Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat
Department of Physics
B.Tech. (Engineering Physics)

Fourth Year of Four Years B.Tech. (Engineering Physics)

Sr. No.	Subject	Code	Scheme L-T-P	Credits (Min.)	Notional hours of Learning (Approx.)
	Seventh Semester (4th year of UG)				
1	Microprocessor and Microcontrollers	EP401	3-0-2	4	85
2	Elective #6	EP4AA	3-1-0	4	70
3	Elective #7	EP4BB	3-X-X	4	70/85
4	Elective #8	EP4CC	3-1-0	4	70
5	Elective #9	EP4DD	3-1-0	4	70
			Total	**20**	**365/380**
6	Minor / Honor (M/H#4)	EP4EE	3-1-0	4	70
7	Minor / Honor (M/H#5) Mini Project	EP4FF	0-0-4	2	70
8	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	EPV07 / EPP07	0-0-10	5	200 (20 x 10)
	Eighth Semester (4th year of UG)				
1	Industrial Internship / Professional Experience (Mandatory)	EP402	0-0-40	20	800 (20 x 40)
			Total	**20**	**800**

Sr. No.	Electives	Code	Scheme L-T-P
	Elective #6 (7th semester)		
1	Astrophysics and Space Science	EP451	3-1-0
2	Advanced Quantum Computation	EP453	3-1-0
3	Electromagnetic Communication	EP455	3-1-0
	Elective #7 (7th semester)		
1	Characterization Techniques	EP457	3-0-2
2	Materials Science and Engineering	EP459	3-1-0
	Elective #8 (7th semester)		
1	Advanced Condensed Matter Physics	EP461	3-1-0
2	General Theory of Relativity	EP463	3-1-0
3	Research Methodology	EP465	3-1-0
	Elective #9 (7th semester)		
1	Nanoscience and Nanotechnology	EP467	3-1-0
2	Laser Technology and Applications	EP469	3-1-0

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24.04.2025

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Third Year of Four Years of B.Tech. (Engineering Physics) B.Tech.- IV, Semester - VII MICROPROCESSOR AND MICROCONTROLLERS EP401	Scheme	L	T	P	Credit
		3	0	2	4

1.	Course Outcomes (COs): At the end of the course, the students will be able to
CO1	To remember components of microprocessors & microcontrollers.
CO2	To understand concept of memory mapping.
CO3	To model microprocessors and microcontrollers using assembly level language.
CO4	To make use of microprocessors and microcontrollers to various devices.
CO5	To design and construct microcontroller-based automatic systems.

2.	Syllabus	
	REVIEW OF DIGITAL LOGIC CONCEPTS	**(04 Hours)**
	Number systems, gates & De-Morgan's equivalents, 3-state logic gates, flip-flops, buffers, decoders, encoders, multiplexers, de-multiplexers.	
	INTRODUCTION TO MICROPROCESSOR SYSTEM	**(04 Hours)**
	Introduction, Registers, concept of address and data buses, system control signals, basic bus timing, memory (RAM, ROM), input output devices, Microcomputer systems, over view of 8-16-32 bit microprocessors family.	
	8085A MICROPROCESSOR ARCHITECTURE	**(08 Hours)**
	Introduction to 8085A, pin diagram and pin description, bus timing and instruction timing, de-multiplexing of buses, generation of control signals, concept of interrupts.	
	MEMORY INTERFACING WITH 8085A	**(06 Hours)**
	Different types of memory, memory map, address decoding scheme for different memory, memory timings.	
	INPUT OUTPUT DEVICES INTERFACING WITH 8085A	**(08 Hours)**
	Basic interfacing concepts, peripheral I/O interfacing and memory mapped I/O interfacing, interfacing of 7 segment LED display, keys, relays, interfacing of programmable devices like 8255, 8254.	
	THE 8051 MICROCONTROLLER ARCHITECTURE	**(06 Hours)**
	Introduction, 8051 family microcontrollers, hardware architecture, input/output pins, I/O ports and circuits, on chip ram, general purpose registers, special function registers, timers-counters, concepts of interrupts.	
	ASSEMBLY LANGUAGE PROGRAMMING OF 8051 & APPLICATIONS	**(09 Hours)**
	Concept of IDE (assembler, compiler, linker, de-bugger), addressing modes, data move instructions, arithmetic and logical instructions, jump, loop and call instructions, concepts of subroutines, interrupt service routine, interfacing peripherals and applications	
	Practical will be based on the coverage of the above topics separately	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

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3.	**Practicals will be based on**
1.	Write a program for addition of 10 data bytes stored at given memory location. Save the results in external memory at given locations.
2.	Write an 8085 program to calculate factorial of a number.
3.	Write an 8085 program to convert BCD number to HEX and vice-versa.
4.	Write an 8085 program to count number of data bytes containing ODD, EVEN & ZERO from a set of data bytes stored from memory location C100H to C10AH
5	Write an 8085 program to count number of data bytes containing POSITIVE, NEGATIVE and ZERO from a set of data bytes stored from memory location C100H to C10AH.
6.	Write an 8085 program to generate 14 numbers from Fibonacci sequence and store them at memory location C000H onwards. Fibonacci sequence starts from 0, 1, …
7.	Write an 8085 program to arrange given numbers in Ascending & Descending orders.
8.	Write an 8085 program to count vowels from given string of data.
9.	Write a program to generate square wave of frequency 2 Hz with a duty cycle of 25% and send it as output to the LED.
10.	Write a program to dancing LED with period of shift being 1 sec.

