BTPH101-18	**Mechanics of Solids**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisites (if any): High-school education with Physics as one of the subject.

Course Objectives: The aim and objective of the course on **Mechanics of Solids** is to introduce the students of B. Tech. to the formal structure of vector mechanics, harmonic oscillators, and mechanics of solids so that they can use these in Engineering as per their requirement.

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the vector mechanics for a classical system.
CO2	Identify various types of forces in nature, frames of references, and conservation laws.
CO3	Know the simple harmonic, damped, and forced simple harmonic oscillator for a mechanical system.
CO4	Analyze the planar rigid body dynamics for a mechanical system.
CO5	Apply the knowledge obtained in this course to the related problems.

Detailed Syllabus:

PART-A

UNIT I: Vector mechanics *(10 lectures)*

Physical significance of gradient, Divergence and curl. Potential energy function, F = - Grad V, equipotential surfaces, Forces in Nature, Newton's laws and its completeness in describing particle motion, Conservative and non-conservative forces, curl of a force field; Central forces; Conservation of Angular Momentum and Energy, Introduction to Cartesian, spherical and cylindrical coordinate system, Inertial and Non-inertial frames of reference; Rotating coordinate system :- Centripetal and Coriolis accelerations.

UNIT II: Simple harmonic motion, damped and forced simple harmonic oscillator *(10 lectures)*

Mechanical simple harmonic oscillators, damped oscillations, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical oscillators, resonance.

PART-B

UNIT III: Planar rigid body mechanics *(10 lectures)*

Definition and motion of a rigid body in plane; Rotation in the plane, Angular momentum about a point of a rigid body in planar motion; center of mass, moment of inertia, theorems of moment of inertia, inertia of plane lamina, circular ring, moment of force, couple, Euler's laws of motion.

UNIT IV: Mechanics of solids *(10 lectures)*

Friction: Definitions: Types of friction, Laws of static friction, Limiting friction, Angle of friction, angle of repose; motion on horizontal and inclined planes. Methods of reducing friction, Concept of stress and strain at a point; Concepts of elasticity, plasticity, strain hardening, failure (fracture/yielding), one dimensional stress-strain curve; Generalized Hooke's law. Force analysis — axial force, shear force, bending moment and twisting moment. Bending stress; Shear stress; Concept of strain energy; Yield criteria.

Reference books and suggested reading:

1. Engineering Mechanics, 2nd ed. - MK Harbola, Cengage Learning India, 2013.
2. Introduction to Mechanics - MK Verma, CRC Press Book, 2009.
3. Mechanics- DS Mathur, S Chand Publishing, 1981.
4. An Introduction to Mechanics - D Kleppner & R Kolenkow, Tata McGraw Hill 2009.
5. Principles of Mechanics - JL Synge & BA Griffiths, Nabu Press, 2011.
6. Mechanics - JP Den Hartog, Dover Publications Inc, 1961.
7. Engineering Mechanics- Dynamics, 7th ed. - JL Meriam, Wiley.
8. Theory of Vibrations with Applications -WT Thomson, Pearson.
9. An Introduction to the Mechanics of Solids, 2nd ed. with SI Units-SH Crandall, NC Dahl & TJ Lardner
10. Classical Mechanics- H. Goldstein, Pearson Education, Asia.
11. Classical mechanics of particles and rigid bodies-K.C Gupta, Wiley eastern, New Delhi.
12. Engineering Physics-Malik and Singh, Tata McGraw Hill.
13. Engineering Mechanics: Statics- 7th ed.-JL Meriam, Wiley, 2011.
14. Analytical Mechanics-Satish K Gupta, Modern Publishers.
15. https://nptel.ac.in/courses/122102004/

BTPH111-18	**Mechanics of Solids Lab**	**L-0, T-0, P-3**	**1.5 Credits**

Pre-requisites (if any): High-school education with Physics lab as one of the subject.

Course Objectives: The aim and objective of the Lab course on **Mechanics of Solids** is to introduce the students of B. Tech to the formal structure of Mechanics of solids so that they can use these in Engineering as per their requirement.

Course Outcomes: At the end of the course, the student will be

CO1	Able to understand the concepts learned in the mechanics of solids.
CO2	Learning the skills needed to verify some of the concepts of theory courses.
CO3	Trained in carrying out precise measurements and handling sensitive equipment.
CO4	Able to understand the principles of error analysis and develop skills in experimental design.
CO5	Able to document a technical report which communicates scientific information in a clear and concise manner.

Detailed syllabus:

Note: Students are expected to perform about 10-12 experiments from the following list, selecting minimum of 7-8 from the Section-A and 3-4 from the Section-B.

Section -A

1. Measurements of length (or diameter) using vernier caliper, screw gauge, and travelling microscope. Use of Plumb line and Spirit level.
2. To determine the horizontal distance between two points using a Sextant.
3. To determine the vertical distance between two points using a Sextant.
4. To determine the height of an inaccessible object using a Sextant.
5. To determine the angular diameter of the sun using the sextant.
6. To determine the angular acceleration α, torque τ, and Moment of Inertia of flywheel.

7. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of **g** and (c) Modulus of rigidity.

8. To determine the time period of a simple pendulum for different length and acceleration due to gravity.

9. To study the variation of time period with distance between centre of suspension and centre of gravity for a compound pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory.

10. To determine the Young's Modulus of a Wire by Optical Lever Method.
11. To determine the Elastic Constants/Young's Modulus of a Wire by Searle's method.

12. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
13. To determine the Modulus of Rigidity of brass using Searle's method.

14. To find the moment of inertia of an irregular body about an axis through its C.G with the torsional pendulum.
15. To determine **g** by Kater's Pendulum.
16. To determine **g** and velocity for a freely falling body using Digital Timing Technique.
17. To find out the frequency of AC mains using electric-vibrator.

Section-B

Virtual lab:

(A) To determine the angular acceleration α and torque τ of flywheel.
(B) To determine the moment of inertia of a flywheel.
(C) To find the acceleration of the cart in the simulator.
(D) To find the distance covered by the cart in the simulator in the given time interval.
(E) To verify that energy conservation and momentum conservation can be used with a ballistic pendulum to determine the initial velocity of a projectile, its momentum and kinetic energy.
(F) To verify the momentum and kinetic energy conservation using collision balls.
(G) To understand the torsional oscillation of pendulum in different liquid. and determine the rigidity modulus of the suspension wire using torsion pendulum.
(H) To find the Time of flight, Horizontal range and maximum height of a projectile for different velocity, angle of projection, cannon height and environment.
(I) The Elastic and Inelastic collision simulation will help to analyse the collision variations for different situations.
(J) Demonstration of collision behaviour for elastic and inelastic type.
(K) Variation of collision behavior in elastic and inelastic type.
(L) Study of variation of Momentum, Kinetic energy, Velocity of collision of the objects and the Center of Mass with different velocity and mass.
(M) Calculation of the Momentum, Kinetic energy, and Velocity after collision.

Reference book and suggested readings:

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

2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.

4. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
6. Laboratory Experiments in College Physics, C.H. Bernard and C.D. Epp, John Wiley and Sons, Inc., New York, 1995.
7. Practical Physics, G.L. Squires, Cambridge University Press, Cambridge, 1985.
8. Experiments in Modern Physics, A.C. Melissinos, Academic Press, N.Y., 1966.
9. Practical Physics, C L Arora. S. Chand & Company Ltd.
10. http://www.vlab.co.in
11. http://vlab.amrita.edu/index.php?sub=1

BTPH102-18	**Optics and Modern Physics**	**L-3, T-1, P-0**	**4 Credits**

Pre-requisite (if any):

1. High-school education with physics as one of the subject.
2. Mathematical course on differential equations.

Course Objectives: The aim and objective of the course on **Optics and Modern Physics** is to introduce the students of B.Tech. to the subjects of wave optics, Quantum Mechanics, Solids, and Semiconductors so that they can use these in Engineering as per their requirement.

Course Outcomes: At the end of the course, the student will be able to

CO1	Identify and illustrate physical concepts and terminology used in optics and other wave phenomena.

CO2	Understand optical phenomenon, such as, interference, diffraction etc. in terms of wave model.
CO3	Understand the importance of wave equation in nature and appreciate the mathematical formulation of the same.
CO4	Appreciate the need for quantum mechanics, wave particle duality, uncertainty principle etc. and their applications.
CO5	Understand some of the basic concepts in the physics of solids and semiconductors.

Detailed Syllabus:

PART-A

UNIT I: Waves and Oscillations *(10 lectures)*

Mechanical simple harmonic oscillators, damped harmonic oscillator, forced mechanical oscillators, impedance, steady state motion of forced damped harmonic oscillator, Transverse wave on a string, wave equation on a string, reflection and transmission of waves at a boundary, impedance matching, standing waves, longitudinal waves and their wave equation, reflection and transmission of waves at a boundary.

UNIT II: Optics and LASERS *(10 lectures)*

Optics: Light as an electromagnetic wave, reflectance and transmittance, Fresnel equations (Qualitative idea),

Brewster's angle, total internal reflection: Interference: Huygens' principle, superposition of waves and interference of light by wavefront splitting and amplitude splitting; Young's double slit experiment, Michelson interferometer. Diffraction: Farunhofer diffraction from a single slit and a circular aperture, Diffraction gratings and their resolving power; LASERS: Spontaneous and stimulated emission, Einstein's theory of matter radiation interaction and A and B coefficients; population inversion, pumping, various modes, properties of laser beams, types of lasers: gas lasers (He-Ne), solid-state lasers (ruby), and its applications.

PART-B

UNIT III: Introduction to Quantum Mechanics *(10 lectures)*

Wave nature of Particles, Free-particle wave function and wave-packets, probability densities, Expectation values, Uncertainty principle, Time-dependent and time-independent Schrodinger equation for wave function, Born interpretation, Solution of stationary-state Schrodinger equation for one dimensional problems: particle in a box, linear harmonic oscillator.

UNIT IV: Introduction to Solids and Semiconductors *(10 lectures)*

Free electron theory of metals, Fermi level, density of states in 1, 2 and 3 dimensions, Bloch's theorem for particles in a periodic potential, Origin of energy bands (Qualitative idea); Types of electronic materials: metals, semiconductors, and insulators, Intrinsic and extrinsic semiconductors, Dependence of

Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction.

Reference books and suggested reading:

1. I. G. Main, “Vibrations and waves in physics”, Cambridge University Press, 1993.
2. H. J. Pain, “The physics of vibrations and waves”, Wiley, 2006.
3. E. Hecht, “Optics”, Pearson Education, 2008.
4. A. Ghatak, “Optics”, McGraw Hill Education, 2012.
5. O. Svelto, “Principles of Lasers”, Springer Science & Business Media, 2010.
6. D. J. Griffiths, “Quantum mechanics”, Pearson Education, 2014.
7. R. Robinett, “Quantum Mechanics”, OUP Oxford, 2006.
8. D.A. Neamen, “Semiconductor Physics and Devices”, Times Mirror High Education Group, Chicago, 1997.
9. E.S. Yang, “Microelectronic Devices”, McGraw Hill, Singapore, 1988.
10. B.G. Streetman, “Solid State Electronic Devices”, Prentice Hall of India, 1995.
11. HK Malik and AK Singh, Engineering Physics, 2nd ed., Tata McGraw Hill, 2018.
12. S. Sharma and J. Sharma, Engineering Physics, Pearson, 2018.
13. https://nptel.ac.in/courses/117108037/3
14. https://nptel.ac.in/courses/115102023/

BTPH112-18	Optics and Modern Physics Lab	L-0, T-0, P-3	1.5 Credits

Pre-requisite (If any): High-school education with physics as one of the subject.

Course Objectives: The aim and objective of the lab on **Optic and Modern Physics** is to introduce the students of B.Tech. class to the formal structure of wave and optics, Quantum Mechanics and semiconductor physics so that they can use these in Engineering branch as per their requirement.

Course Outcomes: At the end of the course, the student will be able to

CO1	Verify some of the theoretical concepts learnt in the theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Introduced to the methods used for estimating and dealing with experimental uncertainties and systematic errors.
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Write a technical report which communicates scientific information in a clear and concise manner.

Detailed Syllabus:

Note: Students are expected to perform about 10-12 experiments from the following list, selecting minimum of 7-8 from the Section-A and 3-4 from the Section-B.

Section-A

1. To study the laser beam characteristics like; wave length using diffraction grating aperture & divergence.
2. Study of diffraction using laser beam and thus to determine the grating element.
3. To study laser interference using Michelson's Interferometer.
4. To determine the numerical aperture of a given optic fibre and hence to find its acceptance angle.
5. To determine attenuation & propagation losses in optical fibres.
6. To determine the grain size of a material using optical microscope.
7. To find the refractive index of a material/glass using spectrometer.
8. To find the refractive index of a liquid using spectrometer.
9. To find the velocity of ultrasound in liquid.
10. To determine the specific rotation of sugar using Laurent's half-shade polarimeter.
11. To study the characteristic of different p-n junction diode - Ge and Si.
12. To analyze the suitability of a given Zener diode as voltage regulator.
13. To find out the intensity response of a solar cell/Photo diode.
14. To find out the intensity response of a LED.

To find out the frequency of AC mains using electric-vibrator

Section-B

Virtual lab:

1. To find the resolving power of the prism.
2. To determine the angle of the given prism.
3. To determine the refractive index of the material of a prism
4. To determine the numerical aperture of a given optic fibre and hence to find its acceptance angle.
5. To calculate the beam divergence and spot size of the given laser beam.

6. To determine the wavelength of a laser using the Michelson interferometer.
7. To revise the concept of interference of light waves in general and thin-film interference in particular.
8. To set up and observe Newton's rings.
9. To determine the wavelength of the given source.
10. To understand the phenomenon Photoelectric effect.
11. To draw kinetic energy of photoelectrons as a function of frequency of incident radiation.
12. To determine the Planck's constant from kinetic energy versus frequency graph.
13. To plot a graph connecting photocurrent and applied potential.
14. To determine the stopping potential from the photocurrent versus applied potential graph.

