DISCIPLINE SPECIFIC CORE (DSC) COURSES

SEMESTER I

Course Code: PHYSICS DSC 1

Course Title: MECHANICS

Total Credits: 04 (Credits: Theory: 02, Practical: 02)

Total Hours: Theory: 30, Practical: 60

Course Objectives: This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with dynamics of a system of particles and ends with the special theory of relativity. Students will appreciate the concept of rotational motion, gravitation and oscillations. The students will be able to apply the concepts learnt to several real world problems.

Course Learning Outcomes: Upon completion of this course, students are expected to understand the following concepts.

- Laws of motion and their application to various dynamical situations.
- Conservation of momentum, angular momentum and energy. Their application to basic problems.
- Particle collision (elastic and in-elastic collisions)
- Motion of simple pendulum
- Postulates of special theory of relativity, inertial and non-inertial frame of reference and their transformation, relativistic effects on the mass and energy of a moving body.

In the laboratory course, after acquiring knowledge of how to handle measuring instruments (like screw gauge, vernier calliper and travelling microscope) student shall embark on verifying various principles and associated measurable quantities.

The pre-requisite for this course is Physics and Mathematics syllabus of class XII.

THEORY (Credit: 02; 30 Hours)

Unit 1: Review of vectors and ordinary differential equation **Hours: 4**

Gradient of a scalar field, divergence and curl of vectors field, polar and axial vectors
Second order homogeneous ordinary differential equations with constant coefficients (Operator Method Only).

Unit 2: Fundamentals of Dynamics **Hours: 7**

Dynamics of a system of particles, centre of mass, determination of centre of mass for discrete and continuous systems having spherical symmetry

Conservation of momentum and energy, Conservative and non-Conservative forces, work – energy theorem for conservative forces, force as a gradient of potential energy. Particle collision (Elastic and in-elastic collisions)

Unit 3: Rotational Dynamics and Oscillatory Motion **Hours: 8**

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 and 2-D).

Idea of simple harmonic motion, differential equation of simple harmonic motion and its solution, Motion of simple pendulum, damped harmonic oscillator

Unit 4: Gravitation **Hours: 3**

Newton's Law of Gravitation, Motion of a particle in a central force field. Kepler's Laws (statements only).

Unit 5: Special Theory of Relativity **Hours: 8**

Frames of reference, Gallilean transformations, inertial and non-inertial frames, Michelson Morley's Experiment, postulates of special theory of relativity, length contraction, time dilation, relativistic transformation of velocity, relativistic variation of mass.

References:

Essential Readings:

1) Vector Analysis – Schaum's Outline, M.R. Spiegel, S. Lipschutz, D. Spellman, 2^{nd} Edn., 2009, McGraw Hill Education.

2) An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014, Cambridge University Press.

3) Mechanics Berkeley Physics Course, Vol. 1, 2/e: Charles Kittel, et. al., 2017, McGraw Hill Education

4) Mechanics, D. S. Mathur, P. S. Hemne, 2012, S. Chand.

5) Intermediate Dynamics, Patrick Hamill, 2010, Jones and Bartlett Publishers.

Additional Readings:

1) Feynman Lectures, Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.

2) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

3) University Physics, H. D. Young, R. A. Freedman, 14/e, 2015, Pearson Education.

4) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.

5) Engineering Mechanics, Basudeb Bhattacharya, 2/e, 2015, Oxford University Press.

6) Physics for Scientists and Engineers, Randall D Knight, 3/e, 2016, Pearson Education.

PRACTICAL (Credit: 02; 60 Hours)

The teacher is expected to give basic idea and working of various apparatus and instruments related to different experiments. Students should also be given knowledge of recording and analysing experimental data.

Every student should perform at least 06 experiments from the following list.

1) Measurement of length (or diameter) using vernier calliper, screw gauge and travelling microscope.
2) Study the random error in observations.
3) Determination of height of a building using a sextant.
4) Study of motion of the spring and calculate (a) spring constant and, (b) acceleration due to gravity (g)
5) Determination of moment of inertia of a flywheel.
6) Determination of g and velocity for a freely falling body using digital timing technique.
7) Determination of modulus of rigidity of a wire using Maxwell's needle.
8) Determination of elastic constants of a wire by Searle's method.
9) Determination of value of g using bar pendulum.
10) Determination of value of g using Kater's pendulum.

References:

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.

2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.

3) Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press.

4) A text book of practical physics, I. Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.

5) B. Sc. practical physics, Geeta Sanon, R. Chand and Co., 2016.

