Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Honours) Applied Physics - (Specialization in Electronics)
A Four-Years Degree Program

Eligibility: Senior Secondary Examination (10+2) or equivalent with at least 50% marks (45% for SC/ST) in aggregate with Physics as one of the main subjects.

Semester I **Contact Hours = 31**

S. No	Course Code	Course Title	Compulsory (C)/ Electives (E)	Load Allocation			Marks Distribution		Total	Credits
				L	T	P	Internal	External		
1	BSAP101C	Solid State Physics	C1	3	1	0	25	50	75	4
2	BSAP102C	Electromagnetism and Waves	C2	3	1	0	25	50	75	4
3	BSAP103C	Physics-I	C3	3	1	0	25	50	75	4
4	BSAP104C	Mathematics-I	C4	3	1	0	25	50	75	4
5	BSHU101C	English	C5	3	0	0	25	50	75	3
6	BSHU102C/ BSHU103C	Punjabi /Or Punjab History & Culture	C6	3	0	0	25	50	75	3
7	SBS101C	Introduction to Shaheed Bhagat Singh and his Co-patriots	C7	1	0	0	25	-	S/US	Non-Credit
8	BSAP105C	MATLAB Lab-I	C8	0	0	4	30	20	50	2
9	BSAP106C	Physics Lab-I	C9	0	0	4	30	20	50	2
		Total		19	4	8	235	340	575	
									Total Credits	26

Semester II **Contact Hours = 35**

S. No	Course Code	Course Title	Compulsory (C)/ Electives (E)	Load Allocation			Marks Distribution		Total	Credits
				L	T	P	Internal	External		
1	BSAP-201C	Digital Electronics	C1	3	1	0	40	60	100	4
2	BSAP-202C	Network Theory	C2	3	1	0	40	60	100	4
3	BSCE-102C	Fundamentals of Information Technology (IT)	C3	3	0	0	40	60	100	3
4	BSNM-203C	Mechanics-II	C4	3	0	0	25	50	75	3
5	BSNM-205C	Integral Calculus	C5	3	0	0	25	50	75	3
6	BSHU201C	English-II	C6	3	0	0	25	50	75	3
7	BSHU202C/ BSHU203C	Punjabi Or Punjab History & Culture	C8	3	0	0	25	50	75	3
8	BSCE-105C	Fundamentals of IT Lab	C7	0	0	4	60	40	100	2
9	BSAP-203C	Digital Electronics Lab	C9	0	0	4	60	40	100	2
10	BSNM-208C	Physics Lab-II	C10	0	0	4	30	20	50	2
		Total		21	02	12	370	480	850	
									Total Credits	29

Semester III **Contact Hours = 30**

S. No	Course Code	Course Title	Compulsory (C)/ Electives (E)	Load Allocation			Marks Distribution		Total	Credits
				L	T	P	Internal	External		
1	BSAP-301C	Microprocessors	C1	3	0	0	40	60	100	3
2	BSNM-303C	Thermal and Statistical Physics	C2	3	0	0	25	50	75	3
3	BSNM-304C	Optics and Laser	C3	3	0	0	25	50	75	3
4	BSNM-306C	Differential Equations	C4	3	0	0	25	50	75	3
5	BSCE-103C	Problem Solving using C	C5	3	1	0	40	60	100	4
6	EVS-101C	Environmental Studies	C6	2	0	0	40	60	100	2
7	BSNM-308C	Physics Lab-III	C7	0	0	4	30	20	50	2
8	BSCE-104C	Problem Solving using C Lab	C8	0	0	4	60	40	100	2
9	BSAP-302C	Microprocessors-Lab	C9	0	0	2	30	20	50	1
10	BMPD-301C	Mentoring and Professional Development	C10	0	0	2	Satisfactory/Un-satisfactory			Non-credit
		Total		17	1	12	300	400	700	23
Total Credits										23

