VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
Ibrahimbagh, Hyderabad-31
DEPARTMENT OF PHYSICS

B.E Physics Syllabus for **CSE** and **IT** Branches

SEMICONDUCTOR PHYSICS AND OPTOELECTRONIC DEVICES

L : T : P	Credits	CIE		SEE		Course Code
		Marks	Exam Duration	Marks	Exam Duration	
3 : 1 : 0	04	40	1 hour 30 min	60	03 hours	U20BS110PH

Course Objectives	Course Outcomes
The student will be able to 1. learn crystal structure and defects in solids 2. aware limits of classical free electron theory and use band theory to classify solids. 3. know construction and signal losses in various optical fibers 4. gain knowledge on working of optoelectronic devices 5. acquire fundamental knowledge on photo-detectors.	***At the end of the course, the student should at least be able:*** 1. segregate crystals based on their structure and apply effects of defects on manipulation of properties of solids. 2. distinguish materials based on band theory of solids and appreciate use of materials for various applications. 3. summarize various merits, demerits and applications of optical fibers. 4. accustom with various device structures of optoelectronic light sources like LED and lasers 5. assimilate working and use of photo detectors in various applications

UNIT-I: FUNDAMENTALS OF CRYSTAL STRUCTURE (12 hours)

Introduction-Space lattice, Basis, Unit cell, Bravais lattices and crystal systems, Miller Indices, X-ray diffraction, Bragg's law, powder x- ray diffraction-, crystalline, polycrystalline and amorphous materials, Point Defects: Schottky, Frankel Defects, effects of defects on properties of solids.

Classical free electron theory (Drude theory) and its limitations, Somerfield theory, de Broglie Hypothesis, wave function, Schrodinger wave equation for a particle in I-D box, Kronig-Penny model (introduction to origin of band gap), Energy bands in solids, E-k diagram, density of states for bulk, thin and nano materials, effective mass, classification of materials as metals, semiconductors, and insulators.

UNIT-II: SEMICONDUCTOR PHYSICS (12 hours)

Intrinsic semiconductors, extrinsic semiconductors-doping, acceptor and donor impurities, Fermi-Dirac Statistics, expression for intrinsic and extrinsic carrier concentration (equilibrium carrier statistics), conductivity of intrinsic and extrinsic semiconductor, law of mass action, dependence of Fermi level on carrier-concentration and temperature, mobility, Hall effect.

Diffusion and Drift current densities- Continuity equation - Semiconductor P-N junction formation, diode in equilibrium without bias, introduction metal-semiconductor Ohmic and Schottky junctions. Direct and indirect band gap semiconductors, carrier generation and recombination, radiative and non- radiative recombination mechanisms in semiconductors.

UNIT-III: FIBER OPTICS (08 hours)

Introduction, total internal reflection, propagation of light in optical fibre, numerical aperture, acceptance angle, types of optical fibres, evanescent field, light sources for optical fibers, Semiconductor materials for opto-electronic devices, various signal losses in optical fibers, Block diagram of optical communication system, advantages and application of optical fibers.

UNIT-IV: LED AND LASER (10 hours)

LIGHT EMITTING DIODE (LED): types of luminescence, construction and working of LED, characteristics of LED, quantum efficiency of LED, Homo junction and Hetero-junction structures, advantages and applications of LED.

LASERS: meta-stable states, population inversion, pumping, components of laser; condition for lasing, characteristics of lasers, types of lasers, construction and working of Ruby laser and He-Ne laser.

Semiconductor lasers- rate equations for carrier and photon-density, and their steady state solutions, modes in resonating cavity, gain and loss, quantum efficiency, construction and working of homo-junction and hetero-junction semiconductor lasers, advantages and applications of lasers.

UNIT-V: PHOTODETECTORS (08 hours)

PHOTO-DETECTORS: photoconductivity, expression for current gain in a photoconductor, construction, working and characteristics of photo-detectors like photo-diode, PIN, and Avalanche diode, performance of photo-detectors.

SOLAR CELL: Photovoltaic effect, air mass conditions, solar radiation spectrum, construction and working of homo and hetero junction solar cell, V-I characteristics of solar cell, quantitative treatment of spectral response, conversion efficiency, fill factor, thin film and tandem solar cells, applications of solar cells.