Reference books and suggested reading:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
4. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
6. Laboratory Experiments in College Physics, C.H. Bernard and C.D. Epp, John Wiley and Sons, Inc., New York, 1995.
7. Practical Physics, G.L. Squires, Cambridge University Press, Cambridge, 1985.
8. Experiments in Modern Physics, A.C. Melissinos, Academic Press, N.Y., 1966.
9. Practical Physics, C L Arora. S. Chand & Company Ltd.
10. http://www.vlab.co.in
11. http://vlab.amrita.edu/index.php?sub=1

BTPH103-18 (Introduction to Electromagnetic Theory)

<u>Course Objectives</u>: The aim and objective of the course is to expose the students to the formal structure of electromagnetic theory so that they can use these in Engineering as per their requirement.

<u>Course Outcomes</u>: At the end of the course, the student will be able to

CO1 Specify the constitutive relationships for fields and understand why they are important.
CO2 Describe the static and dynamic electric and magnetic fields for technologically important structures.
CO3 Measure the voltage induced by time varying magnetic flux.
CO4 Acquire the knowledge of Maxwell equation and electromagnetic field theory and propagation and reception of electro-magnetic wave systems.
CO5 Have a solid foundation in engineering fundamentals required to solve problems and also to pursue higher studies.

<u>Detailed Syllabus:</u>

PART-A

UNIT I: Electrostatics in vacuum and linear dielectric medium *(10 lectures)*
Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential; Uniqueness theorem (Definition); examples: Faraday's cage; Boundary conditions of electric field; Energy of a charge distribution and its expression in terms of electric field. Electrostatic field and potential of a dipole. Bound charges due to electric polarization in Dielectrics; Electric displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab.

UNIT II: Magnetostatics in linear magnetic medium *(10 lectures)*
Bio-Savart law, Divergence and curl of static magnetic field; Concept of vector potential, Magnetization and associated bound currents; auxiliary magnetic field ; Boundary conditions on and . Solving for magnetic field due to bar magnet; magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; magnetic domains, hysteresis and B-H curve.

PART -B

UNIT III: Faraday's law and Maxwell's equations *(10 lectures)*
Faraday's law; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law; energy stored in a magnetic field. Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displacement current and magnetic field arising from time-dependent electric field; Maxwell's equation in vacuum and non-conducting medium; Flow of energy and Poynting vector and Poynting theorem.

UNIT IV: Electromagnetic waves *(10 lectures)*
Wave equation for electromagnetic waves in free space and conducting medium, Uniform plane waves and general solution of uniform plane waves, relation between electric and magnetic fields of an

electromagnetic wave their transverse nature.; Linear, circular and elliptical polarization, Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

Text and Reference Books:

1. D. Griffiths, Introduction to Electrodynamics, Pearson Education India; 4th ed. (2015).
2. J D Jackson, Classical Electrodynamics, John Wiley and Sons (1999).
3. Halliday and Resnick, Fundamentals of Physics, Wiley (2011).
4. W. Saslow, Electricity, Magnetism and Light, Academic Press (2002).
5. HK Malik and AK Singh, Engineering Physics, 2nd ed., Tata McGraw Hill (2018).

BTPH113-18 Electromagnetism Lab

Course Objectives: The aim and objective of the lab course on Electromagnetism is to introduce the students of B. Tech. class to the formal structure of electromagnetism so that they can use these in various branches of engineering as per their requirement.

Course Outcomes: At the end of the course, the student will be able to

CO1 Able to verify some of the theoretical concepts learnt in the theory courses.

CO2 Trained in carrying out precise measurements and handling sensitive equipment.

CO3 understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors."

CO4 Learn to draw conclusions from data and develop skills in experimental design.

CO5 Write a technical report which communicates scientific information in a clear and concise manner.
Detailed Syllabus:

Section-A

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.

2. To study the magnetic field of a circular coil carrying current.

3. To study B-H curve for a ferromagnetic material using CRO.

4. To find out the frequency of AC mains using electric-vibrator.

5. To find out polarizability of a dielectric substance.

6. Determine a high resistance by leakage method using Ballistic Galvanometer.

7. To study the characteristics of a Series RC Circuit.

8. To study the series LCR circuit and determine its (a) Resonant Frequency, (b) Quality.

9. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency (b) Quality factor

10. To determine the value of self-inductance by Maxwell Inductance Bridge.

11. To determine the value of self-inductance by Maxwell Inductance Capacitance Bridge.

12. To determine the mutual inductance of two coils by Absolute method.

13. To study the induced emf as a function of the velocity of magnet and to study the phenomenon of electromagnetic damping.

14. To determine unknown capacitance by flashing and quenching method.

15. To study the field pattern of various modes inside a rectangular waveguide.

16. To determine charge to mass ratio (e/m) of an electron by helical method.

17. To determine charge to mass ratio (e/m) of an electron by Thomson method.

18. To find out the horizontal component of earth's magnetic field (Bh).

Virtual lab: 1. To find out the horizontal component of earth's magnetic field (Bh). 2. An experiment to study the variation of magnetic field with distance along the axis of a circular coil carrying current. 3. Aim is to find the horizontal intensity of earth's magnetic field at a place and moment of the bar magnet. 4. To determine the self-inductance of the coil (L) using Anderson's bridge. 5. To calculate the value of inductive reactance (XL) of the coil at a particular frequency. 6. The temperature coefficient of resistor simulation will help the user to easily identify the change in resistivity of the resistor according to the change in temperature.

Reference books and suggested reading:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

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

4. Engineering Practical Physics, S. Panigrahi& B. Mallick, 2015, Cengage Learning India Pvt. Ltd.

5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

6. Laboratory Experiments in College Physics, C.H. Bernard and C.D. Epp, John Wiley and Sons, Inc., New York, 1995.

7. Practical Physics, G.L. Squires, Cambridge University Press, Cambridge, 1985.

8. Experiments in Modern Physics, A.C. Melissinos, Academic Press, N.Y., 1966.

9. Practical Physics, C L Arora, S. Chand & Company Ltd.

10. http://www.vlab.co.in

11. http://vlab.amrita.edu/index.php?sub=1

BTPH104-18	**Semiconductor Physics**	**L-3, T-1, P-0**	**4 Credits**

Prerequisite (if any): Introduction to Quantum Mechanics desirable

Course Objectives: The aim and objective of the course on **Semiconductor Physics** is to introduce the students of B. Tech. class to the formal structure of semiconductor physics so that they can use these in Engineering as per their requirement.

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand and explain the fundamental principles and properties of electronic materials and semiconductors
CO2	Understand and describe the interaction of light with semiconductors in terms of fermi golden rule.
CO3	Understand and describe the impact of solid-state device capabilities and limitations on electronic circuit performance.
CO4	Understand the design, fabrication, and characterization techniques of Engineered semiconductor materials.
CO5	Develop the basic tools with which they can study and test the newly developed devices and other semiconductor applications.