4.	**Books Recommended**
1.	R. S. Gaonker, Microprocessor Architecture, programming and applications with 8085, 5th Ed., Prentice Hall, New Jersey, 2013.
2.	K. J. Ayala, The 8051 Microcontroller, 3rd Ed., Penram International, Boston, 2007.
3.	M. Mazidi et al., The 8051 Microcontroller and Embedded Systems, 2nd Ed., PRENTICE Hall, New Delhi, 2007.
4.	M. Slater, Microprocessor based Design, Pearson Education, New Delhi, 2016.
5.	B. Ram, Fundamentals of microprocessors and microcomputers, Dhanpat Rai Publ., New Delhi, 2018.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Fourth Year of Four Years of B. Tech. (Engineering Physics) **B. Tech. - IV, Semester - VII** **ASTROPHYSICS AND SPACE SCIENCE** **EP451**	**Scheme**	**L**	**T**	**P**	**Credit**
		3	**1**	**0**	**4**

1.	**Course Outcomes (COs):** **At the end of the course students will be able to**
CO1	Recall & understand the concepts of Astrophysics, and Space Science.
CO2	Understand how astrophysical processes are studied, understood and utilized for furthering our understanding of the universe.
CO3	Apply the concepts of space science to different problems.
CO4	Evaluate the applications to various problems related to Astrophysics and Space Sciences.
CO5	Analyse the satellite system such as GPS, Galileo, IRNSS.

2.	**Syllabus**	
	INTRODUCTION TO THE COURSE	**(04 Hours)**
	LARGE SCALE OBJECTS	**(10 Hours)**
	Astrophysical objects of interests like Galaxies, stars, their Evolution, Clusters, techniques to study these objects.	
	STELLAR OBJECTS	**(10 Hours)**
	Types of stars, their properties. Evolution of stellar objects. The Sun, the standard model. Quiescent Sun, Disturbed sun.	
	SOLAR TERRESTRIAL RELATIONSHIP	**(10 Hours)**
	The quiet and disturbed solar features and their impact on space weather. Magnetosphere, Ionosphere, atmosphere.	
	RADIO WAVE PROPAGATION THROUGH IONOSPHERE	**(06 Hours)**
	Refraction, effect of the ionosphere on wave propagation. Quiet ionosphere, disturbed ionosphere. The effects on technological systems.	
	ADVANCED TOPICS OF RELEVANCE	**(05 Hours)**
	Global Navigational Satellite System like GPS, Galileo, IRNSS.	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**Tutorials will be based on**
1.	first unit on Introduction to the Course.
2.	to understand the large-scale objects such as galaxies, stars etc.
3.	techniques to study such large size objects.
4.	various types of stars and their properties.
5.	quiescent sun and disturbed sun.
6.	standard model to understand the stellar objects.
7.	solar terrestrial relationship.
8.	radio wave and its propagation through the ionosphere etc.
9.	the effects on technological systems.
10.	GPS, Galileo, IRNSS.

4.	**Books Recommended**
1.	Ratcliff, J. A., Introduction to ionosphere & Magnetosphere, Cambridge Univ. Press., Cambridge, 1975.
2.	Hargreaves, J. K., The Solar Terrestrial Environment, Cambridge Univ. Press, Cambridge, 2010.
3.	Kievelson, M. J. et al., Introduction to Space Physics Cambridge Univ. Press, Cambridge, 2019.
4.	Lang, K. R. Sun, Earth and Sky, Springer, New York, 2006.
5.	Basu Baidyabath, T. Chattopadhyay and S. N. Biswas, An Introduction to Astrophysics, PHI Learning Pvt. Ltd., New Delhi, 2018.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Fourth Year of Four Years of B.Tech. (Engineering Physics) B.Tech. - IV, Semester - VII ADVANCED QUANTUM COMPUTATION EP453	Scheme	L	T	P	Credit
		3	1	0	4

PREREQUISITE: ADVANCED QUANTUM MECHANICS (EP251)

1.	**Course Outcomes (COs):** **At the end of the course, the students will be able to**
CO1	Understand quantum communication protocols, QML techniques and programming quantum hardware via pulse programming routines.
CO2	Explain different noise models like bit-flip, phase-flip, etc., and apply QML techniques like VQC, QSVM and quantum clustering.
CO3	Solve quadratic unconstrained binary optimization (QUBO) problems on IBMQ.
CO4	Apply a basic QEC code on IBM Qiskit, and transpile quantum circuits on IBM Q and understand the use of Qiskit runtime.
CO5	Correlate error mitigation while programming NISQ hardware like IBM Q.

2.	**Syllabus**	
	QUANTUM COMMUNICATION PROTOCOLS	**(05 Hours)**
	Introduction to quantum communication protocols: Quantum teleportation and Super-dense coding.	
	VARIATIONAL QUANTUM ALGORITHMS	**(04 Hours)**
	Variational quantum algorithms, Variational quantum eigensolver (VQE).	
	QUANTUM MACHINE LEARNING: THEORY AND APPLICATIONS TO FINANCE	**(08 Hours)**
	Introduction to classical machine learning, Quantum Machine Learning (QML) techniques, Variational Quantum Classifier (VQC), Quantum Support Vector Machines (QSVM).	
	SOLVING OPTIMIZATION PROBLEMS ON A QUANTUM COMPUTER	**(08 Hours)**
	Introduction to Quantum Integer Programming (QuIP) technique, Solving optimization problems on quantum devices, e.g., quadratic unconstrained binary optimization (QUBO) problems on IBMQ and quantum annealers like D Wave.	
	NOISE IN QUANTUM SYSTEMS AND QUANTUM ERROR CORRECTION	**(05 Hours)**
	Theory of noise in quantum devices, bit-flip, phase-flip, depolarizing and T1/T2 processes, Quantum error correction.	
	ERROR MITIGATION FOR NISQ DEVICES	**(05 Hours)**
	Introduction to error mitigation techniques, Zero Noise Interpolation and Probabilistic Error Cancellation.	
	QISKIT RUNTIME AND TRANSPLING	**(05 Hours)**
	Quantum software techniques, Qiskit Runtime, Transpiling on IBM Q.	

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	INTRODUCTION TO PULSE PROGRAMMING	**(05 Hours)**
	Introduction to Pulse Programming, Simple examples.	
	Tutorials will be based on the coverage of the above topics separately.	**(15 Hours)**
		(Total Contact Time: 45 Hours + 15 Hours= 60 Hours)

3.	**Tutorials will be based on**
1	quantum teleportation and Super-dense coding.
2	variational quantum eigensolver (VQE).
3	quantum Machine Learning (QML) techniques.
4	quantum Integer Programming (QuIP) technique.
5	Solving optimization problems on quantum devices.
6	bit-flip, phase-flip, depolarizing and T1/T2 processes.
7	quantum error correction.
8	error mitigation techniques.
9	Qiskit Runtime, Transpiling on IBM Q.
10	pulse Programming.