Semester IV **Contact Hours = 29**

S. No	Course Code	Course Title	Compulsory (C)/ Electives(E)	Load Allocation			Marks Distribution		Total	Credits
				L	T	P	Internal	External		
1	BSAP-401C	Analog Circuits	C1	3	0	0	40	60	100	3
2	BSAP-402C	Microcontrollers	C2	3	0	0	40	60	100	3
3	BSAP-403C	Engineering Materials	C3	3	0	0	40	60	100	3
4	BSNM-403C	Vibration and Waves	C4	3	0	0	25	50	75	3
5	BSNM-404C	Elements of Modern Physics	C5	3	0	0	25	50	75	3
6	BSCE-203C	Object Oriented Programming Concepts using C++	C6	3	1	0	40	60	100	4
7	BSAP-404C	Analog Circuits Laboratory	C7	0	0	2	30	20	50	1
8	BSAP-405C	Microcontrollers Laboratory	C8	0	0	2	30	20	50	1
9	BSNM-408C	Physics Lab-IV	C9	0	0	4	30	20	50	2
10	BMPD-401C	Mentoring and Professional Development	C10	0	0	2	Satisfactory/Un-satisfactory			Non-credit
		Total		18	1	10	255	370	625	23
Total Credits										23

1st Semester

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester **Ist**
Subject Code **BSAP101C**
Subject Name **Solid State Physics**
Contact Hours **L: 03** **T: 01** **P: 00** **Credits: 04**

Syllabus same as approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) 2nd semester.

Course Objective

This course deals with design, basic theory, and analytical concepts of various Solid state devices like Semiconductor diodes, Transistors, FETs and their utilization in designing of different electronic circuits.

Course Outcomes

At the end of this course student will be able to:

1. Understand the basic theory of Solid state devices, materials and their properties
2. Understand the characteristics and working of different Semiconductor diodes and Transistor along with their biasing.
3. Familiar with the working and characteristics of different Rectifiers circuits
4. Understand different Fabrication processes of PCB design.
5. Understand the working of basic Electronic devices and their applications.

Units	Contents	Hours
I	**Fundamentals of Solid State Physics:** Introduction, Semiconductor materials, Metals, Insulators, Semiconductor, Passive and active electronic components, Structure of an atom, Energy bands, Crystal structure, atomic bonding, atomic packing, atomic shape and size, crystal imperfection, atomic diffusion, thermal properties of materials, electrical properties of materials, optical properties of materials, Local field and Clausius-Mossotti equation, free electron model of metals, density of states, Intrinsic semiconductors, Extrinsic semiconductors and their types. Industrial applications of semi-conductor physics.	8
II	**Semiconductor diodes**: PN junction, Junction Theory, PN Junction diode, V-I characteristics of PN-Junction diode, Ideal diode, Static and dynamic resistance of diode, Zener diode, Laser Diodes, Schotteky Diode, Light Emitting diode, Varacter diode, Tunnel diodes and their applications. Rectifiers: Half wave rectifiers, Full wave rectifiers (Centre-tap and Bridge), Efficiency calculations and comparison, Regulated Power supply design.	12
III	**Transistors:** Types, Theory of operation, different configurations and their comparison, Input and Output characteristics of different configurations, Basic CE amplifier circuit, Transistor datasheets, Thermal runaway and heat sinks, Field-effect Transistor, MOSFETs, Different transistor biasing circuits and stabilization of operating points.	12
IV	**Fabrication Processes**: Oxidation; diffusion; Ion-implantation; Annealing; Photolithography; Etching; Chemical Vapour Deposition (CVD); Sputtering; Twin-tub CMOS process. Electronic Devices: CRO, Multimeter, Signal Generator, DSO.	8

Reference Books:

1. Andre Moliton, Solid-State Physics for Electronics, Wiley, 2010
2. James Patterson, Bernard Bailey, Solid State Physics, 2nd Edition, Springer, 2012
3. N N Bhargava, D C Kulshreshtha, S C Gupta, Basic electronics & Linear Circuits, Tata McGraw- Hill Publishing Company limited, 1996.
4. B L Threja, Basic Electronics- Solid state, S Chand & Company, 2012

5. G. Streetman, and S. K. Banerjee, Solid State Electronic Devices, Pearson.
6. 2. D. Neamen, D. Biswas, Semiconductor Physics and Devices, McGraw-Hill Education

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Semester	**Ist**			
Subject Code	**BSAP102C**			
Subject Name	**Electromagnetism and Waves**			
Contact Hours	**L: 03**	**T: 01**	**P: 00**	**Credits: 04**

Syllabus same as approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) 1st semester.

