AnIntroductiontocomputationalPhysics,T.Pang,2ndEdn., 2006,CambridgeUniv. Press

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Medical Physics
(42227535)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

This course introduces a student to the basics of Medical Physics.

Course Learning Outcomes

The last few years have witnessed a tremendous growth in the applications of Physics to the field of medicine. Beginning with the use of Imaging in Diagnostics to Radiation therapy for Cancer, everything involves Physics. Hence, there is a big need for being aware of medical physics. This course introduces a student to the basics of Medical Physics. Today with the changing life styles it is also necessary for one to have a better understanding of the human body from the perspective of Physics. This course seeks to fulfill both these needs.

Unit 1

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.

Other Systems in the body: Pressure system of body. Physics of breathing, Physics of cardiovascular system.
(8 Lectures)

Unit 2

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 3

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. Single and three phase electric supply. Power ratings. Types of X-Ray Generator, high frequency generator, exposure timers and switches, HT cables.
(7 Lectures)

Radiation Physics: Radiation units exposure, absorbed dose, units: rad, gray, relative biological effectiveness, effective dose- Rem & Sievert, inverse square law. Interaction of radiation with matter Compton & photoelectric effect, linear attenuation coefficient. Radiation Detectors: ionization (Thimble chamber, condenser chamber), chamber. Geiger Muller counter, Scintillation counters and Solid-State detectors, TFT.
(7 Lectures)

Unit 4

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 and 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, 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 5

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)

Unit 6

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)

Practical

At least 05 experiments from the following:
1. Understanding the working of a manual Hg Blood Pressure monitor, Stethoscope and to measure the Blood Pressure.
2. Understanding the working of a manual optical eye-testing machine and to learn eye-testing procedure.
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 & to measure background radiation

7. Familiarization with Radiation meter and to measure background radiation.
8. Familiarization with the Use of a Vascular Doppler.

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 the human body, Irving P. Herman, Springer (2007).
• Physics of Radiation Therapy: F M Khan - Williams and Wilkins, 3 rd edition (2003)
• 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.
• 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, 3 rd edition (2003)
• 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.Publications Pvt Ltd.

Nano Materials and Applications (42227532) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

This course introduces briefly the basic concepts of Quantum Mechanics, essential for this course. Schroding wave equation and its applications to simple problems are discussed. The learnt concepts were then used to understand the idea of quantum confinement which is central to the understanding of the optical properties and electron transport phenomenon in nanostructures. Synthesis, characterization and applications of nanomaterials are discussed.

The main prerequisite is an introductory course in Solid State Physics and Quantum Mechanics

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Course Learning Outcomes

On successful completion of the module students should be able to

· *explain the difference between nanomaterials and bulk materials and their properties.*

· *explain various methods for the synthesis/growth of nanomaterials.*

· *explain the role of confinement on the density of state function and so on the various properties exhibited by nanomaterials compared to bulk materials.*

· *explain the various characterization tools required to study the structural, optical and electrical properties of nanomaterials.*

· *to analyze the data obtained from the various characterization techniques.*

· *explain the concept of Quasi-particles such as excitons and how they influence the optical properties.*

· *explain the direct and indirect bandgap semiconductors, radiative and non-radiative processes and the concept of luminescence.*

· *explain the conductance quantization in 1D structure and its difference from the 2DEG system.*

· *explain the necessary and sufficient conditions required to observe coulomb blockade, single electron transistor and the scope of these devices.*

· *explain how MEMS and NEMS devices are produced and their applications.*

· *explain why nanomaterials exhibit properties which are sometimes very opposite, like magnetic, to their bulk counterparts.*

Unit 1

Basic Introduction to solids: classification of solids into crystalline and amorphous materials, classification based on conductivity (with numbers) as metals, semiconductors and insulators, the idea of bandgap and its consequences on optical and electrical properties, electrons as free particles for current conduction (I = nevA), introduce bulk (3D) and nanomaterials {thin films (2D), nanowires (1D) nanodots or quantum dots (0D)} with an example of the colour of say Gold metals and its nanoparticles.

(6 Lectures)

Unit 2

BasicQuantum Mechanics: Idea about particles as wave, electron interference experiment, superposition principle, position (or amplitude), and momentum. Wave-particle duality, uncertainty principle, energy quantization, Schrodinger equation.Applications of Schrodinger equation (quantitative): The free particle, potential step, rectangular potential barrier and the tunnel effect, free and bound states of a particle in square well potential, particle in a box (3D) problem.

(14 Lectures)

Unit 3

Nanoscale Systems:Bulk materials Density of states function and its implication on electrical properties,Band structure and densityof states function fornanoscale materials (Quantitative for 2D, 1D, 0D), Applications of quantum confinement of carriers in 3D, 2D, 1Dnanostructures and itsconsequences on electronic and optical properties.

(10 Lectures)

Unit 4

Synthesis and Characterization(Qualitative):Top down and Bottom up approach, Photolithography. Ball milling.Spin coating, Vacuum deposition: Physical vapor deposition (PVD): Thermal evaporation, Sputtering, Pulsed Laser Deposition (PLD), electric arc deposition for CNT, C_{60}, grapheme, Chemical vapor deposition (CVD). Preparation through colloidal methods (Metals, Metal Oxide nanoparticles), MBE growth of quantum dots.Structure and Surface morphology:X-Ray Diffraction. Scanning Electron Microscopy. Transmission Electron Microscopy Spectroscopy: UV-Vis spectroscopy.(Emphasis should be on to discuss data and plots gathered from these techniques)

(11 Lectures)

Unit 5

Optical and Electron Transport Properties:Bandgap tuning as a function of particle size (discuss results of oxide and metal nanoparticles) Radiative processes: General formalization-absorption, emission and luminescence. Defects and impurities.Time and length scale of electrons in solids, Carrier transport,diffusive and ballistic,in nano structures, Charging effect, Coulomb blockade effect.

(12 Lectures)

Unit 6

Applications (Qualitative): based on optical, electrical and magnetic properties of nanoparticles, nanowires and thin films in electronic industry, medical industry, beauty products, Micro Electromechanical Systems (MEMS).

(7 Lectures)

Practical

1. Synthesis of metal (Au/Ag)nanoparticles by chemical route and study its optical absorption properties.

2. Synthesis of semiconductor (CdS/ZnO/TiO2/Fe2O3etc) nanoparticles and study its XRD and optical absorption properties as a function of time.

3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.

4. Analysis of XRD pattern of nanomaterials and estimation of particle size.

5. To study the effect of size on color of nanomaterials.

6. To prepare composite of CNTs with other materials.

7. Growth of quantum dots by thermal evaporation.

8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.

9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) andstudy its XRD and transmittance spectra in UV-Visible region.

10. Prepare a thin film capacitor and measure capacitance as a function oftemperature or frequency.

11. Fabricate a PN diode by diffusing Al over the surface of N-type Si/Geand study itsV-I characteristic.

12. Fabricate thin films (polymer, metal oxide) using electrodeposition

13. To study variation of resistivity or sheet resistance with temperature of the fabricated thin films using four probe method.

References

Reference Books for Theory:

· Solid State Physics, M. A. Wahab, 2011, Narosa Publications

· Solid State Physics by J. R. Hall and H. E. Hall, 2nd edition Wiley

· Quantum Mechanics by S. P. Singh, M. K. Bagde and K. Singh, S. Chand and Company Ltd.

· Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.

· C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).

· K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).

· Electronic transport in mesoscopic systems by SupriyoDatta (1997) Cambridge University Press.

· Fundamentals of molecular spectroscopy by C. N. Banwell and E. M. McCASH, McGrawHill.

Reference Books for Practicals:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).

2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).

3. K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited).

4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

Additional Resources:

Quantum Transport in semiconductor nanostructures by Carla Beenakker and HenK Van Houten (1991) (available at arXiv: cond-mat/0412664) open source

· Sara cronewett Ph.D. thesis (2001).

Teaching Learning Process

Since this is an advanced course and is only for students who specifically opt for it, the teaching learning process must include

· *That the important concepts be introduced in detail, as per the syllabus, to provide firm support for further exploration*

· *That lab visits, to research labs and USIC, DU or others, be organized so that students can see the various instrumentations/facilities and appreciate the technology that plays a crucial role in shaping this field.*

· *That student should be encouraged to search or they be provided with topics of experiments, outside the syllabus, that shape this field and submit an assignment. Few topics are like: Aharonov-Bohm effect, Bohm Oscillations, classical conductance quantization, fractional quantum hall effect.*

· *That instead of tests, quizzes should be conducted every week to assess the students.*

· *That labs should be setup suitably so that the students learning from theory can be tested, wherever suitable, with practical data.*

Assessment Methods

· *Regular quizzes, one per week, be conducted based on what has been taught in that week instead of lengt test covering several topics.*

· *Assignment based on experiments which contributed to this field be given to students. The students shou be encouraged to write the assignment in their own words as per their understanding.*

· *The students should present the assigned topic through presentation.*

Keywords

Nano,0D, 1D, 2D and 3D nanostructures and confinemnnt, quantum dots, thin films, nanowires, nanorods, 2 dimensional electron gas (2DEG), Quasi-particles, excitons, radiative and non-radiative process, MEMS, NEMS, heterostructure, coulomb blockade, CNT

Nuclear and Particle Physics
(42227639)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

The objective of the course is to impart the understanding of the sub atomic particles and their properties. I will emphasize to gain knowledge about the different nuclear techniques and their applications in different branches of Physics and societal application. The course will focus on the developments of problem based skills.