4.	**Books Recommended**
1	M. A. Nielsen and I. L. Chuang, Quantum Computation and Information, Cambridge Univ. Press, Cambridge, 2012.
2	A. Pathak, Elements of Quantum Computation and Quantum Communication, CRC Press, Boca Raton, 2015.
3	R. Manenti and M. Motta, Quantum Information Science, Oxford Univ. Press, Oxford, 2023.
4	F. Gaitan, Quantum Error Correction and Fault Tolerant Quantum Computing, CRC Press Inc., Boca Raton, 2008.
5	E. F. Combarro, S. G. Castillo and A. D. Meglio, A Practical Guide to Quantum Machine Learning and Quantum Optimization: Hands-on Approach to Modern Quantum Algorithms, Packt Publishing, Birmingham, 2023.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Fourth Year of Four Years of B.Tech. (Engineering Physics) B.Tech. - IV, Semester - VII ELECTROMAGNETIC COMMUNICATIONS PH455	Scheme	L	T	P	Credit
		3	1	0	4

1.	Course Outcomes (COs): At the end of the course students will be able to
CO1	Understand the characteristics of transmission lines and cables.
CO2	Classify the electromagnetic waves in bounded and unbounded mediums, especially focused on microwave and wave guides.
CO3	Extensive summary of propagation properties of radio waves.
CO4	Discuss the fundamental concepts of antenna and its applications.
CO5	Examine the key factors associated with the satellite communications.

2.	Syllabus	
	TRANSMISSION LINES AND CABLES	**(10 Hours)**
	Primary Line Constants, Phase Velocity and Line Wavelength, Characteristic Impedance, Propagation Coefficient, Phase and Group Velocities, Standing Waves, Lossless Lines at Radio Frequencies, Voltage Standing-wave Ratio, Slotted-line Measurements at Radio Frequencies, Transmission Lines as Circuit Elements, Smith Chart, Time-domain Reflectometry, Telephone Lines and Cables, Radio-frequency Lines, Microstrip Transmission Lines, Use of Mathcad in Transmission Line Calculations.	
	INTRODUCTION TO MICROWAVE THEORY AND WAVE GUIDES	**(10 Hours)**
	Electromagnetic wave equation, Microwave, microwave frequency bands, Categories of microwave systems, Applications, Introduction to Wave guides, Rectangular Wave guides, Other Modes.	
	RADIO-WAVE PROPAGATION	**(08 Hours)**
	Propagation in Free Space, Troposphere Propagation, Ionosphere Propagation, Surface Wave, Low Frequency Propagation and Very Low Frequency Propagation, Extremely Low-frequency Propagation, Summary of Radio-wave Propagation.	
	ANTENNAS	**(10 Hours)**
	Antenna Equivalent Circuits, Coordinate System, Radiation Fields, Polarization, Isotropic Radiator, Power Gain of an Antenna, Effective Area of an Antenna, Effective Length of an Antenna, Hertzian Dipole, Half-wave Dipole, Vertical Antennas, Folded Elements, Loop and Ferrite-rod Receiving Antennas, Nonresonant Antennas, Driven Arrays, Parasitic Arrays, VHF-UHF Antennas, Microwave Antennas.	

	SATELLITE COMMUNICATIONS	**(07 Hours)**
	Telephone Systems, Wire Telephony, Public Telephone Network, Problems Facsimile And Television, Facsimile Transmission, Television, Television Signal, Problems, Introduction, Kepler's First Law, Kepler's Second Law, Kepler's Third Law, Orbits, Geostationary Orbit, Power Systems, Attitude Control, Satellite Station Keeping, Antenna Look Angles, Limits of Visibility, Frequency Plans and Polarization, Transponders, Uplink Power Budget Calculations, Down link, Power Budget Calculations, Overall Link Budget Calculations, Digital Carrier.	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**Tutorials will be based on**
1.	Primary line constants, propagation coefficient, phase and group velocities etc.
2.	Smith chart.
3.	Electromagnetic waves and microwaves.
4.	Rectangular wave guides and other various aspects involved in wave guides.
5.	Radio wave propagation in free space, troposphere and ionosphere.
6.	Surface wave.
7.	Design of antenna.
8.	Radiation fields from various kind of antenna.
9.	Non-resonant antennas, receiving antennas.
10.	Satellite communications.

4.	**Books Recommended**
1.	D. Roddy, and J. Coolen, Electronic Communications, Prentice-hall of India Pvt Ltd., New Delhi, India, 2008.
2.	R. Blake, Electronic Communication Systems, Delmar Thomson Learning, New York, 2008.
3.	K. George, and D. Bernard, Electronic Communication Systems, Tata McGraw Hill Education Private Limited, New Delhi, 2009.
4.	H. Simon, Communication Systems, John Wiley & Sons, New York, 2007.
5.	H. Taub and D. L. Schilling, Principles of Communication Systems, McGraw Hill Education, New Delhi, 2017.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Fourth Year of Four Years of B.Tech. (Engineering Physics) **B.Tech. IV, Semester-VII** **CHARACTERIZATION TECHNIQUES** **EP457**	**Scheme**	**L**	**T**	**P**	**Credit**
		3	**0**	**2**	**4**

1.	**Course Outcomes (COs):** **At the end of the course, the students will be able to**
CO1	Recall preliminary concepts of the material's structure and various characterization techniques such as X-ray diffraction, Scanning electron microscopy, Transmission electron microscopy and other magnetic, electrical and thermal measurement techniques for the structure-property relationship of materials.
CO2	Outline different sophisticated characterization tools and explain basic knowledge about working principles.
CO3	Identify characterization tools necessary for measurement or analysis and solve related problems based on concepts used in various techniques.
CO4	Examine the material's properties and analyze the results using specific techniques related to the material's perspective.
CO5	Compile acquired parameters to recommend materials for optimization purposes.