Learning Resources:

1. Charles Kittel, Introduction to Solid State Physics, 7th Edition, John Wiley & Sons, 2008.
2. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley, 2008.
3. Ben. G Streetman, Solid State Electronic Devices, PHI, 2006
4. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, PHI, 2002
5. John M Senior, Optical Fiber Communications: Principles and Practice, 3rd Edition, Pearson, 2010
6. Jasprit Singh, Semiconductor Devices Basic Principles, 2000, John Wiley & Sons
7. M.N. Avadhanulu and P.G. Kshirsagar and TVS Arun, Murthy A Text Book Engineering Physics, 11th Edition, S. Chand, 2018.
8. M.R Shenoy, NPTEL MOOCS course, Semiconductor opto-electronics. 2018
9. M. Ali Omar, Elementary Solid State Physics,1e, Pearson,2002

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
Ibrahimbagh, Hyderabad-31

DEPARTMENT OF PHYSICS

B.E Physics Syllabus for **ECE** and **EEE** Branches

QUANTUM MECHANICS AND MATERIAL SCIENCE

L : T : P	Credits	CIE		SEE		Course Code
		Marks	Exam Duration	Marks	Exam Duration	
3 : 1 : 0	04	40	1 hour 30 min	60	03 hours	U20BS210PH

Course Objectives	Course Outcomes
The student will be able to 1. learn crystal structure and defects in solids 2. distinguish classical and quantum mechanical principles and gain knowledge on quantum mechanics 3. appreciate classification of different solids based on band theory. 4. acquire knowledge on optical fiber communication system and signal losses in optical fibers. 5. narrate properties of dielectric, magnetic materials and superconductors.	***At the end of the course, the student should at least be able:*** 1. segregate crystals based on their structure and apply effects of defects on manipulating properties of solids. 2. apply and solve wave equations for various quantum mechanical systems. 3. distinguish materials based on band theory of solids and their applications. 4. summarize various merits, demerits and applications of optical fibers and light sources. 5. select various dielectric, magnetic materials and superconductors for specific applications in different fields.

UNIT-I: FUNDAMENTALS OF CRYSTAL STRUCTURE (12 hours)

Introduction-Space lattice, Basis, Unit cell, Bravais lattices and crystal systems, X-ray diffraction, Bragg's law, powder x- ray diffraction-derivation of lattice parameters for cubic crystals, crystalline, polycrystalline and amorphous materials, Miller Indices, , inter-planar spacing

Defects in crystals: point defects-Schottky, Frankel defects, compositional and substitution impurities, line defects: screw and edge dislocations, burger vector, burgers circuit, energy of a dislocation, effects of defects on properties of solids. NaCl, Diamond and ZnS crystal structure.

UNIT-II: INTRODUCTION TO QUANTUM MECHANICS (10 hours)

Inadequacy of classical mechanics, photo electric effect, Wave-particle duality, de Broglie waves, Davisson and Germer's experiment, G.P. Thomson experiment, wave packet, uncertainty principle, wave function and its physical significance, postulates of quantum mechanics.

Time-dependent and time-independent Schrodinger equations, quantum mechanical operators, Schrodinger equation for one dimensional problems: free-particle, stationary-state, particle in infinite square-well potential, potential barrier and tunneling- calculation of transmission coefficient, alpha decay.

UNIT-III: BAND THEORY OF SOLIDS (8 hours)

Classical free electron Drude theory and its limitations, Somerfield theory, Fermi-Dirac Statistical distribution, Density of states, Kronig-Penney model- introduction to origin of band gaps in solids, E-k diagram, Qualitative treatment of density of states for bulk material, formation of energy bands. Classification of solids based on energy bands as metals, semiconductors, and insulators. Intrinsic and extrinsic semiconductors, variation of Fermi energy level with temperature and doping, expression for carrier concentration of intrinsic and extrinsic semiconductors.