Course Learning Outcomes

The acquire knowledge can be applied in the areas of nuclear, medical, archaeology, geology and other interdisciplinary fields of Physics and Chemistry. It will enhance the special skills required for these fields.

Unit 1

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density, matter density (experimental determination of each), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/Z plot, angular momentum, parity, magnetic moment, electric moments.

(10 Lectures)

Unit 2

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, nucleon separation energies (up to two nucleons), Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure and the basic assumption of shell model.

(11 Lectures)

Unit 3

Radioactivity decay: Decay rate and equilibrium (Secular and Transient)(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy, decay Chains. (b) β-decay: energy kinematics for β-decay, β-spectrum, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission from the excited state of the nucleus & kinematics, internal conversion.

(10 Lectures)

Unit 4

Nuclear Reactions: Types of Reactions, units of related physical quantities, 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 5

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. (9 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 and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector. (9 Lectures)

Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons (Principal, construction, working, advantages and disadvantages). (7 Lectures)

Unit 6

Particle physics: Particle interactions (concept of different types of forces), basic features, Cosmic Rays, types of particles and its families, Conservation Laws (energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness) concept of quark model, color quantum number and gluons.

(11 Lectures)

References

[1] Basic Ideas and concepts in Nuclear Physics : An introductory Approach by K Heyde, Third edition, IOP Publication, 1999.

[2] Nuclear Physics by S. N. Ghoshal, First edition, S. Chand Publication, 2010.

[3] Concepts of Nuclear Physics by Bernard L Cohen, Tata McGraw Hill Publication, 1974.

[4] Introductory Nuclear Physics by Kenneth S, Krane, Wiley-India Publication, 2008

[5] Nuclear Physics : principles and applications by John Lilley, Wiley Publication, 2006.

[6] Physics and Engineering of Radiation Detection by Syed Naeem Ahmed, Academic Press Elsevier, 2007.

[7] Introduction to Modern Physics by Mani & Mehta, Affiliated East-West Press, 1990.

[8]Introduction to elementary particles by David J Griffiths, Wiley, 2008.

[9] Modern Physics by Serway, Moses and Moyer, CENGAGE LEARNING, 2012.

Additional Resources:
[1] Radiation detection and measurement, G.F. Knoll, John Wiley & Sons, 2010.

[2] Technique for Nuclear and Particle Physics experiments by William R Leo, Springer, 1994.

[3] Concepts of Modern Physics by Arthur Beiser, McGraw Hill Education, 2009.

Numerical Books : Schaum's Outline of Modern Physics, McGraw-Hill Education, 1999 and Modern Physics by R. Murugaeshan, S.Chand Publication, 2010.

Teaching Learning Process

Number of lectures required for individual topics of each Unit is shown in the table along with the reference for each topic.

S. No.	Unit and Syllabus	No. of Lectures	Reference Book
	General Properties of Nuclei		
	Constituents of nucleus and their Intrinsic properties.	1	
	Quantitative facts about mass.	1	
	radii, charge density, matter density (experimental determination	1	

1	*of each).*		
	Binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve and N/Z plot.	4	[1],[2],[3],[9],[1
	Angular momentum, parity.	1	
	Magnetic moment.	1	
	Electric moments.	1	
	Nuclear Models		
	Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, nucleon separation energies (up to two nucleons).	7	*13th Chapter o [11] (13.3), 7^{t} Chapter of [1]*
2	*Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas)*	2	*8th Chapter of [(8.1,8.2)*
	Evidence for nuclear shell structure and the basic assumption of shell model.	2	*9th Chapter of [(9.1) and 5th Chapter of [4] (without any derivation) (5.1, 11th Chapter o [12] (11.6)*
	Radioactivity decay		
3	*Decay rate and equilibrium (Secular and Transient).(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy, decay Chains.*	5	*2nd Chapter of [1], 3rd Chapte of [2] (3.5,3.6) 4thChapter of [1] 4rd Chapter of [2 8th Chapter of [4 13th Chapter o [11] (13.5)*
	(b) β-decay: energy kinematics for β-decay, β-spectrum, positron emission, electron capture, neutrino hypothesis.	3	*5nd Chapter of [(5.1,5.4) (page n 157, only introduction), 8 Chapter of [3] (8.2), 9th Chapte of [4] (9.1,9.2 (o mass of the neutrino),9.6)*
	(c) Gamma decay: Gamma rays emission from the excited state of the nucleus & kinematics, internal conversion.	2	*10th Chapter of [(10.1,10.2,10.6, 12th Chapter of [(no derivation)*
		10	
	Nuclear Reactions		
	Types of reactions, units of related physical quantities,.		

4	*Conservation Laws, kinematics of reactions, Q-value.*	5	*11^{th} Chapter of [(11.1- 11.6)*
	Concept of compound and direct Reaction, resonance reaction.	2	
	Reaction rate, reaction cross section, Coulomb scattering (Rutherford scattering).	1	
	Interaction of Nuclear Radiation with matter		
5	*Energy loss due to ionization (Bethe-Block formula).*	2	*5^{th} chapter of [10^{th} Chapter of [Additional book [7],[8]*
	Energy loss of electrons.	1	
	Cerenkov radiation.	1	
	Gamma ray interaction through matter (photoelectric effect, Compton scattering, pair production).	4	
	Neutron interaction with matter.	1	
	Detector for Nuclear Radiations		
6	*Gas detectors: estimation of electric field, mobility of particle for ionization chamber and GM Counter.*	3	*6^{th} Chapter of [(6.1 to 6.6) Additional book 3^{rd}, 5^{th} and 6^{th} Chapters of [6]*
	Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT).	2	
	Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility).	3	
	Neutron detector.	1	
	Particle Accelerators		
7	*Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. (Principal, construction, working, advantages and disadvantages).*	7	*6^{th} Chapter of [(6.8), 15^{th} Chapt of [4], Additional book [9]*
	Particle physics		
8	*Particle interactions (concept of different types of forces), basic features.*	2	*1^{st} chapter of[1 up to 1.8, 18^{th} Chapters of [4] to 18.4, 13^{th} Chapter of [12] Additional Book [9]*
	Cosmic Rays.	1	
	Types of particles and its families.	2	
	Conservation Laws (energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness).	3	
	Concept of quark model, color quantum number and gluons.	3	

Reference Book :

[1] Basic Ideas and concepts in Nuclear Physics : An introductory Approach by K Heyde, Third edition, IOP Publication, 1999.

[2] Nuclear Physics by S. N. Ghoshal, First edition, S. Chand Publication, 2010.

[3] Concepts of Nuclear Physics by Bernard L Cohen, Tata McGraw Hill Publication, 1974.

[4] Introductory Nuclear Physics by Kenneth S, Krane, Wiley-India Publication, 2008

[5] Nuclear Physics : principles and applications by John Lilley, Wiley Publication, 2006.

[6] Physics and Engineering of Radiation Detection by Syed Naeem Ahmed, Academic Press Elsevier, 2007.

[7] Radiation detection and measurement, G.F. Knoll, John Wiley & Sons, 2010.

[8] Technique for Nuclear and Particle Physics experiments by William R Leo, Springer, 1994.

[9] Introduction to Modern Physics by Mani & Mehta, Affiliated East-West Press, 1990.

[10]Introduction to elementary particles by David J Griffiths, Wiley, 2008.

[11] Modern Physics by Serway, Moses and Moyer, CENGAGE LEARNING, 2012.

[12] Concepts of Modern Physics by Arthur Beiser, McGraw Hill Education, 2009.

Numerical Books : Schaum's Outline of Modern Physics, McGraw-Hill Education, 1999 and Modern Physics by R. Murugaeshan, S.Chand Publication, 2010.

Keywords

Nuclear Physics, Nuclear Structure, Nuclear Decay & Reaction, Accelerators & Detectors, Particle Physics

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Photonic devices and Power Electronics (42517615) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This paper provides an insight on photonic devices such as Light Emitting Diodes, Semiconductor Laser, Laser diode, Photodetectors, Solar cell etc.

2. Also, students will learn about LCD displays, their advantages over LED displays, evolution, elements, modes and configurations of optical fiber system.
3. Emphasis is being laid to introduce students to power electronics, its need and applications.

Course Learning Outcomes

At the end of this course, students will be able to achieve the following learning outcomes:
• Develop understanding of application of fundamental laws of physics in such optoelectronics areas as telecommunications and power electronics for automation in industries.
• Acquire essential laboratory skills in designing experiments, assembling standard optical tools for optical experimentation and power electronics and analyzing acquired data.
• Identify the critical areas in application levels and derive typical alternative solutions, select suitable power converters to control Electrical Motors and other industry grade apparatus.
• Develop understanding to compare performance and basic operation of various power semiconductor devices, passive components and various switching circuits.
• Develop understanding of Basic circuit of power rectifiers and inverters.