Course Code: PHYSICS DSC 2

Course Title: NETWORK ANALYSIS AND ANALOG ELECTRONICS

Total Credits: 04 (Credits: Theory: 02, Practical: 02)

Total Hours: Theory: 30, Practical: 60

Course Objectives:

- This course offers the basic knowledge to students to design and analyze the network circuit analysis and analog electronics.
- 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.
- 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, Network theorems, Mesh Analysis.
- To develop an understanding of the basic operation and characteristics of different type of diodes and familiarity with its working and applications.
- Become familiar with Half-wave, Full-wave center tapped and bridge rectifiers. To be able to calculate ripple factor and efficiency.
- To be able to recognize and explain the characteristics of a PNP or NPN transistor.
- Become familiar with the load-line analysis of the BJT configurations and understand the hybrid model (h- parameters) of the BJT transistors.
- To be able to perform small signal analysis of Amplifier and understand its classification.
- 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 in case of Oscillators.
- To become familiar with construction, working and characteristics of JFET and UJT.

The pre-requisite for this course is Physics and Mathematics syllabus of class XII.

THEORY (Credit: 02; 30 Hours)

Unit 1: **Hours: 8**

Circuit Analysis: Concept of Voltage and Current Sources (ideal and practical). Kirchhoff's Laws. Mesh Analysis, Node Analysis. Star and Delta networks and their Conversion.

Superposition Theorem. Thevenin's Theorem. Norton's Theorem. Reciprocity Theorem. Maximum Power Transfer Theorem.

Unit 2: Hours: 5

Semiconductor Diode: PN junction diode (Ideal and practical), Diode equation (Qualitative only) and I-V characteristics. Idea of static and dynamic resistance, Zener diode working.
Rectifiers: Half wave rectifier (Qualitative only), Full wave rectifiers (center tapped and bridge): circuit diagrams, working and waveforms, ripple factor and efficiency.
Filter circuits: Shunt capacitance and series Inductance filter (no derivation).
Regulation: Zener diode as voltage regulator for load and line regulation

Unit 3: Hours: 7

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.
Amplifiers: Transistor biasing and Stabilization circuits- Voltage Divider Bias. Thermal runaway, stability (Qualitative only). Transistor as a two-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.

Unit 4: Hours: 10

Cascaded Amplifiers: Two stage RC Coupled Amplifier and its frequency response.
Sinusoidal Oscillators: Concept of feedback (negative and positive feedback), Barkhausen criterion for sustained oscillations. Phase shift and Colpitt's oscillator. Determination of frequency and condition of oscillation
Unipolar Devices: JFET. Construction, working and I-V characteristics (output and transfer), Pinch-off voltage. UJT, basic construction, working, equivalent circuit and I-V characteristics. UJT Oscillator.

References:

Essential Readings:

1) Network, Lines and Fields, J. D. Ryder, Prentice Hall of India
2) Integrated Electronics, J. Millman and C.C. Halkias, Tata Mcgraw Hill (2001)
3) Electric Circuits , S. A. Nasar, Schaum Outline Series, Tata McGraw Hill (2004)
4) Electric Circuits, K.A. Smith and R. E. Alley, Cambridge University Press(2014)
5) 2000 Solved Problems in Electronics, J. J. Cathey, Schaum Outline Series, Tata McGraw Hill (1991)

Additional Readings:

1) Microelectronic Circuit, A. S. Sedra, K.C. Smith, A. N. Chandorkar, 6th Edition (2014), Oxford University Press
2) Electronic Circuits: Discreet and Integrated, D. L. Schilling and C. Belove, Tata McGraw Hill.

3) Electronic Devices and Circuits, David A. Bell, 5th Edition 2015, Oxford University Press.

4) Electrical Circuits, M. Nahvi and J. Edminister, Schaum Outline Series, Tata McGraw Hill (2005)

PRACTICAL (Credit: 02; 60 Hours)

At least 06 experiments from the following:

1) To familiarize with basic electronic components (R, L, C, diodes, transistors), digital Multimeter, Function Generator and Oscilloscope
2) Verification of (a) Thevenin's theorem and (b) Norton's theorem.
3) Verification of (a) Superposition Theorem and (b) Reciprocity Theorem
4) Verification of the Maximum Power Transfer Theorem.
5) Study of the I-V Characteristics of (a) p-n junction Diode, and (b) Zener diode.
6) Study of (a) Half wave rectifier and (b) Full wave rectifier (FWR).
7) Study the effect of (a) C- filter and L- filter and (b) Zener regulator.
8) Study of the I-V Characteristics of UJT and design relaxation oscillator.
9) Study of the output and transfer I-V characteristics of common source JFET.
10) Study of Voltage divider bias configuration for CE transistor.
11) Design of a Single Stage CE amplifier of given gain.
12) Study of the RC Phase Shift Oscillator.

References (For Laboratory Work):

1) Electronic Devices and Circuits, Allen Mottershead, Goodyear Publishing Corporation.

2) Electrical Circuits, M. Nahvi and J. Edminister, Schaum Outline Series, Tata McGraw Hill (2005)

3) Network, Lines and Fields, J. D. Ryder, Prentice Hall of India

4) Integrated Electronics, J. Millman and C.C. Halkias, Tata Mcgraw Hill (2001)