UNIT-IV: LASERS AND OPTICAL FIBRES (10 hours)

Lasers: induced absorption, spontaneous and stimulated emissions, Einstein's theory of matter radiation interaction- A and B coefficients; population inversion, meta-stable states, pumping mechanisms, components of laser, Properties of laser beam, construction and working of Ruby laser, Nd: YAG laser (solid state lasers), He-Ne (gas Laser) and semiconductor laser, advantages and applications of lasers.

Optical Fibres: Total internal reflection, numerical aperture, acceptance angle, propagation of light in optical fiber, types of optical fibres based on refractive index and modes of propagation, light sources for optical fibres, various signal losses in optical fibres, Block diagram of optical communication system, advantages and application of optical fibres.

UNIT-V: MATERIALS SCIENCE (12 hours)

Dielectric Materials: Polar and non-polar dielectrics, types of dielectric polarizations, Expressions for electronic polarizability and ionic polarizability, Frequency and temperature dependence of dielectric polarizations, internal filed in solids, Lorentz field, Clausius- Mossotti equation- applications of dielectric materials. Applications of dielectric materials.

Magnetic Materials : Origin of magnetism, classification of various magnetic materials, Ferro, antiferro and ferri-magnetic materials and their properties, Weiss molecular field theory of ferromagnetism- magnetic domains- hysteresis curve-Soft and hard magnetic Materials, fundamentals of Ferrites and their applications.

Superconductivity : Superconductor, General properties of super conductors – Meissner effect- Type I and Type II superconductors-fundamentals of BCS Theory - Josephson's Junction- d.c and a.c Josephson's effects–SQUIDS- Applications of superconductors

Learning Resources:

1. Charles Kittel, Introduction to Solid State Physics, 7th Edition, John Wiley & Sons, 2008.
2. S O Pillai, Solid State Physics, 8th edition, New Age International Publishers, 2018
3. D. J. Griffiths, "quantum mechanics", Pearson Education, 2012.
4. R. Murugeshan and K Sivaprasath, Modern Physics, 18th Edition, S. Chand & Co, 2016
5. M.N. Avadhanulu and P.G. Kshirsagar and TVS Arun Murthy A Text Book Engineering Physics, 11th Edition, S. Chand, 2018.
6. Senior, Optical Fiber Communications: Principles and Practice, 3e: Pearson, 2010
7. G. Keiser, Optical communications, Mc Graw Hill, (2010)

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
Ibrahimbagh, Hyderabad-31

DEPARTMENT OF PHYSICS APPLIED PHYSICS

B.E Physics Syllabus for **CIVIL** and **MECHANICAL ENGINEERING** Branches

APPLIED PHYSICS

L : T : P	Credits	CIE		SEE		Course Code
		Marks	Exam Duration	Marks	Exam Duration	
3 : 1 : 0	04	40	1 hour 30 min	60	03 hours	U20BS020PH

Course Objectives	Course Outcomes
The student will be able to 1. learn mathematical formulations of waves and oscillations 2. Acquire knowledge of on various optical phenomenon like interference, diffraction etc. 3. gain insight on lasing action and lasers 4. grasp the concepts of acoustics 5. learn liquefaction of gasses	***At the end of the course, the student should at least be able:*** 1. solve differential equations that describe the behavior of mechanical oscillators under various conditions 2. apply the fundamental principles of wave optics in relevant fields of engineering. 3. List various types of lasers and their applications 4. apply the principles of acoustics to minimize the reverberation and echo effects. 5. appreciate liquefaction of air & He and applications of low temperatures and their importance.

UNIT-I: OSCILLATIONS (8 hours)

Definition of SHM, equation of motion and it solution to simple harmonic oscillator, time period of compound pendulum, energy of simple harmonic oscillator, equation of motion and it solution to damped harmonic oscillator, logarithmic decrement, energy of damped oscillator, relaxation time, equation of motion and it solution to forced harmonic oscillator, Resonance, Q-factor, sharpness, electromechanical analogy, Lissajous figures.

UNIT-II: WAVE OPTICS (12 hours)

Interference: Light as an electromagnetic wave, superposition theorem, interference of light by wave front splitting and amplitude splitting, interference due to thin parallel film, Newton's rings, and its applications, Michelson interferometer.