Unit 1

Classification of photonic devices. Interaction of radiation and matter, Radiative transition and optical absorption. Light Emitting Diodes- Construction, materials and operation. Semiconductor Laser- Condition for amplification, laser cavity, hetero-structure and quantum well devices. Charge carrier and photon confinement, line shape function. Threshold current. Laser diode. (12 Lectures)

Unit 2

Photodetectors: Photoconductor. Photodiodes (p-i-n, avalanche) and Photo transistors, quantum efficiency and responsivity. Photomultiplier tube. (5 Lectures)

Solar Cell: Construction, working and characteristics (2 Lectures)

LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, applications, advantages over LED displays. (4 Lectures)

Unit 3

Introduction to Fiber Optics: Evolution of fiber optic system- Element of an Optical Fiber Transmission link- Ray Optics-Optical Fiber Modes and Configurations -Mode theory of Circular Wave guides- Overview of Modes-Key Modal concepts- Linearly Polarized Modes -Single Mode Fibers-Graded Index fiber structure. (13 Lectures)

Unit 4

Power Devices: Need for semiconductor power devices, Power MOSFET (Qualitative). Introduction to family of thyristors. Silicon Controlled Rectifier (SCR)- structure, I-V characteristics, Turn-On and Turn-Off characteristics, ratings, Gate-triggering circuits. Diac and Triac- Basic structure, working and V-I characteristics. Application of Diac as a triggering device for Triac. (10 Lectures)

Insulated Gate Bipolar Transistors (IGBT): Basic structure, I-V Characteristics, switching characteristics, device limitations and safe operating area (SOA). (2 Lectures)

Unit 5

Applications of SCR: Phase controlled rectification, AC voltage control using SCR and Triac as a switch. Power Invertors- Need for commutating circuits and their various types, dc link invertors, Parallel capacitor commutated invertors, Series Invertor, limitations and its improved versions, bridge invertors.(12 Lectures)

Practical

PRACTICALS -DSE-1 LAB: PHOTONIC DEVICES AND POWER ELECTRONICS LAB
60 Periods

AT LEAST 06 EXPERIMENTS FROM THE FOLLOWING
1. To determine wavelength of sodium light using Michelson’s Interferometer.
2. Diffraction experiments using a laser.

3. Study of Electro-optic Effect.
4. To determine characteristics of (a) LEDs, (b) Photo voltaic cell and (c) Photo diode.
5. To study the Characteristics of LDR and Photodiode with (i) Variable Illumination intensity, and (ii) Linear Displacement of source.
6. To measure the numerical aperture of an optical fiber.
7. Output and transfer characteristics of a power MOSFET.
8. Study of I-V characteristics of SCR
9. SCR as a half wave and full wave rectifiers with R and RL loads.
10. AC voltage controller using TRIAC with UJT triggering.
11. Study of I-V characteristics of DIAC
12. Study of I-V characteristics of TRIAC

References

• Optoelectronics, J. Wilson and J.F.B. Hawkes, Prentice Hall India (1996)
• Optoelectronics and Photonics, S.O. Kasap, Pearson Education (2009)
• Electronic Devices and Circuits, David A. Bell, 2015, Oxford University Press.
• Introduction to fiber optics, A.K. Ghatak & K. Thyagarajan,Cambridge University Press(1998)
• Power Electronics, P.C. Sen, Tata McGraw Hill
• Power Electronics, M.D. Singh & K.B. Khanchandani, Tata McGraw Hill
• Power Electronics Circuits, Devices & Applications, 3rd Edn., M.H.Rashid, Pearson Education
• A Textbook of Electrical Technology,Vol-II, B.L.Thareja, A.K.Thareja, S.Chand.

Keywords

Photonic devices, radiative transition, optical absorption, Light Emitting Diodes, Semiconductor Laser, Charge carrier and photon confinement, Photodetectors, quantum efficiency, responsivity, Photomultiplier tube, Solar Cell, LCD Displays, Fiber Optics, Power Devices,Insulated Gate Bipolar Transistors (IGBT), Phase controlled rectification

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Physics of the Earth (42227644) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

This course familiarizes the students with the origin of universe and role of earth in the solar system.

Course Learning Outcomes

It focuses on the structure of the earth as well as various dynamical processes occurring on it. It also aims to develop an understanding of evolution of the earth.

Unit 1

The Earth and the Universe:
(17 Lectures)
(a) Origin of universe, creation of elements and earth. A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences.

(b) General characteristics and origin of the Universe. The Big Bang Theory. Age of the universe and Hubble constant. Formation of Galaxies. The Milky Way galaxy, Nebular Theory, solar system, Earth's orbit and spin, the Moon's orbit and spin. The terrestrial and Jovian planets. Titius-Bode law. Asteroid belt. Asteroids: origin types and examples. Meteoroids, Meteors and Meteorites. Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age.
(c) Energy and particle fluxes incident on the Earth.
(d) The Cosmic Microwave Background.

Unit 2

Structure:
(18 Lectures)
(a) The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy. How do we learn about Earth's interior?
(b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. River systems.
(c) The Atmosphere: layers, variation of temperature with altitude, adiabatic lapse rate, variation of density and pressure with altitude, cloud formation.
(d) The Cryosphere: Polar caps and ice sheets. Mountain glaciers, permafrost.

Unit 3

Dynamical Processes:
(18 Lectures)
(a) The Solid Earth: Origin of the magnetic field. Source of geothermal energy. Convection in Earth's core and production of its magnetic field. Mechanical layering of the Earth. Introduction to geophysical methods of earth investigations. Concept of plate tectonics, types of plate movements, hotspots, sea-floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belt, Seismic waves, Richter scale, geophones. Volcanoes: types products and distribution.
(b) The Hydrosphere: Ocean circulations. Oceanic current system and effect of Coriolis forces. Concepts of eustasy, tend – air-sea interaction. Tides. Tsunamis.
(c) The Atmosphere: Atmospheric circulation. Weather and climatic changes. Earth's heat budget. Cyclones and anti-cyclones.
Climate:
i.
ii.
iii.
Earth's temperature and greenhouse effect.
Paleoclimate and recent climate changes.
The Indian monsoon system.
(d) Biosphere: Water cycle, Carbon cycle. The role of cycles in maintaining a steady state.

Unit 4

Evolution:
(18 Lectures)
Stratigraphy: Introduction and types, Standard stratigraphic time scale and introduction to the concept of time in geological studies. Time line of major geological and biological events. Introduction to geochronological methods and their application in geological studies. Radiometric dating: Advantages & disadvantages of various isotopes. History of development of concepts of Uniformitarianism, Catastrophism and Neptunism. Various laws of stratigraphy. Introduction to the geology and geomorphology of Indian subcontinent. Origin of life on Earth
Role of the biosphere in shaping the environment. Future of evolution of the Earth and solar system: Death of the Earth (Probable causes).

Unit 5

Disturbing the Earth – Contemporary dilemmas
(4 Lectures)

(a) Human population growth.
(b) Atmosphere: Greenhouse gas emissions, climate change, air pollution.
(c) Hydrosphere: Fresh water depletion.
(d) Geosphere: Chemical effluents, nuclear waste.
(e) Biosphere: Biodiversity loss. Deforestation. Robustness and fragility of ecosystems.

References

• Planetary Surface Processes, H. Jay Melosh, 2011, Cambridge University Press.
• Consider a Spherical Cow: A course in environmental problem solving, John Harte, University Science Books.
• Holme's Principles of Physical Geology, 1992, Chapman & Hall.
• Planet Earth, Cosmology, Geology and the Evolution of Lifeand Environment, C. Emiliani, 1992, Cambridge University Press.
• The Blue Planet:An Introduction to Earth System Science, Brian J. Skinner, Stephen C. Portere, 1994, John Wiley & Sons.
• Physics of the Earth, Frank D. Stacey, Paul M. Davis, 2008, Cambridge University Press.
• Fundamentals of Geophysics, William Lowrie, 1997, Cambridge University Press.
• The Solid Earth: An Introduction to Global Geophysics, C. M. R. Fowler, 1990, Cambridge University Press.
• The Earth: A Very Short Introduction, Martin Redfern, 2003, Oxford University Press.
• Galaxies: A Very Short Introduction, John Gribbin, 2008, Oxford University Press.
• Climate Change: A Very Short Introduction, Mark Maslin, 3rd Edition, 2014, Oxford University Press.
• The Atmosphere: A Very Short Introduction, Paul I. Palmer, 2017, Oxford University Press.
• IGNOU Study material: PHE 15 Astronomy and Astrophysics Block 2

Quantum Mechanics (42227640) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

In continuation with the course `Elements of modern physics', this course marches ahead to make the students learn applications of

Schrodinger equation to various quantum mechanical problems. It also provides technical knowledge concerning

eigenvalues and eigen functions and their determination. It is recommended that students crediting this course should taken have taken

earlier the courses - (1)"Mathematical Physics" and (2) "Elements of Modern Physics" , in order to perform well in this course.