Detailed Syllabus:

PART-A

UNIT 1: Electronic materials *(10 lectures)*

Free electron theory of metals, Density of states in 1D, 2D, and 3D, Bloch's theorem for particles in a periodic potential, Energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect bandgaps, Types of electronic materials: metals, semiconductors, and insulators, Occupation probability, Fermi level, Effective mass.

UNIT II: Semiconductors *(10 lectures)*

Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal-semiconductor junction (Ohmic and Schottky), Semiconductor materials of interest for optoelectronic devices.

PART-B

UNIT III: Light-semiconductor interaction *(10 lectures)*

Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; Einstein coefficients, Population inversion, application in semiconductor Lasers; Joint density of states, Density of states for phonons, Transition rates (Fermi's golden rule), Optical loss and gain; Photovoltaic effect, Exciton, Drude model.

UNIT IV: Measurement Techniques *(10 lectures)*

Measurement for divergence and wavelength using a semiconductor laser, Measurements for carrier density, resistivity, hall mobility using Four-point probe and van der Pauw method, Hot-point probe measurement, capacitance-voltage measurements, parameter extraction from diode I-V characteristics.

Reference books and suggested reading:

1. J. Singh: Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
2. B. E. A. Saleh and M. C. Teich: Fundamentals of Photonics, John Wiley & Sons, Inc., (2007).
3. S. M. Sze: Semiconductor Devices: Physics and Technology, Wiley (2008).
4. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York (2007).
5. P. Bhattacharya: Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
6. Ben G. Streetman: Solid State Electronics Devices, Pearson Prentice Hall.
7. D.A. Neamen, "Semiconductor Physics and Devices", Times Mirror High Education Group, Chicago, 1997.
8. E.S. Yang, "Microelectronic Devices", McGraw Hill, Singapore, 1988.
9. Online course: "Semiconductor Optoelectronics" by M R Shenoy on NPTEL.
10. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL

BTPH114-18	**Semiconductor Physics Lab**	**L-0, T-0, P-3**	**1.5 Credits**

Pre-requisite (if any): (i) High-school education

Course Objectives: The aim and objective of the Lab course on **Semiconductor Physics** is to introduce the students of B.Tech. class to the formal structure of semiconductor physics so that they can use these in Engineering as per their requirement.

Course Outcomes: At the end of the course, the student will be able to

CO1	Able to verify some of the theoretical concepts learnt in the theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Introduced to the methods used for estimating and dealing with experimental uncertainties and systematic "errors."
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Write a technical report which communicates scientific information in a clear and concise manner.

Detailed Syllabus:

Note: Students are expected to perform about 10-12 experiments from the following list, selecting minimum of 7-8 from the Section-A and 3-4 from the Section-B.

Section-A

1. To study the characteristic of different PN junction diode-Ge and Si.
2. To analyze the suitability of a given Zener diode as a power regulator.
3. To find out the intensity response of a solar cell/Photo diode.
4. To find out the intensity response of a LED.
5. To determine the band gap of a semiconductor.
6. To determine the resistivity of a semiconductor by four probe method.
7. To confirm the de Broglie equation for electrons.
8. To study voltage regulation and ripple factor for a half-wave and a full-wave rectifier without and with different filters.
9. To study the magnetic field of a circular coil carrying current.
10. To find out polarizability of a dielectric substance.
11. To study B-H curve of a ferro-magnetic material using CRO.
12. To find out the frequency of AC mains using electric-vibrator.
13. To find the velocity of ultrasound in liquid.
14. To study the Hall effect for the determination of charge current densities.
15. Distinguish between Diamagnetic material, Paramagnetic and ferromagnetic material.
16. Measurement of susceptibility of a liquid or a solution by Quincke’s method.
17. To study the sample with the nano-scale objects and measure surface topography with different scales, width and height of nano objects, and force-distance curves using AFM.

18. To study the temperature coefficient of Resistance of copper.
19. To determine the ratio k/e Using a transistor.
20. To compare various capacitance and verify the law of addition of capacitance.
21. To determine dipole moment of an organic molecule acetone.
22. To measure the temperature dependence of a ceramic capacitor.
23. Verification of the curie Weiss law for the electrical susceptibility of a ferromagnetic material.
24. To study the laser beam characteristics like; wave length using diffraction grating aperture & divergence. To study laser interference using Michelson's Interferometer.
25. Study of diffraction using laser beam and thus to determine the grating element.

Section-B

Virtual lab:

1. To draw the static current-voltage (I-V) characteristics of a junction diode.
2. To plot the characteristics of thermistor and hence find the temperature coefficient of resistance.
3. To determine the resistivity of semiconductors by Four Probe Method.
4. To study Zener diode voltage as regulator and measure its line and load regulation.
5. To study the B-H Curve for a ferromagnetic material.
6. To study the Hall effect experiment to determine the charge carrier density.
7. To determine the magnetic susceptibilities of paramagnetic liquids by Quincke's Method.
8. To study the phenomena of magnetic hysteresis and calculate the retentivity, coercivity and saturation magnetization of a material using a hysteresis loop tracer.
9. Verification and design of combinational logic using AND, OR, NOT, NAND and XOR gates.

Reference books and suggested reading:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
4. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
6. Laboratory Experiments in College Physics, C.H. Bernard and C.D. Epp, John Wiley and Sons, Inc., New York, 1995.
7. Practical Physics, G.L. Squires, Cambridge University Press, Cambridge, 1985.
8. Experiments in Modern Physics, A.C. Melissinos, Academic Press, N.Y., 1966.
9. Practical Physics, C L Arora, S. Chand & Company Ltd.
10. http://www.vlab.co.in

26. http://vlab.amrita.edu/index.php?sub=1

BTPH105-18 (Semiconductor and Optoelectronics Physics)

Course Objectives:

- To introduce the students to the formal structure of semiconductor physics and Optoelectronics so that they can use these in Engineering as per their requirement
- To impart knowledge related to the structure, fabrication and applications of Optoelectronics devices
- To enhance knowledge related to measurement techniques and V-I characteristics of semiconductor materials

Course Outcomes

After the completion of the course the student will be able to:

CO1 Understand and explain the fundamental principles and properties of electronic materials and semiconductors.

CO2 Understand and describe the interaction of light with semiconductors in terms of fermi golden rule.

CO3 Understand and describe the impact of solid-state device capabilities and limitations on electronic circuit performance.

CO4 Understand the design, fabrication, characterization techniques, and measurements of Engineered semiconductor materials.

CO5 Learn the basics of the optoelectronic devices, LEDs, semiconductor lasers, and photo detectors.

Detailed Syllabus: BTPH105-18

PART-A

UNIT -I:Electronicmaterials*(10lectures)*

Free electron theory of metals, Density of states in 1D, 2D, and 3D, Bloch's theorem for particles in a periodic potential, energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect band gaps, Types of electronic materials: metals, semiconductors and insulators, Occupation probability, Fermi level, Effective mass of electron and hole.

UNIT -II: Semiconductors (10 lectures)

Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal-semiconductor junction (Ohmic and Schottky).