Course Objective

This course deals with fundamental knowledge and background required for better understanding of Electromagnetic Waves (Light- and Acoustic-waves) and their propagation behaviour through different medium.

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Understand basic theorems and laws of Electrostatic.
2. Understand basic theorems and laws of Magnetism.
3. Understand Maxwell's equations for electromagnetic waves.
4. Understand the characteristics and propagation of light wave through vacuum and waveguides.
5. Understand the characteristics and propagation of Acoustic waves.

Units	Contents	Hours
I	**Electrostatics:** Gauss's theorem of electrostatics, Applications of Gauss theorem- Electric field due to point charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential, potential due to a point charge, Electric dipole, Measurement of Capacitance of parallel plate, spherical and cylindrical capacitor, Dielectric medium, Gauss's theorem in dielectrics.	**8**
II	**Magnetism:** Magnetic intensity, permeability, and susceptibility, Magnetic induction (self- and mutual induction), Faraday's laws of electromagnetic induction, Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current, Divergence and curl of magnetic field, Ampere's circuital law, Magnetic properties of dia-, para- and ferro-magnetic materials, Lenz's law.	**8**
III	**Light waves:** Basics of Electromagnetic Waves**,** Electromagnetic nature of light, Displacement current, Maxwell's equations, Lorentz force equation and motion of charges, Poynting vector, Energy density in electromagnetic field, Electromagnetic wave (EM) propagation through vacuum, and dielectric waveguide. Optical Fiber as dielectric medium and its types, Refractive Index, Numerical Aperture, Measurement of Numerical aperture, Measurement of power loss, Attenuation in dielectric waveguide, Dispersion of EM waves inside a dielectric waveguide, Polarization inside a dielectric waveguide, Linear and Non-linear scattering of EM waves inside a dielectric waveguide. Resonant cavities, power losses in a cavity, Earth and ionosphere as resonant cavity. **Applications:** Futuristic telecommunication, surveillance, transportation, and Medical-related industries.	**14**

IV	**Acoustic Waves:** Introduction, frequency, loudness, decibel scale, octave, music scale, Fourier series, Fourier Transformation, Equation of state, continuity, Euler's equation, Linear wave equation, speed of sound in fluids, Acoustic intensity, specific acoustic impedance, spherical waves, cylindrical waves, Waveguides, transmission from one fluid to another, reflection from solid, Transmission through thin partition- Mass law. **Applications:** Underwater acoustics, Telecommunication, and Explosives.	**10**

Reference Books:

1. Edward M. Purcell, Electricity and Magnetism, McGraw-Hill Education 1986.
2. J.H. Fewkes & J. Yarwood. Electricity and Magnetism, Oxford Univ. Press Vol. I, 1991.
3. D C Tayal, Electricity and Magnetism, Himalaya Publishing House 1988.
4. Ronald Lane Reese, University Physics, Thomson Brooks/Cole 2003.
5. D.J. Griffiths, Introduction to Electrodynamics, Benjamin Cummings 3rd Edn, 1998.
6. D. K Mynbaev, and L. L Scheiner, Fiber and Optic Communication Technology, 1st Ed., 2002, Pearson
7. Fundamentals of Acoustics, Lawrence E. Kinsler, Austin R. Frey, 4th Ed., 2000 Wiley Publishers.
8. Noise and Vibration Control, Munjal M. L., World Scientific Publishers in Collaboration with IISc Press, Singapore, 2013

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Semester **Ist**
Subject Code **BSAP103C**
Subject Name **Physics-I**
Contact Hours **L: 03** **T: 01** **P: 00** **Credits: 04**

Syllabus same as that of 'Mechanics-I' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) 1st semester.