Course Learning Outcomes

This Discipline Specific Elective paper will expose the students to a number of basic foundational topics of quantum Mechanics. The minimal expected learning outcomes from the students are enlisted below:

 Application of Time Dependent Schrodinger Equation to get an insight into time evolution

 Understanding the time evolution of quantum mechanical systems

 Grasp over the concept of wavefunctions, their normalization, and properties

 Understanding of momentum and position as operators and their commutation relations

 Enable the students to know the meaning of expectation values of operators corresponding to physical quantities

 The students will be imparted with knowledge of Hamiltonian, Eigenvalues, Eigenvectors, stationary states and linear combination of stationary states to describe the solution of time dependent Schrodinger equation

 The students will be exposed to a number of physical system like square well potential to acquaint them with the applications of boundary conditions to obtain the complete solutions of Schrodinger equation

 They will develop a good understanding of Quantum Mechanical harmonic oscillator where they will also learn the mathematical methods like Frobenius method to obtain solutions of differential equations involved in quantum mechanics

 The students will be able to find the exact solutions of one particle systems, specifically hydrogen atom

 The students get to know about angular momentum operator and angular momentum quantum numbers

 The students will be enabled to understand the interaction of atomic system with electric and magnetic field

 They will know about electron spin, spin orbit interaction, Larmor precession, and LS coupling, JJ coupling in many electron atoms

 The concepts of symmetric and anti-symmetric wavefunctions will be understood by the students

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Unit 1

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 & momentum. Wave Function of a Free Particle. (10 Lectures)

Unit 2

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.

(12 Lectures)

Unit 3

General discussion of bound states in an arbitrary potential : Continuity of a 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.

(10 Lectures)

Unit 4

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 wavefunctions from Frobenius method; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells (basic ideas only) (10 Lectures)

Unit 5

Atoms in Electric and Magnetic Fields: Electron Angular Momentum. Angular momentum Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Normal Zeeman Effect: Electron Magnetic Moment and Magnetic Energy. (8 Lectures)

Unit 6

Many-electron atoms: Pauli's Exclusion Principle. Symmetric and Anti-symmetric Wave Functions. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Spin-orbit coupling in atoms: L-S and J-J couplings.

(10 Lectures)

References

- A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2nd Ed.,2010, McGraw Hill
- Basic Quantum Mechanics, A. Ghatak, Macmillan, 2009
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum Mechanics: Theory and Applications, Ajoy Ghatak & S. Lokanathan, Springer Science & Business Media, 2004
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2ndEdn., 2002, Wiley.
- Quantum Mechanics, G. Aruldhas, 2ndEdn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning

□ Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education

□ Quantum Mechanics, Walter Greiner, 4thEdn., 2001, Springer

Additional Resources:

□ Lectures on Quantum Mechanics: Fundamentals and Applications, eds. A. Pathak and Ajoy Ghatak, Viva Books Pvt. Ltd., 2019

□ Introduction to Quantum Mechanics, R. H. Dicke and J. P. Wittke, Addison-Wesley Publications, 1966

□ Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.

Semiconductor Devices Fabrication (42517511) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This course provides a review of basics of semiconductors such as energy bands, doping, defects etc and introduces students to various semiconductor and memory devices.
2. Thin film growth techniques and processes including various vacuum pumps, sputtering, evaporation, oxidation and VLSI processing are described in detail.
3. By the end of the syllabus, students will have an understanding of MEMS based transducers.

Course Learning Outcomes

At the end of this course, students will be able to achieve the following learning outcomes:

- Learn to distinguish between single crystal, polycrystalline and amorphous materials based on their structural morphology and learn about the growth of single crystals of silicon, using Czocharalski technique, on which a present day electronics and IT revolution is based.
- Students will understand about the various techniques of thin film growth and processes.
- Gain knowledge about characteristics of semiconductor devices (p-n junction diode, MOS, MOSFET, TUNNEL diode)
- Understanding of characteristics of Volatile and Non Volatile memory element and their classifications.
- Appreciate the various VLSI fabrication technologies and learn to design the basic fabrication process of R, C, P-N Junction diode, BJT, JFET, MESFET, MOS, NMOS, PMOS and CMOS technology.
- Gain basic knowledge on overview of MEMS (MicroElectro-Mechanical System) and MEMS based transducers.

Unit 1

Introduction: Review of energy bands in materials. Metal, Semiconductor and Insulator. Doping in Semiconductors, Defects: Point, Line, Schottky and Frenkel. Single Crystal, Polycrystalline and Amorphous Materials. Czochralski technique for Silicon Single Crystal Growth. Silicon Wafer Slicing and Polishing.(5 Lectures)

Vacuum Pumps: Primary Pump (Mechanical) and Secondary Pumps (Diffusion, Turbo-molecular, Cryopump, Sputter - Ion)– basic working principle, Throughput and Characteristics in reference to Pump Selection. Vacuum Gauges (Pirani and Penning). (6 Lectures)

Unit 2

Thin Film Growth Techniques and Processes:
Sputtering, Evaporation (Thermal, electron-Beam, Pulse Laser Deposition (PLD), Chemical Vapor Deposition (CVD). Epitaxial Growth, Deposition by Molecular Beam Epitaxy (MBE). (9 Lectures)

Thermal Oxidation Process (Dry and Wet) Passivation. Metallization. Diffusion of Dopants. Diffusion Profiles. Ion implantation. (5 Lectures)

Unit 3

Semiconductor Devices: Review of p-n Junction diode, Metal-Semiconductor junction, Metal-Oxide-Semiconductor (MOS) capacitor and its C-V characteristics, MOSFET (enhancement and depletion mode) and its high Frequency limit. Microwave Devices: Tunnel diode. (6 Lectures)

Unit 4

Memory Devices: Volatile Memory: Static and Dynamic Random Access Memory (RAM), Complementary Metal Oxide Semiconductor (CMOS) and NMOS, Non-Volatile - NMOS (MOST, FAMOS), Ferroelectric Memories, Optical Memories, Magnetic Memories, Charge Coupled Devices (CCD).(10 Lectures)

Unit 5

VLSI Processing: Introduction of Semiconductor Process Technology, Clean Room Classification, Line width, Photolithography: Resolution and Process, Positive and Negative Shadow Masks, Photoresist, Step Coverage, Developer. Electron Beam Lithography. Idea of Nano-Imprint Lithography. Etching: Wet Etching. Dry etching (RIE and DRIE). Basic Fabrication Process of R, C, P-N Junction diode, BJT, JFET, MESFET, MOS, NMOS, PMOS and CMOS technology. Wafer Bonding, Wafer Cutting, Wire bonding and Packaging issues (Qualitative idea). (12 Lectures)

Unit 6

Micro Electro-Mechanical System (MEMS): Introduction to MEMS, Materials selection for MEMS Devices, Selection of Etchants, Surface and Bulk Micromachining, Sacrificial Subtractive Processes, Additive Processes, Cantilever, Membranes. General Idea MEMS based Pressure, Force, and Capacitance Transducers.(7 Lectures)

Practical

PRACTICALS- DSE LAB: SEMICONDUCTOR DEVICES FABRICATION LAB
60 Periods

AT LEAST 05 EXPERIMENTS FROM THE FOLLOWING
1. Fabrication of alloy p-n Junction diode and study its I-V Characteristics.
2. Study the output and transfer characteristics of MOSFET.
3. To design and plot the static & dynamic characteristics of digital CMOS inverter.
4. Create vacuum in a small tube (preferably of different volumes) using a Mechanical rotary pump and measure pressure using vacuum gauges.
5. Deposition of Metal thin films/contacts on ceramic/thin using Thermal Evaporation and study IV characteristics.
6. Selective etching of Different Metallic thin films using suitable etchants of different concentrations.
7. Wet chemical etching of Si for MEMS applications using different concentration of etchant.
8. Calibrate semiconductor type temperature sensor (AD590, LM 35, LM 75).
9. Quantum efficiency of CCDs.
10. To measure the resistivity of a semiconductor (Ge) crystal with temperature (up to 150oC) by four-probe method.
11. To fabricate a ceramic and study its capacitance using LCR meter.
12. To fabricate a thin film capacitor using dielectric thin films and metal contacts and study its capacitance using LCR meter.
13. Study the linearity characteristics of
(a) Pressure using capacitive transducer
(b) Distance using ultrasonic transducer

References

• Physics of Semiconductor Devices, S. M. Sze. Wiley-Interscience.
• Handbook of Thin Film Technology, Leon I. Maissel and Reinhard Glang.