Diffraction: Fraunhofer diffraction due to a single slit- diffraction due to N- slits (plane transmission grating) -Rayleigh criterion for limit of resolution, resolving power, dispersive power.

Polarization: Polarization of light, Brewster law, Malus law, double refraction, construction and working of Nicol's Prism. Polariser and analyser, Half shade Lorentz Polarimeter.

UNIT-III: LASERS AND OPTICAL FIBRES (10 hours)

Lasers: induced absorption, spontaneous and stimulated emissions, Einstein's theory of matter radiation interaction- A and B coefficients; population inversion, meta-stable states, pumping mechanisms, components of laser, Properties of laser beams, construction and working of solid state lasers: Ruby laser and Nd: YAG, Gas lasers: He-Ne and CO_2 laser, advantages and applications of lasers.

Optical Fibers: Total internal reflection, numerical aperture, acceptance angle, propagation of light in optical fibre, types of optical fibers based on refractive index and modes of propagation etc, light sources for optical fibre communication, various signal losses in optical fibers, Block diagram of optical communication system, advantages and application of optical fibers.

UNIT-IV: ACOUSTICS (10 hours)

Acoustics: Characteristics of sound-pitch, loudness, timbre, Weber-Fechner law: measurement of intensity of sound -reverberation-reverberation time-Sabine's formula-remedies to reverberation- sound absorbent materials-absorption coefficient- conditions for good acoustics of a building-acoustic quieting: effects and remedies

Ultrasonics : properties of ultrasonics, types of ultrasonic waves, production of ultrasonics by piezoelectric and magnetostriction methods, detection of ultrasonics by piezoelectric, Kundt's tube, flame test, thermal detector, acoustic grating: ultrasonic velocity measurements, applications of ultrasonics: SONAR, cavitation (cleaning), drilling, sonogram

UNIT-IV: LOW TEMPERATURE PHYSICS (10 hours)

Introduction to low temperature Physics- Porous plug experiment: Joule Thomson effect, Theory of porous plug experiment- J-K effect for a Van der Waal's gas, J-K effect for real gas, Inversion temperature, Boyle temperature, critical temperature and relationship between them. Regenerative cooling and cascade process, Liquefaction of air by Linde Process, liquefaction of hydrogen, Liquefaction of helium, Properties of cryogenic helium, adiabatic demagnetization, Applications of cryogenic liquids.

Learning Resources:

1. A. P. French, Vibration's and Waves, CRC Press, 2003
2. Lawrence E. Kinsler, Austin R. Frey, Alan B. Coppens and James V. Sanders Fundamentals of Acoustics 4^{th} Edition, John Wily, 2009.
3. M.N. Avadhanulu and P.G. Kshirsagar and TVS Arun Murthy A Text Book Engineering Physics, 11^{th} Edition, S. Chand, 2018.
4. Senior, Optical Fiber Communications: Principles and Practice, 3e: Pearson, 2010
5. Charles Kittel, Introduction to Solid State Physics, 7^{th} Edition, John Wiley & Sons, 2008.
6. Zeemansky, Heat and thermodynamics, Mc Graw Hill, 7^{th} Edition, 1981
7. B.K. Pandey and Chaturvedi, Engineering Physics, Cengage Learning, 2016
8. V. Rajendran, Engineering Physics, Mc Graw-Hill Education, 2014

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
Ibrahimbagh, Hyderabad-31
DEPARTMENT OF PHYSICS SYLLABUS OF APPLIED PHYSICS LAB for All Branches

L : T : P	Credits	CIE		SEE		Course Code
		Marks	Exam Duration	Marks	Exam Duration	
0 :0 :03	01	20	1 hour 30 min	50	03 hours	U20BS011PH

Course Objectives	Course Outcomes
Students are able to 1. Make precise measurements using basic physical principles and acquire skills to handle the instruments 2. Relates the theoretical Knowledge to the behavior of Practical Physical world. 3. Analyze errors in the experimental data. 4. Plot graphs between various physical parameters.	***The students acquire the ability to*** 1. Conduct experiments, take measurements independently. 2. Write appropriate laboratory reports. 3. Compute and compare the experimental results and draw relevant conclusions and interpret the results. 4. Use the graphical representation of data and estimate results from graphs.