Course Objective
This course deals with fundamental knowledge of classical physics including rotational dynamics, gravitational physics, and stress-strain theory.

Course Outcomes
At the end of this course student will demonstrate the ability to:
1. Understand basic laws of conservation of energy and its principles.
2. Understand laws of gravitational force and its industrial applications.
3. Understand fundamentals of rotational dynamics and its applications indifferent devices.
4. Understand the physics of elastic and non-elastic scattering and their utilization in spectroscopy.

Units	Contents	Hours
I	**Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non-conservative forces, Potential Energy, Energy diagram, Stable and unstable equilibrium, Elastic potential energy, Force as gradient of potential energy, Work done by non-conservative forces, Law of conservation of Energy.	6
II	**Fundamentals of Gravitation:** Newton's Law of Gravitation. Motion of a particle in a central force field, Kepler's Laws, Satellite in circular orbit and applications. Geosynchronous orbits, Inertial- and non-inertial reference frames, Galilean transformations, Galilean invariance, Momentum of variable-mass system: motion of rocket, Motion of a projectile in uniform gravitational field, Movement of Galaxy. **Applications:** Global positioning system (GPS), Satellite communication system.	12
III	**Rotational Dynamics**: Newton's Laws of Motion, Dynamics of a system of particles: Centre of Mass, Principle of conservation of momentum, Impulse, Angular Momentum about the Centre of mass, Rotational invariance, Angular momentum, Torque, Rotation about a fixed axis, Moment of Inertia and its calculation for rectangular, cylindrical and spherical bodies, Kinetic energy of rotation, Cylinder on an accelerated rough plane, Behavior of angular momentum vector, Principal axes and Euler's equations. **Applications:** Gyroscope, G-Sensor	10
IV	**Scattering and Elasticity:** Elastic- and Non-elastic scattering, Elastic and Non-elastic collision of particles of different mass and its derivations, Rutherford scattering, Hooke's law, Stress-strain diagram, Relation between elastic constants, Poisson's ratio expression in terms of elastic constants, Work done in stretching and twisting of a wire, Determination of Rigidity modulus by static torsion, Torsional pendulum, Determination of Rigidity modulus and moment of inertia. **Applications:** Elastic Scattering Spectroscopy	12

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Feynman Lectures, Vol-I, R.P Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
4. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
5. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000

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Semester **Ist**
Subject Code **BSAP104C**
Subject Name **Mathematics-I**
Contact Hours **L: 03** **T: 01** **P: 00** **Credits: 04**

Syllabus same as that of 'Differential Calculus' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) 1st semester. Copy attached as Annexure-I(a).

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Semester **Ist**
Subject Code **BSHU101C**
Subject Name **English**
Contact Hours **L: 03** **T: 00** **P: 00** **Credits: 03**

Syllabus same as approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) 1st semester. Copy attached as Annexure-I(b).

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Semester **Ist**
Subject Code **BSHU102C**
Subject Name **Punjabi**
Contact Hours **L: 03** **T: 00** **P: 00** **Credits: 03**

Syllabus same as approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) 1st semester. Copy attached as Annexure-I(c).

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Semester **Ist**
Subject Code **BSHU103C**
Subject Name **Punjab History & Culture**
Contact Hours **L: 03** **T: 00** **P: 00** **Credits: 03**

Syllabus same as approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) 1st semester. Copy attached as Annexure-I(c).

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Semester	**Ist**			
Subject Code	**BSAP105C**			
Subject Name	**MATLAB Lab-I**			
Contact Hours	**L: 00**	**T: 00**	**P: 04**	**Credits: 02**

Course Objective

This laboratory course deals with introduction of MATLAB development environment and general purpose coding skills in MATLAB.

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Understand capabilities of development environment of MATLAB
2. Experimentation in MATLAB development environment and demonstrate general purpose programming skills in MATLAB.
3. Understanding the use of signals generation, plotting and signals handling in MATLAB.
4. Understanding of integration of hardware platforms, Artificial intelligence (AI) and Machine learning (ML) toolboxes of MATLAB.