• Fundamentals of Semiconductor Fabrication, S.M. Device and G. S. May, John-Wiley and Sons, Inc.
• The science and Engineering of Microelectronics Fabrication, Stephen A. Champbell, 2010, Oxford University Press.
• Introduction to Semiconductor materials and Devices, M. S. Tyagi, John Wiley & Sons
• VLSI Fabrication Principles (Si and GaAs), S.K. Gandhi, John Wiley & Sons, Inc.
• Introduction to Semiconductor Devices, Kelvin F. Brennan, 2010, Cambridge University Press

Keywords

Semiconductors, Doping, Defects, Vacuum pumps, Vacuum gauges, thin film deposition techniques, Thermal oxidation, Diffusion, MOS capacitor, MOSFET, Memory devices, CMOS, NMOS, VLSI Processing, MEMS, camntilever, Transducers

Solid State Physics (42227637) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

This syllabus introduces the basic concepts and principles to understand the various properties exhibited by condensed matter, especially solids. These properties depend on the chemical constituents making up the particular solid and their arrangement in the crystal. A semi-classical approach is used to introduce various models, from toy model to a higher level, suitable to explain the particular property exhibited by the solid. Th syllabus is specifically designed to guide the students to learn how to create a theoretical model for a particular property and appreciate the beauty that lies in these solids through their properties.

Course Learning Outcomes

On successful completion of the module students should be able to

· *elucidate the concept of lattice and crystals.*

· *concepts such as the reciprocal lattice and the Brillouin zone and the dynamics of atoms and electrons in the lattice.*

· *diffraction of X-rays by solids to determine the crystal structure.*

· *understand the elementary lattice dynamics and its influence on the properties of materials.*

· *describe the main features of the physics of electrons in solids.*

· *understand the origin of energy bands, and how they influence electronic behaviour.*

· *explain the origin of dia-, para-, and ferro-magnetic properties of solids.*

· *explain the origin of the dielectric properties exhibited by solids and the concept of polarizability.*

· *apply the gained knowledge to solve problems in solid state physics using relevant mathematical tools.*

· *To appreciate how matter exhibits such interesting and wonderful properties and communicates the importance of solid state physics in the modern society.*

Unit 1

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law.

(12 Lectures)

Unit 2

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 (qualitative only). T^3 *law*

(10Lectures)

Unit 3

Free electron theory: Electrons in metals- Drude Model (Basic concept), Elementary band theory: Kronig Penny model. Band Gaps. Classification of Conductors, Semiconductors and insulators based on bandgap. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient.

(10 Lectures)

Unit 4

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetism. Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Curie's law, B-H Curve. Hysteresis and Energy Loss.

(12 Lectures)

Unit 5

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.

(11 Lectures)

Unit 6

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors.

(5 Lectures)

Practical

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 study the response of a dielectric Materials with frequency.

5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR) technique.

6. To determine the refractive index of a dielectric layer using SPR technique.

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 (up to 150^{o} C) by four-probe method and to determine its band gap.

10. To determine the Hall coefficient of a semiconductor sample.

11. Analysis of X-Ray diffraction data in terms of unit cell parameters and estimation of particle size.

12. Measurement of change in resistance of a semiconductor with magnetic field.

References

Reference Books for Theory:

· 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

· Elementary Solid State Physics, M.Ali Omar, 2006, Pearson

· Solid State Physics, Rita John, 2014, McGraw Hill

· Solid State Physics, M.A. Wahab, 2011, Narosa Publications

Reference Books for Practicals:

· 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

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

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Teaching Learning Process

The teaching learning process needs

· *To promote student-centric learning. The basic concept should be introduced thoroughly and students are motivated to construct new ideas or concepts based upon their current/past knowledge.*

· *Emphasis to be given on logical learning wherein day today examples related to solids can be given to the students so as to avoid rote learning by them.*

· *Teaching crystallography on a 2D platform is a real challenge. Students need to be stimulated to widen the imagination and work on software (if possible) which can enhance their knowledge in understanding the crystal structures.*

· *Laboratory visits to various research labs may be organized so that students can appreciate and understar the real-time experiments going on in this field which they might have studied theoretically in their course work.*

· *Quiz may be conducted frequently to assess the understanding of students regarding the basic concepts ir* *solid state physics.*

· *Develop problem solving skills among students.*

· *Project-based learning can be another feature of the teaching-learning process. Students may be divided in groups and be assigned some topics for which they can work together. Emphasis should be given to the state of for the respective topic while documentation. Submitted document (in any form) should be original. Students nee to taught the proper use of resources and avoid any form of plagiarism.*

· *Laboratories should be setup suitably so that the students can practically learn and understand the concep learned in theory.*

Assessment Methods

· *Quiz, problem solving exercise, classroom assessment methods, presentations, end-semester examinatio etc. may constitute the different components of the overall assessment.*

· *Assignments on basic concepts may be given to students where they can do a small research project on t topic and document their work.*

· *Continuous evaluation and gathering feedbacks may prove beneficial in improving teaching learning proces*

· *Continuous learning and assessment in laboratory classes will help the students in developing their practic skills.*

Keywords

Crystal Structure, Reciprocal Lattice, Brillouin Zones, Phonons, Hall Effect, Ferromagnetic Domains, Hysteresis, Polarizability, Superconductivity

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Verilog and FPGA based system design (42227534) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This paper provides a review of combinational and sequential circuits such as multiplexers, demultiplexers decoders, encoders and adder circuits.

2. Evolution of Programmable logic devices such as PAL, PLA and GAL is explained.
3. At the end of the syllabus, students will be able to understand the modeling of combinational and sequential circuits (including FSM and FSMD) with Verilog Design.

Course Learning Outcomes

This paper discusses the fundamental Verilog concepts in-lieu of today's most advanced digital design techniques. At the end of this course, students will be able to develop following learning outcomes:
• Understand the steps and processes for design of logic circuits and systems.
• Be able to differentiate between combinational and sequential circuits.

• Be able to design various types of state machines.
• Be able to partition a complex logic system into elements of data-path and control path.
• Understand various types of programmable logic building blocks such as CPLDs and FPGAs and their tradeoffs.
• Be able to write synthesizable Verilog code.
• Be able to write a Verilog test bench to test various Verilog code modules.
• Be able to design, program and test logic systems on a programmable logic device (CPLD or FPGA) using Verilog.

Unit 1

Digital logic design flow. Review of combinational circuits. Combinational building blocks: multiplexors, demultiplexers, decoders, encoders and adder circuits. Review of sequential circuit elements: flip-flop, latch and register. Finite state machines: Mealy and Moore. Other sequential circuits: shift registers and counters. FSMD (Finite State Machine with Datapath): design and analysis. Microprogrammed control. Memory basics and timing. Programmable Logic devices. (20 lectures)

Unit 2

Evolution of Programmable logic devices. PAL, PLA and GAL. CPLD and FPGA architectures. Placement and routing. Logic cell structure, Programmable interconnects, Logic blocks and I/O Ports. Clock distribution in FPGA. Timing issues in FPGA design. Boundary scan. (20 lectures)

Unit 3

Verilog HDL: Introduction to HDL. Verilog primitive operators and structural Verilog Behavioral Verilog. Design verification. Modeling of combinational and sequential circuits (including FSM and FSMD) with Verilog Design examples in Verilog. (20 lectures)

Practical

PRACTICALS-DSE LAB: VERILOG AND FPGA LAB
60 Periods

AT LEAST 08 EXPERIMENTS FROM FOLLOWING.
1. Write code to realize basic and derived logic gates.
2. Half adder, Full Adder using basic and derived gates.
3. Half subtractor and Full Subtractor using basic and derived gates.
4. Design and simulation of a 4 bit Adder.
5. Multiplexer (4x1) and Demultiplexer using logic gates.
6. Decoder and Encoder using logic gates.
7. Clocked D, JK and T Flip flops (with Reset inputs)
8. 3-bit Ripple counter
9. To design and study switching circuits (LED blink shift)
10. To design traffic light controller.
11. To interface a keyboard
12. To interface a LCD using FPGA
13. To interface multiplexed seven segment display.
14. To interface a stepper motor and DC motor.
15. To interface ADC 0804.

References

- LizyKurien and Charles Roth. Principles of Digital Systems Design and VHDL. Cengage Publishing. ISBN-13: 978-8131505748.
- Palnitkar, Samir, Verilog HDL. Pearson Education; Second edition (2003).
- Ming-Bo Lin. Digital System Designs and Practices: Using Verilog HDL and FPGAs. Wiley India Pvt Ltd. ISBN-13: 978-8126536948
- Zainalabedin Navabi. Verilog Digital System Design. TMH; 2ndedition. ISBN-13: 978-0070252219.
- Wayne Wolf. FPGA Based System Design. Pearson Education.
- S. K. Mitra, Digital Signal processing, McGraw Hill, 1998
- VLSI design, Debaprasad Das, 2nd Edition, 2015, Oxford University Press.

- D.J. Laja and S. Sapatnekar, Designing Digital Computer Systems with Verilog, Cambridge University Press, 2015.
- U. Meyer Baese, Digital Signal Processing with FPGAs, Springer, 2004
- Verilog HDL primer- J. Bhasker. BSP, 2003 II edition

Keywords

Combinational circuits, Multiplexer, Demultiplexer, Encoder, Decoder, Shift registers, Counters, Programmable logic devices, Verilog HDL

Verilog and FPGA based system Design (42517614) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. This paper provides a review of combinational and sequential circuits such as multiplexers, demultiplexers decoders, encoders and adder circuits.