1. Determination of characteristics of He-Ne and Semiconductor lasers.
2. Determination of radius of curvature of a given Plano-convex lens by forming Newton’s Rings.
3. Determination of wavelength of spectral lines of Mercury light source using diffraction grating under normal incidence.
4. Calculation of numerical aperture, acceptance angle and power loss due to bending of an optical fibre.
5. Michelson’s interferometer-determination of wavelength of laser light.
6. Determination of energy gap of a given semiconductor by four probe method
7. Study of I-V characteristics of P-N Junction diode, Zener diode and LED
8. Study of I-V characteristics of solar cell and to calculate fill factor and efficiency
9. Characteristics of Photodiode and Photocell
10. Hall’s effect- determination of Hall’s coefficient
11. e/m of electron-Thomson’s method
12. Study of resonance in LCR series & parallel circuits and to find resonant frequency & Q- factor
13. Temperature Characteristics of Thermistor and to find Thermistor constants Melde’s experiment
14. Fly Wheel –determination of moment of inertia.
15. Torsional Pendulum to calculate rigidity modulus of two wires of different materials
16. Compound Pendulum –determination of radius of gyration and acceleration due to gravity.
17. B-H curve-estimation of Hysteresis loss of a ferromagnetic sample
18. Seebeck Effect-determination of Seebeck coefficient
19. Gyroscope- study of gyroscopic effects.
20. Helmholtz coil –calculation of magnetic field along the axis

From the above pool of experiments a list can be prepared by the faculty member concerned to finalize the Branch-wise experiments appropriately depending on the theory syllabi. Each student should perform at least 12 (Twelve) experiments.

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
DEPARTMENT OF PHYSICS
Open elective Course
SMART MATERIALS AND APPLICATIONS

L : T : P	Credits	CIE		SEE		Course Code
		Marks	Exam Duration	Marks	Exam Duration	
02 :0 :0	02	40	90 min	60	3hours	U20OE310PH

Course Objectives	Course Outcomes
The student will be able to 1. grasp the concepts of peizo and ferro electric materials 2. Learn fundamentals of pyro and thermo electric materials 3. gain knowledge on shape memory alloys 4. acquire fundamental knowledge on chromic materials	***At the end of the course, the student should at least be able:*** 1. summarize various properties and applications of peizo and ferro electric materials 2. apply fundamental principles of pyro and thermo electricity in relevant fields of engineering 3. acquaint with various types of shape memory alloys and their properties and applications 4. appreciate the importance of chromic materials in engineering field.

UNIT I: PIEZO AND FERRO MATERIALS (8 hours)
Piezo electric effect and inverse piezoelectric effect, Piezo electric materials, Structure of Quartz crystal, Piezoelectric oscillator, Magnetostriction, Magnetostriction oscillator, piezo-electric sensors, applications of Piezo-electric materials.
Characteristics and properties of ferro-electric materials, Structure of Barium Titanate, Curie-Weiss law, applications of Ferro electric materials

UNIT II: PYRO AND THERMO-ELECTRIC MATERIALS (6 hours)
Pyroelectricity: pyro electric effect, pyro electric materials, pyro-electric sensors.
Thermoelectricity: thermoelectric effect, Seebeck effect, Peltier effect, thermoelectric sensor, Properties and applications of thermoelectric materials, thermoelectric generator and Thermoelectric cooler.

UNIT III: SHAPE MEMORY MATERIALS (8 hours)
Introduction to shape memory alloys (SMA)- Shape Memory Effect (SME) different phases of Shape memory alloys, Austenite, Martensite, Properties and characteristics of engineering SMAs**,** Super elasticity, one and two way shape memory effects, Properties of Ni-Ti shape memory alloy, Cu-based shape memory alloys, biomedical Materials, Advantages, disadvantages of SMAs, Applications of SMAs.

UNIT-IV: CHROMIC MATERIALS (6 hours)
Electro-chromaticity, Electro-chromic materials, Electro-chromic sensors and devices.
Photo-chromaticity, Photo-chromic materials, Photo-chromic sensors and devices.
Thermo-chromaticity, thermo-chromic materials, thermo-chromic sensors and devices.
Smart fluids: Magneto-rheological and Electro-rheological fluids.