	Syllabus	
	STRUCTURAL ANALYSIS BY X-RAYS	**08 Hours**
	X-rays and their properties, Safety precautions, generation of X-rays, characteristic X-ray spectrum, Moseley's law, methods to remove K_β radiation, X-ray interaction with matter, X-ray Diffraction, Bragg's Law, basic powder diffraction, factors affecting the intensity of diffraction peaks, diffraction analysis for cubic lattices, phase identification, Indexing patterns, Scherrer formula, grain size, particle size, crystal perfection, and micro/macro strains, X-ray reflectivity.	
	MICROSTRUCTURAL OBSERVATION	**07 Hours**
	Advantages/disadvantages as compared to Optical Microscopy and other imaging techniques, scanning electron microscopy and image formation, modes of operation, microanalysis using WDS and EDS, Applications of SEM, qualitative and quantitative analysis, Composition analysis by EDX, Electron diffraction, Transmission electron microscopy imaging, analysis of SAED patterns, lattice imaging, TEM sample preparation.	
	MOLECULAR SPECTROSCOPY STRUCTURE DETERMINATION	**06 Hours**
	Microwave and Infrared Spectroscopy, Fourier transform IR, Raman spectroscopy.	
	ELECTRON SPECTROSCOPY FOR SURFACE ANALYSIS	**07 Hours**
	X-ray Photoelectron spectroscopy, Auger electron spectroscopy, photoelectron spectra, Auger electron spectra peak shifts, information about chemical state and elemental compositions, X-ray absorption, peak identification, chemical shift, Qualitative and quantitative analysis.	
	SCANNING PROBE MICROSCOPY FOR SURFACE MORPHOLOGY	**08 Hours**
	Atomic Force Microscopy (contact & non-contact mode), broad areas of applications, AFM basics, Scanning Tunnelling Microscopy, Magnetic Force Microscopy.	

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	THERMAL CHARACTERIZATION	**04 Hours**
	Nomenclature, Importance of thermal characterization techniques, Thermo-gravimetric analysis, Differential thermal analysis, Differential scanning calorimetry – working principle, differences and applications.	
	ELECTRICAL AND MAGNETIC CHARACTERIZATION	**05 Hours**
	2-probe and 4-probe techniques, Van der Pauw method, Sheet resistance, Hall measurement, Magnetoresistance, Vibrating Sample Magnetometer, SQUID, Dielectric measurement, Impedance analyzer.	
	Practical will be based on the coverage of the above topics separately	**(30 Hours)**
	(Total Contact Time: 45 Hours + 30 Hours = 75 Hours)	

3.	**Practicals will be based on**
1.	Structural determination by X-ray diffraction.
2.	Refinement of structural parameters obtained by XRD.
3.	Determination of optical band gap of prepared given samples by UV-Vis spectroscopy.
4.	Analysis of various bonding in given samples by Infrared spectroscopy.
5.	Measurement of magnetic properties of a given magnetic material.
6.	Analysis of thermal properties of a given sample.
7.	Electrical resistivity of a resistive material as a function of temperature using the DC four-probe method.
8.	To study the temperature dependence of the Hall coefficient of semiconducting materials.
9.	Frequency-dependent Dielectric measurements of given samples and their analysis.
10.	Study of magnetoresistance of a semiconductor material.

4.	**Books Recommended**
1.	Cullity B. D., Stock S. R., Elements of X-Ray Diffraction, 3rd Edition, Pearson, New York, 2014.
2.	Kaufmann E. N., Characterization of Materials, (Vol. 1-3) John Wiley & Sons Inc, New Jersey, 2012.
3.	Banwell C. N., McCash E. M., Fundamentals of Molecular Spectroscopy, 4th Edition, McGraw Hill Education, London, 2017.
4.	Williams D. B., Carter C. B., Introduction to Transmission Electron Microscope, 2nd Edition, Springer, New York, 2009.
5.	Zhang S., Li L., Kumar A., Materials Characterization Techniques, CRC Press, New York, 2008.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Third Year of Four Years of B.Tech. (Engineering Physics) **B.Tech.- IV, Semester - VII** **MATERIALS SCIENCE AND ENGINEERING** **EP459**	**Scheme**	**L**	**T**	**P**	**Credit**
		3	**1**	**0**	**4**

1.	**Course Outcomes (COs):** **At the end of the course, the students will be able to**
CO1	Recall a variety of engineering materials for their applications in contemporary devices.
CO2	Understand various methods involved in crystal growth techniques.
CO3	Understand dielectric, optical, magnetic, superconducting, and thermoelectric properties.
CO4	Categorize advance materials, polymers, ceramics and composites.
CO5	Appling properties of materials for various application aspects.

2.	**Syllabus**	
	INTRODUCTION TO MATERIALS SCIENCE	**(05 Hours)**
	Equilibrium and Kinetics, Structure of Solids, Crystal Imperfections, Nucleation, Crystal Growth Mechanisms, Defects in Crystals, Dislocations.	
	PHASE DIAGRAMS AND CRYSTAL GROWTH	**(12 Hours)**
	Gibbs's Free Energy, Chemical Potential, Phase Transformations, Gibb's phase rule, one-component and two-component phase diagrams, properties of phases in materials, iron-carbon alloy, Phase deformation in materials, Growth from the Solid Phase and melts, Diffusion in Solids, Elastic, Anelastic and Viscoelastic Behaviour, Plastic Deformation and Creep, Fracture.	
	GROWTH TECHNIQUES	**(08 Hours)**
	Crystal Growth from Melt, Solution, Vapour, Hydrothermal synthesis, Epitaxial Techniques, Liquid Phase Epitaxy, Vapour Phase Epitaxy, Metal-Organic Chemical Vapour Deposition, Molecular Beam Epitaxy, Atomic Layer Epitaxy.	
	MATERIAL PROPERTIES	**(17 Hours)**
	Dielectric Materials: Polarization mechanism, Temperature and Frequency Effects, Dielectric loss, Electric Breakdown, Spontaneous polarization, Ferroelectrics, Piezoelectric effect. Magnetic Materials: Concept of magnetism, Classification of magnetic materials, their properties and Applications, Hysteresis, magnetic storage. Optical Materials: light interactions with solids and optical properties of nonmetals, Beer-Lambert law, transmission, and photoconductivity, relation between refractive index and dielectric constant, Optical absorption, Introduction to Photonic band gap materials and its applications. Thermoelectric Materials: Thermoelectric (TE) effects and coefficients (Seebeck, Peltier, Thompson); TE materials and devices, Heat conduction, Cooling, Figure of Merit; TE power generation (efficiency), refrigeration. Superconducting Materials: Meissner effect, critical field, type-I and type-II superconductors, Field penetration and London equation, BCS Theory, High-temperature Superconductors. Advanced Materials: Smart Materials, Quantum Dots, Spintronics	