2. Evolution of Programmable logic devices such as PAL, PLA and GAL is explained.
3. At the end of the syllabus, students will be able to understand the modeling of combinational and sequential circuits (including FSM and FSMD) with Verilog Design.

Course Learning Outcomes

This paper discusses the fundamental Verilog concepts in-lieu of today's most advanced digital design techniques. At the end of this course, students will be able to develop following learning outcomes:
• Understand the steps and processes for design of logic circuits and systems.
• Be able to differentiate between combinational and sequential circuits.
• Be able to design various types of state machines.
• Be able to partition a complex logic system into elements of data-path and control path.
• Understand various types of programmable logic building blocks such as CPLDs and FPGAs and their tradeoffs.
• Be able to write synthesizable Verilog code.
• Be able to write a Verilog test bench to test various Verilog code modules.
• Be able to design, program and test logic systems on a programmable logic device (CPLD or FPGA) using Verilog.

Unit 1

Digital logic design flow. Review of combinational circuits. Combinational building blocks: multiplexors, demultiplexers, decoders, encoders and adder circuits. Review of sequential circuit elements: flip-flop, latch and register. Finite state machines: Mealy and Moore. Other sequential circuits: shift registers and counters. FSMD (Finite State Machine with Datapath): design and analysis. Microprogrammed control. Memory basics and timing. Programmable Logic devices. (20 lectures)

Unit 2

Evolution of Programmable logic devices. PAL, PLA and GAL. CPLD and FPGA architectures. Placement and routing. Logic cell structure, Programmable interconnects, Logic blocks and I/O Ports. Clock distribution in

FPGA. Timing issues in FPGA design. Boundary scan. (20 lectures)

Unit 3

Verilog HDL: Introduction to HDL. Verilog primitive operators and structural Verilog Behavioral Verilog. Design verification. Modeling of combinational and sequential circuits (including FSM and FSMD) with Verilog Design examples in Verilog. (20 lectures)

Practical

PRACTICALS-DSE LAB: VERILOG AND FPGA LAB
60 Periods

AT LEAST 08 EXPERIMENTS FROM FOLLOWING.
1. Write code to realize basic and derived logic gates.
2. Half adder, Full Adder using basic and derived gates.
3. Half subtractor and Full Subtractor using basic and derived gates.
4. Design and simulation of a 4 bit Adder.
5. Multiplexer (4x1) and Demultiplexer using logic gates.
6. Decoder and Encoder using logic gates.
7. Clocked D, JK and T Flip flops (with Reset inputs)
8. 3-bit Ripple counter
9. To design and study switching circuits (LED blink shift)
10. To design traffic light controller.
11. To interface a keyboard
12. To interface a LCD using FPGA
13. To interface multiplexed seven segment display.
14. To interface a stepper motor and DC motor.
15. To interface ADC 0804.

References

- LizyKurien and Charles Roth. Principles of Digital Systems Design and VHDL. Cengage Publishing. ISBN-13: 978-8131505748
- Palnitkar, Samir, Verilog HDL. Pearson Education; Second edition (2003).
- Ming-Bo Lin. Digital System Designs and Practices: Using Verilog HDL and FPGAs. Wiley India Pvt Ltd. ISBN-13: 978-8126536948
- Zainalabedin Navabi. Verilog Digital System Design. TMH; 2ndedition. ISBN-13: 978-0070252219
- Wayne Wolf. FPGA Based System Design. Pearson Education.
- S. K. Mitra, Digital Signal processing, McGraw Hill, 1998
- VLSI design, Debaprasad Das, 2nd Edition, 2015, Oxford University Press.
- D.J. Laja and S. Sapatnekar, Designing Digital Computer Systems with Verilog, Cambridge University Press, 2015.
- U. Meyer Baese, Digital Signal Processing with FPGAs, Springer, 2004
- Verilog HDL primer- J. Bhasker. BSP, 2003 II edition

Keywords

Combinational circuits, Multiplexer, Demultiplexer, Encoder, Decoder, Shift registers, Counters, Programmable logic devices, Verilog HDL

Applied Optics
(32223908)
Skill-Enhancement Elective Course - (SEC) Credit:4

Unit 1

Photo-sources and Detectors (9 lectures)
Lasers: an introduction, Planck's radiation law (qualitative idea), Energy levels, Absorption process, Spontaneous and stimulated emission processes, Theory of laser action, Population of energy levels, Einstein's coefficients and optical amplification, properties of laser beam, Ruby laser, He-Ne laser, and semiconductor lasers; Light Emitting Diode (LED) and photo-detectors.

Unit 2

Fourier Optics and Fourier Transform Spectroscopy (Qualitative explanation) (6 lectures)
Concept of Spatial frequency filtering, Fourier transforming property of a thin lens, Fourier Transform Spectroscopy (FTS): measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry, and forensic science.

Unit 3

Holography (6 lectures)
Introduction, Basic principle and theory: recording and reconstruction processes, Requirements of holography-coherence, etc. Types of holograms: The thick or volume hologram, Multiplex hologram, white light reflection hologram; application of holography in microscopy, interferometry, and character recognition.

Unit 4

Photonics: Fibre Optics (9 lectures)

Optical fibres: Introduction and historical remarks, Total Internal Reflection, Basic characteristics of the optical fibre: Principle of light propagation through a fibre, the coherent bundle, The numerical aperture, Attenuation in optical fibre and attenuation limit; Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating.

Practical

Experiments on Lasers:
a. To determine 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
e. To determine the wavelength and angular spread of laser light by using plane diffraction grating.

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. Characteristics of Photovoltaic Cell/ Photodiode.
e. Characteristics of IR sensor

Experiments on Fourier Optics:
a. Optical image addition/subtraction
b. Optical image differentiation
c. Fourier optical filtering
d. Construction of an optical 4f system

Experiments on Fourier Transform Spectroscopy
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.
Experiments on Holography and interferometry:
a. Recording and reconstruction of holograms (Computer simulation can also be done).
b. To construct a Michelson interferometer or a Fabry Perot interferometer.
c. To determine the wavelength of sodium light by using Michelson's interferometer.
d. To measure the refractive index of air.

Experiments on Fibre Optics
a. To measure the numerical aperture of an optical fibre

b. To measure the near field intensity profile of a fibre and study its refractive index profile
c. To study the variation of the bending loss in a multimode fibre
d. To determine the power loss at a splice between two multimode fibre
e. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern

References

- LASERS: Fundamentals & applications, K.Thyagrajan& A.K.Ghatak, 2010, Tata McGraw Hill
- Introduction to Fourier Optics, Joseph W. Goodman, The McGraw- Hill, 1996.
- Introduction to Fiber Optics, A. Ghatak & K. Thyagarajan, Cambridge University Press.
- Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
- Optical Electronics, Ajoy Ghatak and K. Thyagarajan, 2011, Cambridge University Press
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.

Teaching Learning Process

- Chalk and Blackboard approach
- Group discussion in the class
- PPT presentation on special topics.

Assessment Methods

- Assignments
- Class test
- Semester end examination

Basic Instrumentation Skills
(32223904)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

1. This course is to get exposure with various aspects of instruments and their usage through hands-on mode.

2. Students will obtain a thorough understanding of basics of measurement, measurement devices such as electronic voltmeter, Oscilloscope, signal and pulse generators, Impedance bridges, digital instruments etc.

Course Learning Outcomes

At the end of this course, students will be able to develop following learning outcomes:
• Course learning begins with the basic understanding of the measurement and errors in measurement. It then familiarizes about each and every specification of a multimeter and their significance with hands on mode.
• Explanation of the Specifications of CRO and their significance. Complete explanation of CRT.
• Students learn the use of CRO for the measurement of voltage (dc and ac), frequency and time period. Covers the Digital storage Oscilloscope and its principle of working.
• Students learn principles of voltage measurement. Students should be able to understand the advantages of electronic voltmeter over conventional multimeter in terms of sensitivity etc. Types of AC milivoltmeter should be covered.
• Covers the explanation and specifications of Signal and pulse Generators : low frequency signal generator and pulse generator. Students should be familiarized with testing and specifications.
• Students learn about the working principles and specifications of basic LCR bridge.
• Hands-on mode Understanding and usage of analog & digital instruments.
• Hands-on mode for working of digital multimeter and frequency counter.

Unit 1

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. Block diagram ac millivoltmeter, specifications and their significance. (4 Lectures)

Unit 2

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

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

Unit 3

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

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

Unit 4

Digital Instruments: 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)

Practical

The test of lab skills will be of the following test items:
1. Use of an oscilloscope.
2. Oscilloscope 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 using Oscilloscope.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a Oscilloscope.
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)

- It is further suggested that students may be motivated to pursue semester long dissertation wherein he/she may do a hands-on extensive project based on the extension of the practicals enumerated above.

References

• 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

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Keywords

Errors in measurement, accuracy, sensitivity, multimeter, electronic voltmeter, Oscilloscope, dual trace, Digita storage Oscilloscope, signal generator, pulse generator, Impedance bridge, Q-meter, digital voltmeter, digit multimeter

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Computational Physics Skills (32223902) Skill-Enhancement Elective Course - (SEC) Credit:4

Unit 1

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)

Unit 2

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 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)

Unit 3

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)

Unit 4

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)

Practical

- 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, etal. New Age International Publishers, New Delhi(1999)

• ElementaryNumericalAnalysis, K.E.Atkinson,3rd Edn., 2007, WileyIndiaEdition.