PART-B

UNIT -III: Optoelectronic devices (10 lectures)

Radiative and non-radiative recombination mechanisms in semiconductors, Semiconductor materials of interest for optoelectronic devices; Semiconductor light emitting diodes (LEDs): light emitting materials, device structure, characteristics; Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission, Semiconductor laser: population inversion at a junction, structure, materials, device characteristics, Photovoltaics: Types of semiconductor photo detectors-p-n junction, PIN, and Avalanche-and their structure, materials, working principle, and characteristics, Noise limits on performance.

UNIT-IV: Measurement techniques (10 lectures)

Measurement for divergence and wavelength using a semiconductor laser, Measurements for carrier density, resistivity, and hall mobility using Four-point probe and van der Pauw method, Hot-point probe measurement, capacitance-voltage measurements, parameter extraction from diode I-V characteristics.

Reference books and suggested reading:

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
2. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc. (2007).
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
4. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York (2007).
5. P. Bhattacharya: Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
6. Solid state electronics devices: Ben. G. Streetman Pearson Prentice Hall.
7. D.A. Neamen: “Semiconductor Physics and Devices”, Times Mirror High Education Group, Chicago, 1997.
8. E.S. Yang: “Microelectronic Devices”, McGraw Hill, Singapore, 1988.
9. Online course: “Semiconductor Optoelectronics” by M R Shenoy on NPTEL.
10. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL.

PART-B

UNIT-III:Optoelectronicdevices*(10lectures)*

Radiativeandnon-radiativerecombinationmechanismsinsemiconductors,Semiconductormaterialsofinterestforoptoelectronicdevices;Semiconductorlightemitting diodes(LEDs):lightemitting materials,devicestructure,characteristics;Opticaltransitionsinbulksemiconductors:absorption,spontaneousemission,andstimulatedemission,Semiconductorlaser:populationinversionatajunction,structure,materials,devicecharacteristics,Photovoltaics:Typesofsemiconductorphotodetectors-p-njunction,PIN,andAvalanche-andtheirstructure,materials,workingprinciple,andcharacteristics,Noiselimitsonperformance.

UNIT-IV:Measurementtechniques*(10lectures)*

Measurementfordivergenceandwavelengthusingasemiconductorlaser,Measurementsforcarrierdensity,resistivity,andhallmobilityusingFour-pointprobeandvanderPauwmethod,Hot-pointprobemeasurement,capacitance-voltagemeasurements,parameterextraction fromdiode I-Vcharacteristics.

Referencebooks andsuggestedreading:

1. J.Singh,SemiconductorOptoelectronics:PhysicsandTechnology,McGraw-HillInc. (1995).
2. B. E. A.SalehandM. C.Teich, FundamentalsofPhotonics,JohnWiley&Sons,Inc.(2007).
3. S.M.Sze,SemiconductorDevices:PhysicsandTechnology, Wiley(2008).
4. A.YarivandP.Yeh,Photonics:OpticalElectronicsinModernCommunications,OxfordUniversityPress,NewYork(2007).
5. P.Bhattacharya:SemiconductorOptoelectronicDevices,PrenticeHallof India(1997).
6. Solidstateelectronicsdevices:Ben.G.StreetmanPearsonPrenticeHall.
7. D.A.Neamen:“SemiconductorPhysicsandDevices”,TimesMirrorHighEducationGroup,Chicago,1997.
8. E.S.Yang:“MicroelectronicDevices”,McGrawHill,Singapore,1988.
9. Onlinecourse:“SemiconductorOptoelectronics”byM R Shenoyon NPTEL.
10. Onlinecourse:"OptoelectronicMaterialsandDevices"byMonicaKatiyarandDeepakGuptaon NPTEL.

BTPH115-18	**Semiconductor and Optoelectronics Physics Lab**	**L-0, T-0, P-3**	**1.5 Credits**

Pre-requisite (if any): High-school education

Course Objectives: The aim and objective of the Lab course on **Semiconductor and Optoelectronics Physics** is to introduce the students of B.Tech. class to the formal lab structure of semiconductor physics so that they can use these in Engineering as per their requirement.

Course Outcomes: At the end of the course, the student will be able to

CO1	Able to verify some of the theoretical concepts learnt in the theory courses.
CO2	Trained in carrying out precise measurements and handling sensitive equipment.
CO3	Introduced to the methods used for estimating and dealing with experimental uncertainties and systematic "errors."
CO4	Learn to draw conclusions from data and develop skills in experimental design.
CO5	Write a technical report which communicates scientific information in a clear and concise manner.

Detailed Syllabus:

Note: Students are expected to perform about 10-12 experiments from the following list, selecting minimum of 7-8 from the Section-A and 3-4 from the Section-B.

Section-A

1. To study the characteristic of different PN junction diode-Ge and Si.
2. To analyze the suitability of a given Zener diode as a power regulator.
3. To find out the intensity response of a solar cell/Photo diode.
4. To find out the intensity response of a LED.
5. To determine the band gap of a semiconductor.
6. To determine the resistivity of a semiconductor by four probe method.
7. To confirm the de Broglie equation for electrons.

8. To study voltage regulation and ripple factor for a half-wave and a full-wave rectifier without and with different filters.
9. To study the magnetic field of a circular coil carrying current.
10. To find out polarizability of a dielectric substance.
11. To study B-H curve of a ferro-magnetic material using CRO.
12. To find out the frequency of AC mains using electric-vibrator.
13. To find the velocity of ultrasound in liquid.
14. To study the Hall effect for the determination of charge current densities.

15. Distinguish between diamagnetic material, paramagnetic and ferromagnetic material.
16. Measurement of susceptibility of a liquid or a solution by Quincke's method.

17. To study the sample with the nano-scale objects and measure surface topography with different scales, width and height of nano objects, and force-distance curves using AFM.
18. To study the temperature coefficient of Resistance of copper.
19. To determine the ratio k/e using a transistor.
20. To compare various capacitance and verify the law of addition of capacitance.
21. To measure the temperature dependence of a ceramic capacitor.
22. Verification of the curie Weiss law for the electrical susceptibility of a ferromagnetic material.
23. To study the laser beam characteristics like; wave length using diffraction grating aperture & divergence.

24. To study laser interference using Michelson's Interferometer.
25. Study of diffraction using laser beam and thus to determine the grating element.

Section-B

Virtual lab:

1. To draw the static current-voltage (I-V) characteristics of a junction diode.
2. To plot the characteristics of thermistor and hence find the temperature coefficient of resistance.
3. To determine the resistivity of semiconductors by Four Probe Method.
4. To study Zener diode voltage as regulator and measure its line and load regulation.

5. To study the B-H Curve for a ferromagnetic material.
6. To study the Hall effect experiment to determine the charge carrier density.
7. To determine the magnetic susceptibilities of paramagnetic liquids by Quincke's Method.

8. To study the phenomena of magnetic hysteresis and calculate the retentivity, coercivity and saturation magnetization of a material using a hysteresis loop tracer.