S.No.	Experiments
1.	Learning of development environment of MATLAB
2.	Learning of basic statements and writing programs of input/output in MATLAB.
3.	Generation and operations on matrices.
4.	Write the program for representing data in various types of plots and graphs.
5.	Write a MATLAB program to generate the sinusoidal signal of given frequency and amplitude.
6.	Writing the program for file handling.
7.	Writing MATLAB code to generate GUI.
8.	Write a MATLAB program to draw various types of shapes.
9.	Write a program to show the various signals in continuous time form.
10.	Write a program to show the various signals in discrete time form.
11.	Displaying and loading the image files in MATLAB
12.	Displaying and loading the video files in MATLAB
13.	Loading and playing the audio files in MATLAB
14.	Study of integrating hardware platforms for data capturing in MATLAB
15.	Study of Artificial intelligence (AI) and Machine learning (ML) libraries of MATLAB.

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Semester	**Ist**			
Subject Code	**BSAP106C**			
Subject Name	**Physics Lab-I**			
Contact Hours	**L: 00**	**T: 00**	**P: 04**	**Credits: 02**

Syllabus same as approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical)

Course Objective

The main objective of this course is to provide lab experience to carry out basic measurements of electromagnetic waves and their behaviour through lens, prism, and waveguides.

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Measure basic parameters of electromagnetic wave, i.e. Light and dielectric waveguide, i.e. Optical Fiber
2. Measure basic parameters of a material using different optical devices and methods.
3. Measure basic parameter like intensity and wavelength of laser light
4. Understand the working and uses of Sonometer.
5. Understand the working of Polarimeter for measuring specific rotation.

S.No.	Experiments
1.	To measure Numerical Aperture, Refractive index, and loss of optical signal of an Optical Fibre.
2.	To measure angular divergence of a Laser beam.
3.	To determine the number of lines per cm on a plane grating using laser.
4.	To measure focal length of Convex lens by displacement method.
5.	To determine the magnifying power of an Astronomical telescope.
6.	To determine the Refractive Index of the Material of a given Prism using Sodium Light.
7.	To determine Dispersive Power of the Material of a given Prism using Mercury Light.
8.	To determine the intensity of laser in diffraction patterns of single and double slits.
9.	To determine the wavelength of Laser light using diffraction of single and double Slits.
10.	To determine the frequency of alternating current using a sonometer and an electromagnet.
11.	To determine the Resolving Power of a Prism.
12.	To determine the Polarizability of a dielectric material.
13.	To determine Wavelength of sodium light using Newton's Rings and Fresnel Biprism.
14.	To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.
15.	To study the specific rotation of sugar using Laurent's half shade polarimeter.

2nd Semester

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Applied Physics (specialization in Electronics)

Semester **2nd**
Subject Code **BSAP-201C**
Subject Name **Digital Electronics**
Contact Hours **L: 03** **T: 01** **P: 00** **Credits: 04**

Course Outcomes:

After undergoing this course, students will be able to

1. Understand the significance and use of different number systems, weighted & non-weighted codes along with their conversions. Learn Boolean algebra& its laws.
2. Minimize Boolean expressions using different techniques: Algebraic method, K- Map Technique and QM Methods, develop basic understanding of Logic gates and universal behaviour of NAND/NOR gates.
3. Obtain knowledge of combinational circuits and design procedure of various combinational logic circuits like Adder, Sub tractor, Comparator, MUX/DEMUX, Parity checker etc. Classification of memory devices and to develop understanding about their Organization.
4. Know about different sequential circuits like Flip-flops, Counters & their types. To design counters and know about working of shift registers.
5. Know need of signal conversion, Study different types of signal convertors: ADC and DAC along with their working.

Module 1: NUMBER SYSTEMS: Binary, Octal, Decimal, Hexadecimal. Number base conversions, 1's, 2's complements, signed Binary numbers. Binary Arithmetic, Binary codes: Weighted BCD, Gray code, Excess 3 code, ASCII. LOGIC GATES: AND, OR, NOT, NAND, NOR, Exclusive-OR and Exclusive-NOR. Implementations of Logic Functions using gates, NAND-NOR implementations.