Learning Resources:

1. K. Otsuka and C M Wayman, Shape memory materials, Cambridge university press, 1998.
2. T W Duerig, K N Melton, D Stockel, C M Wayman, Engineering aspects of shape memory alloys, Butterworth-Heinemann, 1990
3. A.K. Sawhney, A Course in Electronic Measurements and Instrumentation, Dhanpat Rai & Sons, 2015
4. D. Patranabis, Sensors and Transducers, PHI Learning Pvt. Ltd., 2013

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
DEPARTMENT OF PHYSICS
Open elective Course

INTRODUCTION TO OPTOELECTRONIC DEVICES

L : T : P	Credits	CIE		SEE		Course Code
		Marks	Exam Duration	Marks	Exam Duration	
03 :0 :0	03	40	90 min	60	3hours	U20OE410PH

Course Objectives	Course Outcomes
The student will be able to 1. gain knowledge on working of optoelectronic light sources like LED 2. grasp the concepts of lasing action, merits and demerits of lasers 3. acquire the fundamental knowledge on photo-detectors. 4. Narrate the properties of chromic materials	***At the end of the course, the student should at least be able:*** 1. accustom with various device structures of optoelectronic light sources like LED 2. acquaint with various types of lasers and their applications 3. assimilate working and use of photo detectors and solar cells in various applications 4. appreciate the importance of chromic materials in engineering field

UNIT-I: LIGHT EMITTING DIODES
Review of semiconductors, direct and indirect band semiconductors, electron-hole pair generation and recombination process- emission radiation and band gap of semiconductor-electroluminescence-construction and working of homojunction LED- introduction to SLED and ELED-semiconductor materials for LED fabrication, and OLEDS, applications of LEDs.

UNIT-II: SEMICONDUCTOR LASERS
Semiconductor diode laser -construction-working principle- advantages and applications of diode lasers. Semiconductor lasers- rate equations for carrier and photon-density, and their steady state solutions, modes in resonating cavity, gain and loss, quantum efficiency, construction and working of homo-junction and hetero-junction semiconductor lasers, advantages and applications of lasers.

UNIT-III: SOLAR CELLS
Solar spectrum-Solar Cell- Photovoltaic effect- I-V characteristics of solar cell -fill factor, efficiency- materials fabrication of solar cells-thin film solar cell-solar panels- applications of solar cells.

UNIT-IV: PHOTODETECTORS
Photodiodes: Working and construction of Photodiode and its characteristics- dark current-PIN Photodiode-Avalanche Photodiode-Photodiode Quantum Efficiency-advantages and applications of photodiodes.

UNIT-V: CHROMIC MATERIALS (6 hours)
Electro-chromaticity, Electro-chromic materials, Electro-chromic sensors and devices.
Photo-chromaticity, Photo-chromic materials, Photo-chromic sensors and devices.
Thermo-chromaticity, thermo-chromic materials, thermo-chromic sensors and devices.
Smart fluids: Magneto-rheological and Electro-rheological fluids.

Learning Resources:

1. Ben G Streetman and Sany Kumar Banerjee, Solid state electronic devices, 7^{th} edition, Pearson, 2016
2. Jasprit Singh, Semiconductor devices: Basic principles, Wiley, Delhi, 2014
3. M.N. Avadhanulu, Kshirsagar and TVS Arun Murthy, A textbook of Engineering Physics, 11^{th} Edition, S. Chand, 2018.