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	Polymers, Ceramics and composite Materials: Classification and applications.	
	ENGINEERING DESIGN PARAMETERS FOR SELECTION OF MATERIALS:	**(03 Hours)**
	Environmental aspects, Industrial aspects and medical aspects.	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**Tutorials will be based on**
1.	Atomic bonding
2.	Phase equilibrium, phase diagram
3.	Stress and Strain
4.	Growth Techniques
5.	Nucleation and growth of nuclei
6.	Crystal growth, defects in crystals, dislocations
7.	Material's properties: dielectric, magnetic, optical, thermoelectric and superconducting
8.	Ceramics, Polymers, and Composites
9.	Advance Materials
10.	Engineering design parameters

4.	**Books recommended**
1.	Callister W. D. Jr., Rethwisch D. G., Material Science and Engineering: An Introduction, 10th Edition, Wiley, New Jersey, 2020.
2.	Raghavan V., Materials Science and Engineering: A First Course, 6th Edition, PHI, New Delhi, 2015.
3.	Smith W. F., Hashemi J., Presuel-Moreno F., Foundations of Materials Science and Engineering, 6th Edition, McGraw Hill Education, New Delhi, 2022.
4.	Shackelford J. F., Introduction to Materials Science for Engineers, 8th Edition, Pearson, England, 2016.
5.	Bhat H. L., Introduction to Crystal Growth-Principles and Practice, CRC Press, New York, 2015.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

	Scheme	L	T	P	Credit
Fourth Year of Four Years of B.Tech. (Engineering Physics) **B.Tech. IV, Semester-VII** **ADVANCED CONDENSED MATTER PHYSICS** **EP461**		**3**	**1**	**0**	**4**

1.	**Course Outcomes (COs):** **At the end of the course, the students will be able to**
CO1	Recall the significance and value of condensed matter physics, both scientifically and in the wider community.
CO2	Interpret the electron transport and lattice vibration.
CO3	Explain the temperature dependence of electrical and thermal conductivities.
CO4	Apply the knowledge of magnetism and superconductivity towards their applications.
CO5	Examine the problem and make inference out of that.

2.	**Syllabus**	
	CRYSTALLINE SOLIDS	**09 Hours**
	Principles of condensed matter physics, Symmetry in perfect solids, Space groups, diffraction of waves in periodic structures.	
	LATTICE VIBRATION	**09 Hours**
	Vibrations of crystal lattices, phonons and Debye theory of specific heats, Lattice vibration, thermal expansion and Phonon thermal conductivity.	
	THE FREE ELECTRON THEORY	**09 Hours**
	Free electron theory, Band structure of solids, effective mass, electrons and holes, electrical conductivity, Hall effect and cyclotron resonance, carrier lifetime.	
	DIELECTRICS	**05 Hours**
	Dielectric solids, polarizability, susceptibility, Dispersion and absorption of electromagnetic waves, Different types of polarizabilities.	
	MAGNETISM	**05 Hours**
	Dia-, Para-, and Ferromagnetism in solids, exchange interactions, magnetic ordering, spin waves, Band magnetism.	
	SUPERCONDUCTIVITY	**04 Hours**
	Superconductors, Ginzburg- Landau theory and BCS theory, Josephson tunnelling, High-temperature superconductors.	
	NON-CRYSTALLINE SOLIDS	**04 Hours**
	Scaling theory and weak localization, defects in solids, point defects and dislocations.	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

Subject Code: ##nXX; ##: Department Identity, n: Year, XX: Subject Sequence number XX: last digit 0 (subject offered in both ODD and EVEN semesters, XX: 01 to 30 – last digit ODD and EVEN for ODD and EVEN semesters (Mandatory Core), XX: 31 to 50 (Optional Core), XX: 51 to 99 (Elective), Subjects list for Minor and Honor (M/H#1-4), Subjects list for Specialization track (#1-4) EG: Engineering Subject, SC: Science Subject (offered combinedly by departments) (SVNIT Surat)

3.	**Tutorials will be based on**
1.	Symmetry in perfect solids.
2.	Diffraction from crystalline materials.
3.	Free electron theory of metals.
4.	Electrical conductivity of metals.
5.	Thermal conductivity of metals.
6.	Thermal conductivity (Phonon part) of metals.
7.	Dielectric materials.
8.	Magnetism and Magnetic materials.
9.	Superconductors.
10.	Defects and Dislocations in Crystals.