Module 2 : BOOLEAN ALGEBRA: Boolean postulates and laws – De-Morgan's Theorem, Principle of Duality, Boolean expression – Boolean function, Minimization of Boolean expressions – Sum of Products (SOP), Product of Sums (POS), Minterm, Maxterm, Canonical forms, Conversion between canonical forms, Karnaugh map Minimization, Don't care conditions, Quine-McCluskey method.

Module 3: COMBINATIONAL CIRCUITS: Design procedure – Adders, Subtractors, BCD adder, Magnitude Comparator, Multiplexer/Demultiplexer, encoder/decoder, parity checker, code converters. Implementation of combinational logic using MUX, BCD to 7 segment decoder.

Module 4: SEQUENTIAL CIRCUITS: Flip flops SR, JK, T, D and Master slave, Excitation table, Edge triggering, Level Triggering, Realization of one flip flop using other flip flops. Asynchronous/Ripple counters, Synchronous counters, Modulo-n counter, Ring Counters. Design of Synchronous counters: state diagram, Circuit implementation. Shift registers.

Module 5: MEMORY DEVICES: Classification of memories, RAM organization, Write operation, Read operation, Memory cycle. ROM organization, PROM, EPROM, EEPROM, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

Module 6: A/D & D/A CONVERTORS: Analog & Digital signals. sample and hold circuit, A/D and D/A conversion techniques (Weighted type, R-2R Ladder type, Counter Type, Dual Slope type, Successive Approximation type).

Recommended Text and Reference Books

1. Morris Mano, Digital Design, Prentice Hall of India Pvt. Ltd

2. Donald P.Leach and Albert Paul Malvino, Digital Principles and Applications, 5 ed., Tata McGraw HillPublishing CompanyLimited, New Delhi, 2003.
3. R.P.Jain, Modern Digital Electronics, 3 ed., Tata McGraw–Hill publishing company limited, New Delhi, 2003.
4. Thomas L. Floyd, Digital Fundamentals, Pearson Education, Inc, New Delhi, 2003
5. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, Digital System - Principles and Applications, PearsonEducation.
6. Ghosal, Digital Electronics, Cengage Learning.

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Semester **2nd**
Subject Code **BSAP-202C**
Subject Name **Network Theory**

Contact Hours **L: 03** **T: 01** **P: 00** **Credits: 04**

Syllabus same as approved by Board of Studies of ECE for B.Tech. (ECE) 2022

Course Outcomes

At the end of this course student will be able to:

1. Analyze linear networks using network theorems.
2. Use Laplace transform to analyze transient & steady state response of linear networks.
3. Comprehend network parameters to analyze two port networks.
4. Realize one port networks using Foster's and Cauer's methods.

Unit 1: Network Theorems

Node and mesh analysis; impedance matrix approach for networks analysis; Network theorems: superposition, reciprocity, Thevenin's, Norton's, Maximum power Transfer, compensation and Tallegen's theorem as applied to AC circuits; Trigonometric and Exponential Fourier series, Fourier Transform and continuous spectra Three phase unbalanced circuit and power calculation.

Unit 2: Transient & Steady State Analysis

Transient behavior, concept of complex frequency, Driving points, Poles and Zeros, Laplace transforms and properties: singularity functions, waveform synthesis; time domain analysis of RC, RL & RLC networks with and without initial conditions; Laplace Transforms for steady state and transient response of networks, quality factor.

Unit 3: Two Port Networks

Impedance parameters; admittance parameters; transmission parameters; hybrid parameters; inter-relationships between two port network parameters; interconnection of two port networks; T and Pi representation of two port networks; image impedance; characteristic impedance; propagation constant; filters: low pass, high pass; band pass, band stop & Butterworth filter.

Unit 4: Network Synthesis

Realizability criteria: Hurwitz polynomial, positive real functions; network realization using Foster's first and second forms; network synthesis using Cauer's first and second forms.