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
DEPARTMENT OF PHYSICS
Open elective Course
THIN FILM TECHNOLOGY AND APPLICATIONS

L : T : P	Credits	CIE		SEE		Course Code
		Marks	Exam Duration	Marks	Exam Duration	
03 :0 :0	03	40	90 min	60	3hours	U20OE420PH

Course Objectives	Course Outcomes
Students are able to	***The students acquire the ability to***
1. Learn the fundamental atomistic mechanisms. 2. Know thin film deposition techniques 3. Acquire knowledge on thin film devices 4. Acquaint with thin film devices 5. Appreciate applications of thin films	1. acquire range of basic knowledge fundamental definitions of thin film technology 2. narrate various thin film deposition techniques 3. list various thin film devices and their use 4. insights in possibilities and the importance of different thin films and coatings for a variety industrial applications

UNIT-I: THIN FILM GROWTH

Classification of films- formation of thin films- Condensation and nucleation, growth and coalescence of islands, -nucleation theories: capillarity and atomistic models, sticking coefficient, adhesion, substrate effect, film thickness effect.

UNIT-II: DEPOSITION TECHNIQUES

Thin film deposition techniques- simple thermal evaporation- Chemical vapor deposition technique- Advantages and disadvantages of Chemical Vapor deposition (CVD), physical vapour deposition electron beam evaporation- RF sputtering, flash evaporation, Laser ablation- spin coating- molecular beam epitaxy (MBE), Spin coating,Film thickness measurement-ellipsometry, quartz crystal oscillator techniques, structure and microstructure of thin films.

UNIT-III: THIN FILM MATERIAL CHARACTERIZATION TECHNIQUES

Characterization techniques: X-Ray Diffraction (XRD), working principles of Scanning Electron Microscopy (SEM), working of Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscope (STM), Field Ion Microscope (FEM).

UNIT-IV: PROPERTIES OF THIN FILMS

Electrical conduction in continuous and discontinuous metallic thin films. Transport and optical properties of metallic, semiconducting and dielectric films.

UNIT-V: THIN FILM DEVICES AND APPLICATIONS

Anti-reflection coatings, fabrication of thin film resistor, capacitor, diode, gas sensors and temperature sensors. Thin film solar cells, Quantum well and Quantum dot solar cells. Application of thin films in different areas such as electronics, medical, defense, sports, automobiles, applications of thin films in various fields etc.

Learning resources:

1. Kasturi Chopra Thin Film Device Applications, Mac Graw Hill, New York, 2012
2. A. Goswami, thin film fundamentals, New age international, 2006
3. K.L. Chopra, thin film phenomenon, Mac Graw Hill, New York, 1990

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
Ibrahimbagh, Hyderabad-500 031, Telangana State

DEPARTMENT OF PHYSICS
Open elective Course
VACUUM TECHNOLOGY AND APPLICATIONS

L : T : P	Credits	CIE		SEE		Course Code
		Marks	Exam Duration	Marks	Exam Duration	
03 :0 :0	03	40	90 min	60	3hours	U20OE510PH

Course objectives	*Course outcomes*
Students will be able to learn	***At the end of the course students will be***
1. Learn basic terms and definitions of vacuum technology 2. Acquire knowledge on vacuum pump parameters 3. Gain insight of various vacuum production methods 4. Learn measurement of vacuum 5. Known various applications of vacuum.	1. Define various vacuum ranges and terms related to vacuum technology 2. List out vacuum pump parameters 3. Narrate working of various types of vacuum pumps 4. Explain working of different vacuum measuring devices 5. List our application and use of vacuum in various fields of engineering and technology.

UNIT-I: FUNDAMENTALS OF VACUUM
Vacuum Nomenclature and Definitions, units of vacuum, Vacuum ranges, Types of flow: turbulent flow, viscous or laminar flow, molecular flow, Knudsen flow Vacuum Physics-out gassing, Mean free path of the molecules, adsorption, desorption, evaporation theory-rate of evaporation, Hertz- Knudsen equation, types of evaporation.

UNIT-II: VACUUM TERMINOLOGY
Methods of production of vacuum, vacuum pump function basics, throughput, pumping speed, conductance, evacuation rate, fore vacuum and high-vacuum pumping, Pump Choice, valve less, valved pumping system, Positive Displacement Vacuum Pumps, Momentum Transfer Vacuum Pumps, Entrapment Pumps, traps and baffles. Function of the oil in oil-sealed vacuum pumps. Effects of condensable vapours on mechanical pump performance, Water vapour tolerance of a pump, Back-streaming

UNIT-III: VACUUM PUMPS
Systems construction and working of vacuum pumps: Roots vacuum pumps, Rotary vane pump, multi stage rotary pumps, diffusion pump, Turbomolecular pumps, cryo-pump, ion getter pumps,

UNIT-IV: VACUUM MEASUREMENT
Overview of gauges, direct reading and indirect reading gauges, classification of pressure gauge, Vacuum gauges: thermocouple gauge, Pirani gauge, cold cathode and hot cathode ionization gauge, Penning gauge, leak detection, Leak detection methods-leak rate.