4.	**Books Recommended**
1.	Marder M.P., Condensed Matter Physics, 2nd Edition, John Wiley & Sons Inc, New Jersey, 2011.
2.	Basu S., Condensed Matter Physics: A Modern Perspective, IOP Publishing, Bristol, UK, 2022.
3.	Blundell S., Magnetism in Condensed Matter, 1st Edition, Oxford University Press, Oxford, 2001.
4.	Girvin S. M., Yang K., Modern Condensed Matter Physics, 1st Edition, Cambridge University Press, Cambridge, 2019.
5.	Kittel C., Kittel's Introduction to Solid State Physics, Wiley India Edition, India, 2019.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Fourth Year of Four Years of B.Tech. (Engineering Physics) B.Tech. IV, Semester-VII GENERAL THEORY OF RELATIVITY EP463	Scheme	L	T	P	Credit
		3	1	0	4

1.	**Course Outcomes (COs):** **At the end of the course, the students will be able to**
CO1	Define the geodesics, killing vectors, principle of equivalence and Cosmological principle
CO2	Understand the Schwarzschild exterior solution and event horizon.
CO3	Derive the Einstein field equations and Oppenheimer - Volkoff equation.
CO4	Explain the linearized filed equations and gravitational waves.
CO5	Apply the cosmological principle and hydrodynamics approximation to study the universe.

2.	**Syllabus**	
	MATHEMATICAL BACKGROUND AND FIELD EQUATIONS	**(12 Hours)**
	Vectors and Tensors, parallel transport, covariant differentiation, Geodesics, Riemann-Christoffel curvature tensor - its symmetry properties, Ricci tensor, Bianchi identities, vanishing of the curvature tensor as a condition for flatness, Geodesic deviation equation, Principle of general covariance and principle of equivalence, Einstein field equations, derivation from a variational principle.	
	SCHWARZSCHILD SOLUTION AND BLACK HOLES	**(12 Hours)**
	Schwarzschild exterior solution, Birkhoff's theorem, Geodesics in a Schwarzschild geometry, Crucial tests of general relativity - perihelion shift, bending of light, gravitational redshift, Schwarzschild blackhole - event horizon and static limit, Kruskal - Szekere's diagram, Maxwell's equations in general relativity, Reissner - Nordstrom solutions - charged blackhole, Kerr - Newman solutions, Kerr - Newman blackholes, Ergosphere, Penrose process and extraction of energy from a blackhole.	
	SPHERICAL STAR AND WEAK FIELD	**(11 Hours)**
	Interior solutions for a spherical star, Oppenheimer - Volkoff equation, Chandrasekhar limit and white dwarfs, Oppenheimer - Volkoff limit and neutron stars, pulsars, Oppenheimer - Snydder non-static dust model - gravitational collapse, Linearized filed equations and gravitational waves, Lie derivatives, spacetime symmetries, Killing vectors.	
	COSMOLOGY	**(10 Hours)**
	Cosmological principle, Hydrodynamics approximation and general relativity, Robertson-Walker metric, Red shift, Hubble's observations, Friedman models, cosmological parameters, age of the Universe, cosmological horizons, models with lambda - term.	
	Tutorials will be based on the coverage of the above topics separately.	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours= 60 Hours)	

Subject Code:##nXX; ##: Department Identity, n: Year, XX: Subject Sequence number XX: last digit 0 (subject offered in both ODD and EVEN semesters, XX: 01 to 30 – last digit ODD and EVEN for ODD and EVEN semesters (Mandatory Core), XX: 31 to 50 (Optional Core), XX: 51 to 99 (Elective), Subjects list for Minor and Honor (M/H#1-4), Subjects list for Specialization track (#1-4)EG: Engineering Subject, SC: Science Subject (offered combinedly by departments) (SVNIT Surat)

3.	**Tutorials will be based on**
1	Geodesic and Ricci tensor.
2	Einstein field equations.
3	Gravitational redshift.
4	Schwarzschild and Kerr-Newman blackhole.
5	Chandrasekhar and Oppenheimer - Volkoff limit.
6	Linearized filed equations and gravitational waves.
7	Lie derivatives, spacetime symmetries.
8	Cosmological principle and Hydrodynamics approximation.
9	Friedman models.
10	Cosmological parameters and cosmological horizons.

4.	**Books Recommended**
1.	J. Hartle, Gravity: An Introduction to Einstein's General Relativity, Cambridge University Press, Cambridge, 2021.
2.	A. Zee, Einstein Gravity in a Nutshell, Princeton University Press, New Jersey, 2013.
3.	B. Schutz, A First Course in General Relativity (2nd Edition), Cambridge University Press, Cambridge, 2009.
4.	J.V. Narlikar, Lectures on General Relativity and Cosmology, Palgrave, London, 2013.
5.	S. Weinberg, Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, Wiley, New York, 1972.
Additional Reference Books:	
1.	B. Schutz, A First Course in General Relativity, Cambridge University Press, Cambridge, 2009.
2.	C. W. Misner, K. S. Thorne, J. A. Wheeler, Gravitation, Princeton University Press, New Jersey, 1973.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Fourth Year of Four Years of B.Tech. (Engineering Physics) B.Tech. - IV, Semester - VII RESEARCH METHODOLOGY EP465	Scheme	L	T	P	Credit
		3	1	0	4

1.	Course Outcomes (COs): At the end of the course, the students will be able to
CO1	To identify and formulate a research problem for a given specialisation with good research ethics.
CO2	To perform statistical analysis of the sample data collected using various sampling techniques and statistical softwares.
CO3	To apply hypothesis testing techniques using different sampling distributions/tests.
CO4	To compile information to prepare an effective research report and paper.
CO5	To prepare and present a research poster and oral presentation effectively to the peers.