9. Verification and design of combinational logic using AND, OR, NOT, NAND and XOR gates.

Reference books and suggested reading:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11^{th} Edn, 2011, Kitab Mahal.
4. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4^{th} Edition, Cambridge University Press.
6. Laboratory Experiments in College Physics, C.H. Bernard and C.D. Epp, John Wiley and Sons, Inc., New York, 1995.
7. Practical Physics, G.L. Squires, Cambridge University Press, Cambridge, 1985.
8. Experiments in Modern Physics, A.C. Melissinos, Academic Press, N.Y., 1966.
9. Practical Physics, C L Arora, S. Chand & Company LTD.
10. http://www.vlab.co.in
11. http://vlab.amrita.edu/index.php?sub=1

COURSE	**:**	**Chemistry-I (Theory)**
COURSE CODE	**:**	**BTCH101-18**

Course Objectives

1. The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. the basic chemistry will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The students with in-depth knowledge of the basic phenomenon/concepts of chemistry will be able to understand the new developments and breakthroughs efficiently in engineering and technology. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Thus to understand phenomena at nanometer levels, one has to base

the description of all chemical processes at molecular levels to enhance the thinking capabilities of students in line with the modern trends in engineering and technology.

Course contents

(i) Atomic and molecular structure (12 lectures)

Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

(ii) Spectroscopic techniques and applications (8 lectures)

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterisation techniques. Diffraction and scattering.

(iii) Intermolecular forces and potential energy surfaces (4 lectures)

Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

(iv) Use of free energy in chemical equilibria (6 lectures)

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion.

Use of free energy considerations in metallurgy through Ellingham diagrams.

(v) Periodic properties (4 Lectures)

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries

(vi) Stereochemistry (4 lectures)

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

(vii) Organic reactions and synthesis of a drug molecule (4 lectures)

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Suggested Text Books

(i) University chemistry, by B. H. Mahan, Third Edition, Narosa Publishing House Pvt. Ltd.

(ii) Fundamentals of Molecular Spectroscopy, by C. N. Banwell, Fourth Edition, McGraw Hill Education Pvt. Ltd.

(iii) Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan

(iv) Physical Chemistry, by P. W. Atkins, Oxford University Press.

Course Outcomes: After the completion of the course, the student will be able to:

CO1. Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.

CO2. Acquire basic knowledge of chemistry to appreciate its applications in diverse fields.

CO3. Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.

CO4. Rationalise periodic properties such as ionization potential, electron affinity, oxidation states and electronegativity.

CO5. Rationalise bulk properties and processes using thermodynamic considerations.

CO6. Understand the major chemical reactions that are used in the synthesis of molecules.

COURSE : Chemistry-I (Lab.)

COURSE CODE : BTCH102-18

Course Objectives:

The chemistry laboratory course consists of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The objective of this course is to acquaint the students with practical knowledge of the basic phenomenon/concepts of chemistry the students face during course of their study in the industry and engineering field. The students will be able to understand and explain scientifically the various chemistry related problems in the industry/engineering and develop experimental skills for building technical competence.

<u>Course Contents</u>

Choice of 10 experiments from the following:

- Determination of surface tension and viscosity
- Thin Layer Chromatography
- Ion exchange column for removal of hardness of water
- Colligative properties using freezing point depression
- Determination of the rate constant of a reaction
- Determination of cell constant and conductance of solutions
- Synthesis of a polymer/drug
- Saponification/acid value of an oil
- Chemical analysis of a salt
- Lattice structures and packing of spheres
- Models of potential energy surfaces
- Chemical oscillations- Iodine clock reaction
- Determination of the partition coefficient of a substance between two immiscible liquids
- Adsorption of acetic acid by charcoal
- Use of the capillary viscometers to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

<u>Course Outcomes</u>:

After the completion of the course the student will be able to:

CO1: analyze & generate experimental skills.

CO2: enhance the thinking capabilities in the modern trends in Engineering & Technology.

CO3: learn and apply basic techniques used in chemistry laboratory for analyses, synthesis, purification and identification.

CO5: measure molecular/system properties such as surface tension, viscosity, conductance of solutions, hardness of water, etc

CO6: learn safety rules in the practice of laboratory investigations.

Code	Subject Name	Contact hrs per week	Credits
BTAM101-18	Mathematics-1 (Calculus & Linear Algebra)	4L: 1T: 0P	4 credits

Detailed Contents

Section-A

Unit-I: **Calculus (10 hours)** Rolle's theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Indeterminate forms and L' Hôpital's rule; Maxima and minima; Evaluation of definite and Improper integrals; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Unit-II: **Multivariable Calculus (15 hours)** Limit, continuity and partial derivatives, Total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Multiple Integration: double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes by (double integration), Center of mass and Gravity (constant and variable densities).

Section-B

Unit-III: **Sequences and Series (12 hours)** Convergence of sequence and series, tests for convergence of positive term series: root test, ratio test, p-test, comparison test; Alternate series and Leibnitz's test; Power series, Taylor's series, series for exponential, trigonometric and logarithmic functions.

Unit-IV: **Matrices (13 hours)** Algebra of matrices, Inverse and rank of a matrix, introduction of null space and kernel, statement of rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Similar matrices; Diagonalization of matrices; Cayley-Hamilton Theorem.

Course Objectives

The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and differential equations. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines. **The students will learn:**

- The differential and integral calculus for applications of definite integrals to evaluate surface areas and volumes of revolutions.
- The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.

- The tool of matrices and convergence of sequence and series for learning advanced Engineering Mathematics.
- The tools of differentiation and integration of functions of multiple variables which are used in various techniques dealing engineering problems.

Course Outcomes

After Successful completion of the course the students will be able to:

CO1. Understand the fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.

CO2. Understand and use tools of differentiation and integration of functions of multiple variables which are used in various techniques dealing engineering problems

CO3. Acquire knowledge of differential and integral calculus for applications of definite integrals to evaluate surface areas and volumes of revolutions.

CO4. Understand and use the tools of matrices and convergence of sequence and series for learning advanced Engineering Mathematics.

List of Books Referred

TEXT/ REFERENCE BOOKS:

Suggested Text/Reference Books

1. Thomes, G.B, Finney, R.L. Calculus and Analytic Gemetry, Ninth Edition, Peason Education.

2. Kreyszig, E., Advanced Engineering Mathematics, Eighth edition, John wiley.

   https://www-elec.inaoep.mx/~jmram/Kreyzig-ECS-DIF1.pdf

3. T. Veerarajan, Engineering Mathematics for first year, Tata McGraw-Hill, NewDelhi, 2008.
4. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill New Delhi,11th Reprint, 2010.
5. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005
6. Peter. V. O‟ Nil, Advanced Engineering Mathematics, Wordsworth Publishing Company.
   http://kisi.deu.edu.tr/ali.sevimlican/Peter_V__O'Neil-Advanced_Engineering_Mathematics,_7th_Edition__-Cengage(2011).pdf