Electrical circuits and Network Skills (32223903) Skill-Enhancement Elective Course - (SEC) Credit:4

Unit 1

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law.Series, parallel, and series-parallel combinations. AC and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. (3 Lectures)

Electrical Circuits: Basic 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. (2 Lectures)

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters and motors. Speed & power of ac motor. (3 Lectures)

Unit 2

Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers.Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources (3 Lectures)

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Relay protection device. (3 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, and solder. Preparation of extension board. (5 Lectures)
Network Theorems:(1) Thevenin theorem (2) Norton theorem (3) Superposition theorem (4) Maximum Power Transfer theorem. (3 Lectures)

Practical

AT LEAST 08 EXPERIMENTS FROM THE FOLLOWING
1. Series and Parallel combinations: Verification of Kirchoff's law.
2. To verify network theorems: (I) Thevenin (II) Norton (III) Superposition theorem (IV) Maximum power transfer theorem
3. To study frequency response curve of a Series LCR circuit.
4. To verify (1) Faraday's law and (2) Lenz's law.
5. Programming with Pspice/NG spice.
6. Demonstration of AC and DC generator.
7. Speed of motor
8. To study the characteristics of a diode.
9. To study rectifiers (I) Half wave (II) Full wave rectifier (III) Bridge rectifier
10. Power supply (I) C-filter, (II) п- filter
11. Transformer – Step up and Step down
12. Preparation of extension board with MCB/fuse, switch, socket-plug, Indicator.
13. Fabrication of Regulated power supply.

It is further suggested that students may be motivated to pursue semester long dissertation wherein he/she may do a hands-on extensive project based on the extension of the practicals enumerated above.

References

• Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press
• 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.
•Electrical Circuit Analysis, K. Mahadevan and C. Chitran, 2nd Edition, 2018, PHI learning Pvt. Ltd.

Teaching Learning Process

- Chalk and Blackboard approach
- Group discussion in the class
- PPT presentation on special topics.

Assessment Methods

- Assignments
- Class test
- Semester end examination

Introduction to Physical Computing (xxx1) Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

Physical computing is an interactive physical system that senses, processes and responds to our analog worl An embedded computer together with sensors and actuators to connect with the physical environment includi human interaction, represents a common method of implementing a physical computing system.

Embedded computers have revolutionized our world. Embedded computers are much lower in cost and size a serve a single dedicated function of implementing and improving the function of the gadget. The study of elements of physical computing using embedded computers would be very beneficial towards implementing experimental setups in physics.

Unit 4

1. Digital Input and Output
2. Measuring time and events. Pulse Width Modulation.

Total Lectures: 6

Unit 5

1. Analog Input and Output.
2. Physical Interface: sensors and actuators

Total Lectures: 6

Unit 6

1. Communication with the outside world.
2. System Integration and debugging.

Total Lectures: 3

1. Hello LED: Connect a LED to a digital output pin and turn it on and off.
2. Hello Switch: Read a switch a toggle an LED when the switch is pressed and released.
3. Hello ADC: Connect a potentiometer to an ADC input and print the analog voltage on the serial monitor.
4. Hello Blink: Read a switch and changing the LED blink rate every time the switch is pressed and released.
5. Hello PWM: Write a Pulse Width Modulation code in software and vary the LED intensity.
6. Hello Random: Read a switch and every time the switch is pressed and released, generate and print a random number on the serial monitor.
7. Hello Random2: Connect a Seven Segment Display (SSD) and print the random number on this display each time a switch is pressed and released. Collect large data sample and plot relative frequency of occurrence of each 'random' number
8. Hello LCD: Connect a (16X2) LCD to an Arduino and print 'Hello World'.
9. Hello LCD2: Connect a temperature sensor to an ADC input and print the temperature on the LCD
10. Hello PWM2: Connect a RGB LED and 3 switches. Use hardware PWM feature of the Arduino and change the relative intensity of each of the LEDs of the RGB LED and generate large number of colors.

Mini Projects:

1. Connect 2 SSDs and every time a switch is pressed and released, print 2 random numbers on the two SSDs
2. Connect a switch and 4 RGB LEDs in a 'Y' configuration. Change the LED lighting patterns each time a switch is pressed and released (total 4095 patterns possible). Arrange acrylic mirrors in a triangle and make a LED kaleidoscope using the RGB LEDs as the light source.
3. Connect a photo-gate mechanism to a bar pendulum. Verify that the period of oscillation is independent of the amplitude for small amplitudes. What happens when the amplitude is large?
4. Connect 8 switches and a small speaker and an audio amplifier and make a piano.
5. Connect 2 sets of 3 switches for two players. Connect LCD and implement a 'rock-paper-scissors' game.

References

Reference Books:

1. Learn Electronics with Arduino: An Illustrated Beginner's Guide to Physical Computing. Jody Culkin and Eric Hagan. Shroff Publishers. ISBN: 9789352136704.
2. Programming Arduino: Getting Started with Sketches, Second Edition. Simon Monk. McGraw-Hill Education. ISBN-10: 1259641635.
3. Physical Computing: Sensing and Controlling the Physical World with Computers, 1st Edition. Thomson. ISBN-10: 159200346X.

Teaching Learning Process

- Chalk and Blackboard approach
- Group discussion in the class
- PPT presentation on special topics.

Assessment Methods

- Assignments
- Class test
- Semester end examination

Numerical Analysis
(xxx2)
Skill-Enhancement Elective Course - (SEC) Credit:4

Unit 1

Errors and iterative Methods: Truncation and Round-off Errors. Floating Point Computation, Overflow and underflow. Single and Double Precision Arithmetic, Iterative Methods. (2 Lectures)
Solutions of Algebraic and Transcendental Equations: (1) Fixed point iteration method, (2) Bisection method, (3) Secant Method, (4) Newton Raphson method, (5) Generalized Newton's method. Comparison and error estimation (5+1 Lectures)

Unit 2

Interpolation: Forward and Backward Differences. Symbolic Relation, Differences of a polynomial. Newton's Forward and Backward Interpolation Formulas (5 Lectures)

Unit 3

Least Square fitting: (1) Fitting a straight line. (2) Non-linear curve fitting: (a) Power function, (b) Polynomial of nth degree, and (c) Exponential Function. (3) Linear Weighed Least square Approximation (5 Lectures)

Unit 4

Numerical Differentiation: (1) Newton's interpolation Formulas & (2) Cubic Spline Method, Errors in Numeric Differentiation. Maximum and Minimum values of a Tabulated Function (4 Lectures)
Numerical Integration: Generalized Quadrature Formula. Trapezoidal Rule. Simpson's 1/3 and 3/8 Rules. Weddle's Rule, Gauss-Legendre Formula. (4 Lectures)
Solution of Ordinary Differential Equations: First Order ODE's: solution of Initial Value problems: (1) Euler's Method, (2) Modified Euler's method (4 Lectures)

Practical

AT LEAST 08 EXPERIMENTS FROM THE FOLLOWING
Algebraic and transcendental equation
1. To find the roots of an algebraic equation by Bisection method.
2. To find the roots of an algebraic equation by Secant method.
3. To find the roots of an algebraic equation by Newton-Raphson method.
4. To find the roots of a transcendental equation by Bisection method.
Interpolation
1. To find the forward difference table from a given set of data values.
2. To find a backward difference table from a given set of data values.
Curve fitting
1. To fit a straight line to a given set of data values.
2. To fit a polynomial to a given set of data values.
3. To fit an exponential function to a given set of data values.
Differentiation
1. To find the first and second derivatives near the beginning of the table of values of (x,y).
2. To find the first and second derivatives near the end of the table of values of (x,y).
Integration
1. To evaluate a definite integral by trapezoidal rule.

2. To evaluate a definite integral by Simpson 1/3 rule.
3. To evaluate a definite integral by Simpson 3/8 rule.
4. To evaluate a definite integral by Gauss Quadrature rule.
Differential Equations
1. To solve differential equations by Euler's method
2. To solve differential equations by modified Euler's method

References

• Elementary Numerical Analysis, K.E.Atkinson,3 r d Ed n. , 2007 , Wiley India Edition.
• Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
• A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
• Schaum's Outline of Programming with C++. J.Hubbard, 2000, McGrawHill Pub.
• Numerical Recipes in C++: The Art of Scientific Computing, W.H. Press et.al., 2ndEdn., 2013, Cambridge University Press.
• An introduction to Numerical methods in C++, Brian H. Flowers, 2009, Oxford University Press.

Physics Workshop Skills
(32223901)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode. This course enable students to understand working of various measuring devices and different type of errors student can encounter in the measurement process. This course also develop the mechanical skills of the students by direct exposure to different machines and tools by demonstration and experimental technique.