2.	Syllabus	
	FOUNDATION OF RESEARCH	**(05 Hours)**
	Meaning of research, Objectives, Motivation, Utility, Characteristics and Types. Characteristics of scientific methods, understanding the language of research: Concept, Construct, definition, Variable. Scientific Research Process. Steps of research, methods of research, research ethics, Introduction to Intellectual Property Rights (IPR).	
	PROBLEM IDENTIFICATION & FORMULATION	**(05 Hours)**
	Definition and formulating the research problem, Necessity of defining the problem, Importance of literature review in defining a problem. Literature survey: primary and secondary; web sources; critical literature review. Research question, Investigation question, Hypothesis testing, Qualities of a good hypothesis, Null hypothesis and Alternative Hypothesis.	
	RESEARCH DESIGN	**(06 Hours)**
	Concept and importance in research, features of a good research design, Exploratory Research Design: Concept, types and uses, Descriptive Research Design: Concept, types and uses. Experimental Design: Concept of independent and dependent variables. Biased and unbiased research design.	
	SAMPLING FUNDAMENTALS:	**(08 Hours)**
	Need for sampling, Steps in sampling design, Different types of sample designs, Complex random sampling designs, Important sampling distributions (of mean, proportion, t-, F-, and Chi-square distribution), Central limit theorem, Concept of standard error, Estimating population mean and proportion, Determination of sample size through confidence level, probability estimation and probability distributions.	
	MEASUREMENT, DATA, AND ANALYTICS	**(10 Hours)**
	Structured and unstructured data, Scales of measurement, Population and sample, Descriptive statistics, Data visualization. Probability and random variables, Sampling and estimation, Hypothesis testing, Analysis of variance (ANOVA), Correlation, and Regression analysis. Data Analytics: Elements of association, Clustering, and Classification. Brief introduction to various open-source/commercially available software packages, e.g., MINITAB, ORIGIN, MS Office, etc.	

	INTERPRETATION OF RESULTS, RESEARCH DOCUMENTATION AND PRESENTATION	**(06 Hours)**
	Understanding of interpretation of results, Steps of interpretation; Elements of preparing a research paper and a thesis: Abstract, Keywords, Symbols and Abbreviations, Introduction, Materials and Methods (Theoretical/Experimental), Results and Discussion, Conclusions, Citations and References/Bibliography, Table of Content (ToC), Scope of future work and Appendixes. Elements of good English writing. Ethical issues related to publishing, Plagiarism and Self-plagiarism, Plagiarism detection software's (Turnitin, etc.). Types of presentation: Poster, Oral and Invited talk.	
	STUDENTS ASSIGNMENTS, DISCUSSION AND REVIEW	**(05 Hours)**
	(a) Read, evaluate and present a good journal paper in relevant field of research; (b) Conduct literature review for a specific research topic and prepare a report with citations; (c) To write a sample research paper and thesis proposal.	
	Tutorials will be based on the coverage of the above topics separately.	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours= 60 Hours)	

3.	**Tutorials will be based on**
1	error analysis.
2	research design.
3	sampling and their types.
4	sampling distributions (of mean, proportion, t-, F-, and Chi-square distribution).
5	central limit theorem, standard error and population mean.
6	probability estimation and distribution.
7	probability and random variables.
8	hypothesis testing.
9	scales of measurement, population and sample, ANOVA.
10	correlation, variance and regression analysis.

4.	**Books Recommended**
1	C. R. Kothari and G. Garg, Research Methodology: Methods and Techniques, 4th Ed., New Age International, New Delhi, 2019.
2	D. Napolean and B. B. S. Narayanan, Research Methodology – As Theoretical Approach, Laxmi Publications, New Delhi, 2014.
3	B. L. Garg, R. Karadia, F. Agrawal and U. K. Agrawal, An Introduction to Research Methodology, RBSA Publishers, Jaipur, 2002.
4	P. R Bevington and D. K. Robinson, Data Reduction and Error Analysis for the Physical Sciences, 3rd Ed., McGraw Hill, New York, 2003.
5	H. S. Asthana and B. Bhushan, Statistics for Social Sciences (With SPSS Applications), 2nd Ed., PHI Learning, New Delhi, 2016.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Fourth Year of Four Years of B.Tech. (Engineering Physics) B.Tech. IV, Semester-VII NANOSCIENCE AND NANOTECHNOLOGY EP467	Scheme	L	T	P	Credit
		3	1	0	4

1.	**Course Outcomes (COs):** **At the end of the course, students will be able to**
CO1	Define various terminologies and developments involved with nanoscience and nanotechnology.
CO2	Classify the nanomaterials depending on the nature of dimensionalities and type of materials classes and explain the basic concepts of nanomaterials.
CO3	Apply the concepts of nanoscience to investigate the problem.
CO4	Analyze the properties of nanomaterials through suitable characterization techniques.
CO5	Interpret and determine the materials' properties.

2.	**Syllabus**	
	INTRODUCTION	**(07 Hours)**
	Development of nanoscience and nanotechnology, naturally occurring nanomaterials, Crystallinity of nanomaterials, Metallic nanostructures, Semiconductor nanostructures Magnetic nanomaterials, Chemically assisted nanostructures, Growth in 2-D nanostructures, Carbon nanomaterials.	
	PROPERTIES OF NANOMATERIALS	**(08 Hours)**
	Surface-to-volume ratio, Surface states and energy, Nanoscale oscillators, Confinement in nanostructures, Density of States and number of states of 0-, 1-, 2-, 3-dimensional systems, Change in the Band structure and gap, Energy levels, confinement energy and emission in nano.	
	NANOMATERIALS SYNTHESIS	**(10 Hours)**
	Introduction to synthesis techniques, Top-down and bottom-up approach, biological methods, Sol-gel method, Nucleation and growth, Ball Milling technique, Chemical vapor deposition, Physical Vapor deposition: Concept of Epitaxy and sputtering, Molecular Beam Epitaxy, Basics of Photolithography and its limitations, Nanolithography.	
	CHARACTERIZATION OF NANOMATERIALS	**(10 Hours)**
	X-ray diffraction technique; Microscopes and their limitations, Scanning Electron Microscopy, Transmission Electron Microscopy including high-resolution imaging; Surface Analysis techniques: AFM, SPM, STM, XPS; Vibration Spectroscopy, Particle size analyzer.	
	APPLICATION OF NANOMATERIALS	**(10 Hours)**
	Nanoelectronics, Nanobiotechnology, Catalysis by nanoparticles, Quantum dot devices, Quantum well devices, High-T_c Superconductors (of nanoscale), Nanomaterials for memory application, CNT-based devices, MEMS and NEMS.	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**