UNIT-V: VACUUM APPLICATIONS
Deposition of thin films, Vacuum technology in the semiconductor industry, Vacuum technology in metallurgical processes, Vacuum technology in the chemical industry,

SUGGESTED BOOKS:
1. Dorothy M. Hoffman and Bawa Singh, Handbook of Vacuum Science and Technology, Academic Press, 1998
2. M. N. Avadhanulu and P.G. Kshirsagar, Textbook of Engineering Physics, Revised Edition, S.Chand, 2015
3. David J. Hucknall, Vacuum Technology and Applications, Butterworth- Heinema Ltd,1991
4. John F. O'HanlonA User's Guide to Vacuum Technology, Jhon Willey and sons, 2006

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
Ibrahimbagh, Hyderabad-500 031, Telangana State
DEPARTMENT OF PHYSICS
Open elective Course
FUNDAMENTALS OF NANO MATERIALS AND THEIR APPLICATIONS

L : T : P	Credits	CIE		SEE		Course Code
		Marks	Exam Duration	Marks	Exam Duration	
03 :0 :0	03	40	90 min	60	3hours	U20OE610PH

Course objectives	Course outcomes
Students will be able to learn	**At the end of the course students will be**
1. Learn bulk, thin and nano structures 2. Acquire knowledge on properties of nano materials 3. Appreciate fabrication techniques of nano materials 4. Learn nanomaterial characterization techniques. 5. Appreciate application of nano materials	1. Distinguish bulk, thin and nano materials from the point of view of size effects 2. List various properties of nano materials 3. Narrate various nanonmaterial preparation techniques 4. Describe necessary characterization techniques of nano materials 5. Write various applications of CNTS and nano structures.

UNIT-I: INTRODUCTION TO NANOSCIENCE
Distinction between bulk, thin and nano materials-surface to volume ratio, change of electronic structure, density of states of thin and nano materials, quantum confinement-quantum size effect-Reduction of dimensionality, Quantum wells (two dimensional),Quantum wires (one dimensional), Quantum dots (zero dimensional).

UNIT-II: PROPERTIES OF NANO MATERIALS
Material behavior at reduced dimensions, Electrical properties: conductivity, surface scattering, ballistic transport Magnetic properties: Soft magnetic Nano-crystalline alloy, Permanent magnetic Nano-crystalline materials, Giant Magnetic Resonance, chemical properties, optical properties and thermal properties.

UNIT-III: NANOMATERIALS PREPARATION TECHNIQUES
Bottom-up and Top-down approaches. Preparation techniques Bottom-up methods: Physical Vapor Deposition, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Solgel method ,Self assembly, top-down methods: ball milling, Nano-lithography, Spark plasma sintering.

UNIT-IV: NANO MATERIAL CHARACTERIZATION TECHNIQUES
Characterization techniques: X-Ray Diffraction (XRD), working principles of Scanning Electron Microscopy (SEM), working of Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscope (STM), Field Ion Microscope (FEM).

UNIT-V: CARBON NANO MATERIALS AND APPLICATIONS
Graphene, Elementary ideas on Carbon nanotubes, CNTs, types of CNTs-single wall (SWCNT) and multiwall carbon nanotubes (MWCNT), properties and characteristics of SWCNTS and MWCNTS. Applications of nano materials in Cosmetic sector, Food, Agricultural, engineering, automotive Industry, environment, medical applications, Textiles, Paints, Energy, space Applications, nanosensors and nanocatalysts.

Learning Resources:

1. B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, Text Book of Nano Science and Nano Technology –University Press (India) 2013
2. K.K. Chattopadhyay and A.N. Benerjee, Introduction to Nanoscience and Nanotechnology , PHI, 2019