7. Jain, R.K and Lyengar, S.R.K., Advanced Engineering Mathematics, Narosa Publishing Company.

8. Bali, N. P., Engineering Mathematics-I, Laxmi Publications, New Delhi

9. **Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi.**

10. Taneja, H.C., Engineering Mathematics, Volume-I & Volume-II, I.K. Publisher.

11. Babu Ram, Advance engineering Mathematics, Pearson Education.

12. H. K. Dass, Higher Engineering Mathematics, Sultan Chand's Publisher, New Delhi

Online Learning Websites

- http://tutorial.math.lamar.edu/ (Good)
- http://www.slideshare.net/yanaqlah/partial-differentiation-application
- http://www.maplesoft.com/applications/Category.aspx?cid=157
- http://www.slideshare.net/varunakapuge/application-of-vector-integration
- http://calculus.nipissingu.ca/calc_app.html
- http://www.studyyaar.com/index.php/module-video/watch/183-curve-tracing-in-cartesian-form--part-1
- http://um.mendelu.cz/maw-html/menu.php
- http://www.la-citadelle.com/courses/calculus/

Online Material

- http://econ109.econ.bbk.ac.uk/brad/advcalc/Notes%203%20Applications%20of%20partial%20differentiation.pdf
- http://www.maths.manchester.ac.uk/~mprest/Partial-Part%20II-2012.pdf
- https://www.whitman.edu/mathematics/multivariable/multivariable_16_Vector_Calculus.pdf
- http://gnindia.dronacharya.info/APSDept/Downloads/question_papers/ISem/Engg-Maths1/UNIT-1/Curve-tracing.pdf
- http://www.mecmath.net/calc3book.pdf
- http://www.maths.tcd.ie/~brittons/2E01/MA2E01_Chapter_5.pdf

Online Video Lectures

- https://www.youtube.com/watch?v=pAb1autRHGA
- https://www.youtube.com/watch?v=HeKB72M2Puw
- https://www.youtube.com/watch?v=gLWUrF_cOwQ
- https://www.youtube.com/watch?v=hJ0FMHVZVSc
- https://www.youtube.com/watch?v=pSoldEpyEwQ

BTAM201-18	**Mathematics-II (Differential equations)**	**4L:1T:0P**	**4 credits**

Course Objectives:

The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary and partial differential equations. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

Detailed Contents:

Section A

Unit-I: Ordinary differential equations: First and Higher order (15 hours)

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree:

equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions.

Unit-II: Partial Differential Equations: First order (10 hours)

First order partial differential equations, solutions of first order linear and non-linear PDEs. Solution to homogenous and non-homogenous linear partial differential equations second and higher order by complimentary function and particular integral method.

Section B

Unit-III: Partial Differential Equations: higher order (12 hours)

Second-order linear equations and their classification, Initial and boundary conditions (with an informal description of well-posed problems), D'Alembert's solution of the wave equation. Separation of variables method to simple problems in Cartesian coordinates.

Unit-IV: Partial Differential Equations: higher order (contd.) (13 hours)

The Laplacian in plane, cylindrical and spherical polar coordinates. One dimensional diffusion equation and its solution by separation of variables. Boundary-value problems: Solution of boundary-value problems for various linear PDEs

Textbooks/References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
3. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
4. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
5. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
6. G.F. Simmons and S.G. Krantz, Differential Equations, Tata McGraw Hill, 2007.
7. S. J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, 1993.
8. R. Haberman, Elementary Applied Partial Differential equations with Fourier Series and Boundary Value Problem, 4th Ed., Prentice Hall, 1998.
9. Ian Sneddon, Elements of Partial Differential Equations, McGraw Hill, 1964.
10. Manish Goyal and N.P. Bali, Transforms and Partial Differential Equations, University Science Press, Second Edition, 2010.

Course Outcomes: The students will learn:

The mathematical tools needed in evaluating multiple integrals and their usage.

The effective mathematical tools for the solutions of differential equations that model physical processes.

The tools of differentiation and integration of functions that are used in various techniques dealing engineering problems

BTAM104-18	**Mathematics Paper-I (Calculus & Linear Algebra)**	**4L:1T:0P**	**4 credits**

Course Objective:

The objective of this course is to familiarize the prospective engineers with techniques in basic calculus and linear algebra. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Detailed Contents:

Section-A

Unit-I: Calculus (13 hours)

Rolle's theorem, Mean value theorems, Statements of Taylor's and Maclaurin theorems with remainders; Indeterminate forms and L' Hôpital's rule; Maxima and minima.

Evaluation of definite and improper integrals; Applications of definite integrals to evaluate surface areas and volumes of revolutions; Beta and Gamma functions and their properties.

Unit-II: Matrix Algebra (12 hours)

Matrices, vectors addition and scalar multiplication, matrix multiplication; Linear systems of equations, linear Independence, rank of a matrix, determinants, Cramer's Rule, inverse of a matrix, Gauss elimination and Gauss-Jordan elimination.

Section-B

Unit-III: Linear Algebra (13 hours)

Vector Space, linear dependence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank and nullity, statement of rank-nullity theorem, Matrix associated with a linear map.

Unit-IV: Linear Algebra (Contd.) (12 hours)

Eigenvalues, eigenvectors, symmetric, skew-symmetric, and orthogonal Matrices, eigen bases; Similar matrices, diagonalization.

Suggested Text/Reference Books

G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.

Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.

B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.

N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.

B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.

V. Krishnamurthy, V.P. Mainra and J.L. Arora, An introduction to Linear Algebra, Affiliated East–West press, Reprint 2005.

Course Outcomes: The students will be able

CO1: Acquire knowledge of differential and integral calculus to notions of curvature and to improper integrals.

CO2: Understand the problem of Beta and Gamma functions.

CO3: Develop critical thinking skills in the concept of matrices and linear algebra including linear transformations, eigenvalues, diagonalization and orthogonalization

CO4: Understand the basics of The objective of this course is to familiarize the prospective engineers with techniques in basic calculus and linear algebra

BTA204-18	**Mathematics Paper-II (Probability & Statistics)**	**4L:1T:0P**	**4 credits**

Course Objective:

The objective of this course is to familiarize the students with statistical techniques. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in the discipline.

Detailed Content:

Section-A

Unit I: (10 hours)

Measures of Central tendency: Moments, skewness and kurtosis, Variance, Correlation coefficient, Probability, conditional probability, independence; Discrete random variables, Independent random variables, expectation of Discrete random variables.

Unit II: (15 hours)

Probability distributions: Binomial, Poisson and Normal, Poisson approximation to the binomial distribution, evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.

Section-B

Unit III: (10 hours)

Continuous random variables and their properties, distribution functions and densities, normal and exponential densities. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas.

Unit IV; (15 hours)

Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

Suggested Text/Reference Books

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
3. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
4. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed., Wiley, 1968.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
7. T. Veerarajan, Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi, 2010.

Course Outcomes: The students will learn:

The ideas of probability and random variables and various discrete and continuous probability distributions and their properties. The basic ideas of statistics including measures of central tendency, correlation and regression and the statistical methods of studying data samples.