Recommended Books

1. Van, Valkenburg, *Network Analysis*, PHI
2. F F Kuo, *Network Analysis & Synthesis*, Wiley
3. A. Sudhakar, SP Shyammohan, *Circuits and Network*, Tata McGraw-Hill
4. A William Hayt, *Engineering Circuit Analysis*, McGraw-Hill Education

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Semester **2nd**
Subject Code **BSCE-102C**
Subject Name **Fundamentals of Information Technology**

Contact Hours **L: 03** **T: 00** **P: 00** **Credits: 03**

Syllabus same as approved by Board of Studies of ECE for B.Sc. (Computer Applications & Electronics)

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

1. Identify of input and output devices of Computers
2. Utilize the functioning of various components of the computer system
3. Define the role of the Operating system
4. Prepare documents using word processing, Spreadsheet, and Presentation Graphics Software.
5. Highlight Internet safety, legal, and other issues.

Unit-I: Human-Computer Interface: Concepts of Hardware and Software; Data and Information. Functional Units of Computer System: CPU, registers, system bus, main memory unit, cache memory, Inside a computer, SMPS, Motherboard, Ports and Interfaces, expansion cards, ribbon cables, memory chips, processors.
Devices: Input and output devices (with connections and practical demo), keyboard, mouse, joystick, scanner, OCR, OMR, bar code reader, web camera, monitor, printer, and plotter.
Memory: Primary, secondary, auxiliary memory, RAM, ROM, cache memory, hard disks, optical disks.
Data Representation: Bit, Byte, Binary, Decimal, Hexadecimal, and Octal Systems, Conversions, and Binary Arithmetic (Addition/ Subtraction/ Multiplication) Applications of IT.

Unit-II: Concept of Computing, Types of Languages: Machine, assembly and High level Language; Operating system as user interface, utility programs.
Word processing: Editing features, formatting features, saving, printing, table handling, page settings, spell-checking, macros, mail-merge, equation editors.

Unit-III: Spreadsheet: Workbook, worksheets, data types, operators, cell formats, freeze panes, editing features, formatting features, creating formulas, using formulas, cell references, replication, sorting, filtering, functions, Charts & Graphs.
Presentation Graphics Software: Templates, views, formatting slide, slides with graphs, animation, using special features, presenting slide shows.

Unit-IV: Electronic Payment System: Secure Electronic Transaction, Types of Payment System: Digital Cash, Electronic Cheque, Smart Card, Credit/Debit Card E-Money, Bit Coins and Crypto currency, Electronic Fund Transfer (EFT), Unified Payment Interface (UPI), Immediate Payment System (IMPS), Digital Signature and Certification Authority.
Introduction to Bluetooth, Cloud Computing, Big Data, Data Mining, Mobile Computing and Embedded Systems and Internet of Things (IoT)

Suggested Readings/ Books:

1. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education
2. Computer Fundamentals, A. Goel, 2010, Pearson Education.
3. Fundamentals of Computers, P. K.Sinha & P. Sinha, 2007, BPB Publishers.
4. IT Tools, R.K. Jain, Khanna Publishing House
5. "Introduction to Information Technology", Satish Jain, Ambrish Rai & Shashi Singh, Paperback Edition, BPB Publications, 2014.

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester **2nd**
Subject Code **BSNM-203C**
Subject Name **Mechanics-II**

Contact Hours **L: 03** **T: 00** **P: 00** **Credits: 03**

Syllabus same as that of 'Mechanics-II' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical)

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Understand basic laws of physics in rotating coordinate systems.
2. Understand principles and physics of oscillations and measurements of their related physical quantities.
3. Understand fundamentals of special theory of relativity and transformation theories.