Course Learning Outcomes

Students will learn some very basic principles of workshop skills important for many practical applications such as

Learning measuring devices like Vernier calliperse, Screw gauge, travelling microscope.and Sextant for measuring various length scales.

Developing mechanical skill such as casting, foundry, machining, forming and welding and will become familiar with common machine tools like lathe, shaper, drilling, milling, surface machines and Cutting tools.

Getting acquaintance with prime movers: Mechanism, gear system, wheel, Fixing of gears with motor axle. Lever mechanism, Lifting of heavy weight using lever. braking systems, pulleys

Unit 1

Introduction: Measuring devices: Vernier calliper, Screw gauge and travelling microscope. 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.
(6 lectures)

Unit 2

Mechanical Skill: Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. 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.
(14 Lectures)

Unit 3

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. (10 Lectures)

Practical

Main emphasis is on taking observations, calculations, graph and result. Perform at least three practical from the following.
1. Comparison of diameter of a thin wire using screw gauge and travelling microscope.
2. Drilling of Hole in metal, wood and plastic.
3. Cutting of metal sheet.
4. Cutting of glass sheet
5. Lifting of heavy weights using simple pulley/lever arrangement.

References

 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]

Teaching Learning Process

Students are expected to understand clearly the basic principles of Physics workshop techniques useful for various practical applications through the real hand on experiences in the workshops. They are expected to be trained in taking observations, calculations, graph and result.

Assessment Methods

Assessment methods are the strategies, techniques, tools and instruments for collecting information to determine the extent to which students demonstrate desired learning outcomes. Several methods should be used to assess student learning outcomes.Learning outcomes will be assessed using the following: oral and written examinations, closed-book and open-book tests; problem-solving exercises, practical assignment laboratory reports, observation of practical skills, individual project reports, seminar presentation; viva voce interviews; computerised adaptive testing, literature surveys and evaluations, outputs from collaborative work etc.

Keywords

Measuring Devices, Sextant, Mechanical skill,foundry, lathe, drilling milling, prime movers, gear system, lever, pulley experiment

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Radiation Safety (32223907) Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

It is a course focus on the applications of nuclear techniques and radiation protection. It will not only enhance the skills towards the basic understanding of the radiation but will also provide the knowledge about the protective measures against the radiation exposure

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Course Learning Outcomes

This will prepare the work force for jobs in industry and medical fields.

Unit 1

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)

Unit 2

Interaction of Radiation with matter:

Types of Radiation: Alpha, Beta, Gamma andNeutron and their sources, sealed and unsealed sources, Interaction of Photons - Photo-electric effect, Compton Scattering, Pair Production, Linear and Mass AttenuationCoefficients, Interaction of Charged Particles: Heavy charged particles - Beth-BlochFormula, Scaling laws, Mass Stopping Power, Range, Straggling, Channelling andCherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), Interaction of Neutrons- Collision, slowing down and Moderation.

(7 Lectures)

Unit 3

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 Geiger Muller Counter), Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry.

(7 Lectures)

Unit 4

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, limitations, 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)

Unit 5

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, Sterilization, Food preservation.

(5 Lectures)

Unit 6

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Practical

Experiments: Minimum four experiments need to be perform from the following,

1. 1. Estimate the energy loss of different ions in Water and carbon, using SRIM/TRIM etc. simulation software.
2. 2. Simulation study (using SRIM/TRIM or any other software) of radiation depth in materials (Carbon, Silver, Gold, Lead) using H-ion.
3. 3. Comparison of interaction of H like ions in given medium (Carbon/Water) using simulation software (SRIM etc.).
4. 4. Study the background radiation in different places and identify the source material from gamma ray energy spectrum. (Data may be taken from the Department of Physics & Astrophysics, University of Delhi and gamma ray energies are available in the website http://www.nndc.bnl.gov/nudat2/)
5. 5. Study the background radiation levels using Radiation meter.
6. 6. Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
7. 7. Study of counting statistics using background radiation using GM counter.
8. 8. Study of radiation in various materials (e.g. KSO4 etc.). Investigation of possible radiation in different routine materials by operating GM counter at operating voltage.
9. 9. Study of absorption of beta particles in Aluminium using GM counter.
10. 10. Detection of α particles using reference source & determining its half-life using spark counter
11. 11. Gamma spectrum of Gas Light mantle (Source of Thorium)

References

1. Nuclear and Particle Physics by W. E. Burcham and M. Jobes, Harlow Longman Group, 1995.

2. G. F. Knoll, Radiation detection and measurement, 4th Edition, Wiley Publications, 2010.

3. Thermoluminescence dosimetry by A. F. Mcknlay, Bristol, Adam Hilger (Medical Physics Hand book 5)

4. Fundamental Physics of Radiology by W .J. Meredith and J.B. Massey, John Wright and Sons, UK, 1989.

5. An Introduction to Radiation Protection by A. Martin and S. A. Harbisor, John Willey & Sons, Inc. New York, 1981.

6. Medical Radiation Physics by W. R. Hendee, Year book Medical Publishers, Inc., London, 1981.

7 Nuclear Physics: Principles and Applications by John Lilley, Wiley Publication, 2006.

8 Physics and Engineering of Radiation Detection by Syed Naeem Ahmed, Academic Press Elsevier, 2007.

9 Technique for Nuclear and Particle Physics experiments by William R Leo, Springer, 1994.

Additional Resources:

10. IAEA Publications: (a) General safety requirements Part 1, No. GSR Part 1 (2010), Part 3 No. GSR Part 3 (Interium) (2010); (b) Safety Standards Series No. RS-G-1.5 (2002), Rs-G-1.9 (2005), Safety Series No. 120 (1996); (c) Safety Guide GS-G-2.1 (2007).

11. AERB Safety Guide (Guide No. AERB/RF-RS/SG-1), Security of radioactive sources in radiation facilities, 2011

12. AERB Safety Standard No. AERB/SS/3 (Rev. 1), Testing and Classification of sealed Radioactivity Sources. , 2007

Renewable Energy and Energy harvesting (32223905)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

Energy drives life, movements and changes. Human beings have been dependent on fossil fuels to extract energy for a long time. But in

today's world, availability of fossil fuels is increasingly becoming scarcer, and hence, one needs to plan for the distant future and for the

generations yet to come and live in a decent manner. Therefore, one needs to look into and study various alternate energy sources. 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. Similarly, water, a vital ingredient for the survival of all species, is

no longer abundant. One needs to think seriously about rain water harvesting.

This paper describes the ways of harvesting energy using wind,

solar, mechanical, ocean, geothermal energy and so on. This paper provides a review and working of various energy harvesting systems

which are installed worldwide.

Course Learning Outcomes

Significance of renewable energy and details concerning various sources of energy will be imparted to the students:

- Knowledge of various sources of energy for harvesting will be given
- Understand the need of energy conversion and the various methods of energy storage
- Students will have a good understanding of various renewable energy systems, and its

components.

 They will be able to gain knowledge about renewable energy technologies, different storage technologies, distribution grid, smart grid including sensors, regulation and their control.

 Student will understand the concept of direct energy conversion systems and their applications

 Students will able to identify and design the model for sending the wind energy or solar energy plant.

Unit 1

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, bio-gas generation, geothermal energy tidal energy, Hydroelectricity. (3 Lectures)

Unit 2

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 photo-voltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. (6 Lectures)

Unit 3

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)

Unit 4

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. Rain water harvesting. (9 Lectures)

Unit 5

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of

piezoelectric effect, materials and mathematical description of piezo-electricity,

Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy

harvesting applications, Human power

Electromagnetic Energy Harvesting: Linear generators, physical/mathematical

models, recent applications

Carbon captured technologies, cell, batteries, power consumption

Environmental issues and Renewable sources of energy, sustainability. Merits of Rain Water harvesting (9 Lecture)

Practical

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-driven thermo-electric modules.

References

• Non-conventional energy sources, B.H. Khan, McGraw Hill 60

• Solar energy, Suhas P Sukhative, Tata McGraw - Hill Publishing Company Ltd.

• Renewable Energy, Power for a sustainable future, Godfrey Boyle, 3rd Edn.,

2012, Oxford University Press.

• Renewable Energy, 3rd Edition,

• Solar Energy: Resource Assesment Handbook, P Jayakumar, 2009

• J.Balfour, M.Shaw and S. Jarosek, Photo-voltaics, Lawrence J Goodrich (USA).

Additional Resources:

• http://en.wikipedia.org/wiki/Renewable_energy

Weather Forecasting (32223909) Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

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

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Course Learning Outcomes

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

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Unit 1

Introduction to atmosphere: Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement
(9 Periods)

Unit 2

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)

Unit 3

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

Unit 4

Climate and Climate Change: Climate: its classification; causes of climate change; global warming and its outcomes; air pollution and its measurement, particulate matters PM 2.5, PM 10. Health hazards due to high concentration of PM2.5; aerosols, ozone depletion
(6 Periods)

Unit 5

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)

Practical

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.
(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).
5. Simulation of weather system
6. Field visits to India Meteorological department and National center for medium range weather forecasting

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References

Reference books:
1. Aviation Meteorology, I.C. Joshi, 3 rd 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. Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

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