Category			Engineering Science Course		
Course title			**Basic Electrical Engineering (Theory & Lab.)**		
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester –I/II
	3	**1**	**2**	**5**	
Pre-requisites (if any): Nil					

Course code: **BTEE-101-18**
Course Title: **Basic Electrical Engineering (4 credits)**

[L: 3; T: 1; P: 0]

Internal Marks: 40 External Marks: 60 Total Marks: 100

Detailed contents:

- ***Module 1: DC Circuits (8 hours)***

  Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin's and Norton's Theorems. Time-domain analysis of first-order RL and RC circuits.

- ***Module 2: AC Circuits (8 hours)***

  Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.

- ***Module 3: Transformers (6 hours)***

  Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

- ***Module 4: Electrical Machines (8 hours)***

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

- ***Module 5: Power Converters (6 hours)***

  DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

- ***Module 6: Electrical Installations (6 hours)***

  Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Course Objectives:

1) Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.

2) Provide working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices.

3) To explain the working principle, construction, applications of DC machines, AC machines & the importance of transformers in transmission and distribution of electric power.

4) To Gain knowledge about the fundamentals of LT components of switchgear, wiring and earthing.

Course Outcomes

After the completion of the course the student will be able to:

CO1. To understand and analyze basic electric and magnetic circuits.

CO2. To identify the type of electrical machine used for that particular application.

CO3. To study the working principles of electrical machines and power converters.

CO4. To introduce the components of low voltage electrical installations.

List of Books Referred

TEXT/ REFERENCE BOOKS:

T/R	BOOK TITLE/ AUTHORS/ PUBLICATION
T1	D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010
T2	D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009
R1	L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011
R2	E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010
R3	V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989

List of Videos and internet material referred

27. **Transformer 3D Animation : https://www.youtube.com/watch?v=U3CubKnkO4c**
28. **https://www.youtube.com/watch?v=DsVbaKZZOFQ**
29. **https://www.youtube.com/watch?v=tiKH48EMgKE&list=PLZY3yNTglIyWtOLxTl9ZlA
K9zIgPK3H9d**
30. **https://www.youtube.com/watch?v=gW45N2WpD64**
31. **https://www.youtube.com/watch?v=QkbnOga09Vg**

WEB SOURCE REFERENCES:

1 http://nptel.ac.in/courses/122104013/10
2 http://nptel.ac.in/courses/122104013/12
3 http://nptel.ac.in/courses/117107095/
4 http://nptel.ac.in/courses/117103063/

Course code: BTEE-102-18

Course Title: Basic Electrical Engineering Laboratory **(1 credit)**

[L: 0; T:0; P : 2]

Internal Marks: 30

External Marks: 20

Total Marks: 50

List of experiments/demonstrations:

a. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
b. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.
c. Transformers: Observation of the no-load current waveform on an oscilloscope (non-sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
d. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side. Cumulative
e. three-phase power in balanced three-phase circuits.
f. Demonstrate of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine
g. (field winging - slip ring arrangement) and single-phase induction machine. Torque Speed Characteristic of separately excited dc motor.
h. Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at super-synchronous speed.
i. Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.
j. Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform
k. (c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switchgear.

Laboratory Outcomes

i. Get an exposure to common electrical components and their ratings.
ii. Make electrical connections by wires of appropriate ratings.
iii. Understand the usage of common electrical measuring instruments.
iv. Understand the basic characteristics of transformers and electrical machines.
v. Get an exposure to the working of power electronic converters.

S. No.	Suggested List of Experiments
1.	To verify Ohm’s Law and its limitations.
2.	To verify Kirchhoff’s Laws.
3.	To measure the resistance and inductance of a coil by ammeter-voltmeter method
4.	To find voltage-current relationship in a R-L series circuit and to determine the power factor of the circuit.
5.	To verify the voltage and current relations in star and delta connected systems.
6.	To measure power and power factor in a single- phase AC circuit.
7.	To verify series and parallel resonance in AC circuits.
8.	To observe the B-H loop of ferromagnetic core material on CRO.
9.	To use a bridge rectifier for full- wave rectification of AC supply and to determine the relationship between RMS and average values of the rectified voltage.
10.	To measure the minimum operating voltage, current drawn, power consumed, and the power factor of a fluorescent tube light.
11.	To connect measuring analog and digital instruments to measure current, voltage, power and power factor.
12.	To obtain the characteristics of a transistor under common base (CB) and common emitter (CE) configuration.
13.	To perform open- and short circuit tests on a single- phase transformer and calculate its efficiency.
14.	To start and reverse the direction of rotation of a (i) DC motor (ii) Induction motor
15.	Determining of voltage regulation of transformer by directly loading.
16.	Study of starters for (i) DC motor (ii) Induction motor

BTHU-101-18 English 2L: 0T: 0P 2 credits

Course Outcomes:

a. The objective of the course is to help the students become the independent users of English language.
b. Students will acquire basic proficiency in reading & listening, comprehension, writing and speaking skills.
c. Students will be able to understand spoken and written English language, particularly the language of their chosen technical field.
d. They will be able to converse fluently.
e. They will be able to produce on their own clear and coherent texts.

Detailed contents

Unit-1 Vocabulary Building & Basic Writing Skills

a. The concept of Word Formation
b. Root words from foreign languages and their use in English
c. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
d. Synonyms, antonyms, and standard abbreviations. Sentence Structures
e. Use of phrases and clauses in sentences Importance of proper punctuation
f. Creating coherence
g. Organizing principles of paragraphs in documents Techniques for writing precisely

Unit-2 Identifying Common Errors in Writing

a. Subject-verb agreement Noun-pronoun agreement Misplaced modifiers
b. Articles
c. repositions Redundancies
d. Clichés

Unit-3 Mechanics of Writing

Writing introduction and conclusion
Describing
Defining
Classifying

Providing examples or evidence

Unit-4 Writing Practices

Comprehension
Précis Writing
Essay Writing
Business Writing-Business letters, Business Emails, Report Writing, Resume/CV

Suggested Readings:

(i) *Practical English Usage*. Michael Swan. OUP. 1995.

(ii) *Remedial English Grammar*. F.T. Wood. Macmillan.2007

(iii) *On Writing Well*. William Zinsser. Harper Resource Book. 2001

(iv) *Study Writing*. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

(v) *Communication Skills*. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.

(vi) *Exercises in Spoken English*. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

BTHU-102-18 (English Laboratory)

0L: 0T: 2P 1 credit

Course Outcomes:

a. The objective of the course is to help the students become the independent users of English language.
b. Students will acquire basic proficiency in listening and speaking skills.
c. Students will be able to understand spoken English language, particularly the language of their chosen technical field.
d. They will be able to converse fluently
e. They will be able to produce on their own clear and coherent texts.

Detailed contents

Interactive practice sessions in Language Lab on Oral Communication

Listening Comprehension
Self-Introduction, Group Discussion and Role Play
  Common Everyday Situations: Conversations and Dialogues
  Communication at Workplace
Interviews
Formal Presentations

Suggested Readings:

(i) *Practical English Usage*. Michael Swan. OUP. 1995.
(ii) *Communication Skills*. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.
(iii) *Exercises in Spoken English*. Parts. I-III. CIEFL, Hyderabad. Oxford University Press