Subject Code:##nXX; ##: Department Identity, n: Year, XX: Subject Sequence number XX: last digit 0 (subject offered in both ODD and EVEN semesters, XX: 01 to 30 – last digit ODD and EVEN for ODD and EVEN semesters (Mandatory Core), XX: 31 to 50 (Optional Core), XX: 51 to 99 (Elective), Subjects list for Minor and Honor (M/H#1-4), Subjects list for Specialization track (#1-4)EG: Engineering Subject, SC: Science Subject (offered combinedly by departments) (SVNIT Surat)

	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)

3.	**Tutorials will be based on**
1.	Why do nano-materials have drastic changes compared to bulk size?
2.	Surface-effect
3.	Atomic bonding
4.	Why do plants & fruits have different colours?
5.	The density of states and Fermi energy
6.	Nanoclusters
7.	Water purification
8.	Functional Nanomaterials
9.	Recent advancement and future of the nanotechnology
10.	Structure visualization by Xcrysden or VESTA

4.	**Books Recommended**
1.	Fulekar M.H., Nanotechnology: Importance and Application, IK International, New Delhi, 2010.
2.	Cao G., Wang Y., Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, World Scientific, Singapore, 2011.
3.	Springer Handbook of Nanotechnology, Edited by B. Bhushan, 4th Edition, Springer Verlag, Berlin, 2017.
4.	T. Pradeep. Textbook of Nanoscience and Nanotechnology, McGraw Hill Education (India) Private Limited, New Delhi, 2012.
5.	Kulkarni S.K., Nanotechnology: Principles and Practices, 3rd Edition, Springer, New Delhi, 2014.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Fourth Year of Four Years of B. Tech. (Engineering Physics) B. Tech. - IV , Semester - VII LASER TECHNOLOGIES AND APPLICATIONS EP469	Scheme	L	T	P	Credit
		3	1	0	4

1.	Course Outcomes (COs): At the end of the course, students will be able to
CO1	Determine optical gain in media and threshold pump conditions for lasers.
CO2	Classify various laser systems.
CO3	Design resonator cavities for various laser systems.
CO4	Explain methods for laser pulse generations.
CO5	Analyse lasers for application in various spectroscopic applications.
CO6	Apply lasers in manufacturing and other applications.

2.	Syllabus	
	REVIEW OF PHYSICS OF LASERS	**(04 Hours)**
	Fundamentals of light-matter interactions, Einstein's coefficients, laser rate equations, cavity modes, laser beam-parameters and characteristics, spectral line-width, laser pumping systems: optical pumping, electrical pumping other methods of pumping, different, gain calculation, threshold condition.	
	RESONATORS	**(06 Hours)**
	Cavity resonator: time constant and quality factor of optical cavity, stability of resonators, g parameters, various types of resonators.	
	LASER SYSTEMS	**(08 Hours)**
	Various laser systems and their components: Solid state lasers: Ruby Laser and Nd: YAG laser; Gas lasers: He-Ne laser, CO2 laser and Nitrogen laser; Liquid lasers: Dye lasers; Semiconductor lasers; Free electron lasers, Class of lasers and laser Safety	
	LASER PULSE GENERATION	**(08 Hours)**
	Q-switching: theory and various methods; mode locking: methods of mode locking, efficiency of mode locking, ultrashort (nanosecond, picosecond and femtosecond) laser pulse generation.	
	APPLICATIONS IN TIME-RESOLVED SPECTROSCOPY	**(08 Hours)**
	Fluorescence lifetime, various measurement techniques- oscilloscope method, time-correlated single photon counting, Streak Camera, fluorescence up conversion, higher harmonic generation: white light continuum generation, optical parametric amplifier, pump-probe spectroscopy.	
	APPLICATIONS IN MANUFACTURING	**(06 Hours)**

	Lasers as heat source in manufacturing industries, laser beam profile management, Laser annealing, laser based drilling, welding and cutting applications, Lasers in materials processing, Laser based surface treatments, Lasers and additive manufacturing.	
	OTHER APPLICATIONS OF LASERS	**(05 Hours)**
	Application of lasers in optical communication, modulation for data transmission, optical fibre, fibre lasers; Application in Holography.	
	Tutorials will be based on the coverage of the above topics separately	**(15 Hours)**
	(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)	

3.	**Tutorials will be based on**
1.	Calculations based on optical gain in media and threshold pump conditions.
2.	Problem based on laser cavity design and modes.
3.	Modulators design problems.
4.	Laser power calculations and problems based on optical power measurements.
5.	Problems based on Q-switching and mode locking of lasers.
6.	Numerical questions based on the aspects covered in spectroscopy applications of lasers.
7.	Numerical questions based on the aspects covered in manufacturing applications of lasers.

4.	**Books Recommended**
1.	Denis Hall and P.E. Jackson, The Physics and Technology of Laser Resonators, CRC Press, Boca Raton, 2020
2.	C. Breck Hitz, James J. Ewing and Jeff Hecht, Laser Technologies, 4th Ed., Wiley-IEEE Press, New Jersey, 2012.
3.	Reinhart Poprawe (Ed.), Tailored Light 2: Laser Application Technology, Springer, New York, 2011.
4.	W. T. Silfvast, Laser Fundamentals, 2nd Ed., Cambridge University Press, Cambridge, 2004.
5.	Orazio Svelto, Principles of Lasers, 5t Ed., Springer, New York, 1998.

Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

Fourth Year of Four Years of B.Tech. (Engineering Physics) B.Tech.- IV, Semester - VIII Industrial Internship / Professional Experience EP402	Scheme	L	T	P	Credit
		0	0	40	20

In this course, students will carry out industrial / research internship and will write a project/ dissertation report which will be examined by a duly formed departmental evaluation committee.

Subject Code: ##nXX; ##: Department Identity, n: Year, XX: Subject Sequence number XX: last digit 0 (subject offered in both ODD and EVEN semesters, XX: 01 to 30 – last digit ODD and EVEN for ODD and EVEN semesters (Mandatory Core), XX: 31 to 50 (Optional Core), XX: 51 to 99 (Elective), Subjects list for Minor and Honor (M/H#1-4), Subjects list for Specialization track (#1-4) EG: Engineering Subject, SC: Science Subject (offered combinedly by departments) (SVNIT Surat)