Contents	Hours
Central Force Motion: Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system. inertial frames and fictitious forces. Uniformly rotating frame. Laws of physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of velocity and acceleration in cylindrical and spherical Coordinate systems.	12
Oscillations: Simple Harmonic Oscillations (SHM). Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. Hooke's law, Elastic moduli-Relation between elastic constants, Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants, Work done in stretching and work done in twisting a wire, Twisting couple on a cylinder, Determination of Rigidity modulus by static torsion, Torsional pendulum, Determination of Rigidity modulus and moment of inertia, q, η and σ by Searles method.	14
Special Theory of Relativity: Michelson-Morley Experiment. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless particles. Mass-energy equivalence. Relativistic kinematics. Transformation of energy and momentum.	14

Reference Books:

1. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
2. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
3. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
4. Feynman Lectures, vol-I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
5. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
6. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
7. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

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Semester 2nd
Subject Code BSNM-205C
Subject Name Integral Calculus

Contact Hours L: 03 T: 00 P: 00 Credits: 03

Syllabus same as that of 'Integral Calculus' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) attached as Annexure-1(a).

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Semester 2nd
Subject Code BSHU-201C
Subject Name English-II

Contact Hours L: 03 T: 00 P: 00 Credits: 03

Syllabus same as that of 'English' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) attached as Annexure-1(b).

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Semester 2nd
Subject Code BSHU-202C
Subject Name Punjabi

Contact Hours L: 03 T: 00 P: 00 Credits: 03

Syllabus same as that of 'Punjabi' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) attached as Annexure-1(c).

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Semester 2nd
Subject Code BSHU-203C
Subject Name Punjab History & Culture

Contact Hours L: 03 T: 00 P: 00 Credits: 03

Syllabus same as that of 'Punjab History & Culture' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) attached as Annexure-1(d).

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Semester **2nd**
Subject Code **BSCE-105C**
Subject Name **Fundamentals of IT Lab**

Contact Hours **L: 00** **T: 00** **P: 04** **Credits: 02**

Syllabus same as approved by Board of Studies of ECE for B.Sc. (Computer Applications & Electronics)

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

1. Highlight the features of word processing, spreadsheet and presentation tools
2. Identify the right components for its documents on editor, spread sheet and presentation software.
3. Prepare documents and apply formatting.
4. select the right tool for different requirements.
5. Apply various operations.

Word Orientation: The instructor needs to give an overview of word processor. Details of the four tasks and features that would be covered Using word – Accessing, overview of toolbars, saving files, Using help and resources, rulers, format painter.

1. Using word to create Resume Features to be covered: - Formatting Fonts in word, Drop Cap in word, Applying Text effects, Using Character Spacing, Borders and Colors, Inserting Header and Footer, Using Date and Time option in Word.
2. Creating an Assignment Features to be covered: - Formatting Styles, Inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes.
3. Creating a Newsletter Features to be covered :- Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes and Paragraphs
4. Creating a Feedback form Features to be covered :- Forms, Text Fields, Inserting objects, Mail Merge in Word.

Excel Orientation: The instructor needs to tell the importance of Excel as a Spreadsheet tool, give the details of the four tasks and features that would be covered Excel – Accessing, overview of toolbars, saving excel files,

1. Creating a Scheduler Features to be covered :- Gridlines, Format Cells, Summation, auto fill, Formatting Text
2. Calculations Features to be covered :- Cell Referencing, Formulae in excel – average, std.deviation, Charts, Renaming and Inserting worksheets, Hyper linking, Count function, LOOKUP/VLOOKUP
3. Performance Analysis Features to be covered :- Split cells, freeze panes, group and outline, Sorting, Boolean and logical operators, Conditional formatting
4. Game (like Cricket, badminton) Score Card Features to be covered :- Pivot Tables, Interactive Buttons, Importing Data, Data Protection, Data Validation

Presentation Orientation:

1. Students will be working on basic power point utilities and tools which help them create basic power point presentation. Topic covered includes :- PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows
2. This session helps students in making their presentations interactive. Topics covered includes : Hyperlinks, Inserting –Images, Clip Art, Audio, Video, Objects, Tables and Charts

3. Concentrating on the in and out of Microsoft power point. Helps them learn best practices in designing and preparing power point presentation. Topics covered includes: - Master Layouts (slide, template, and notes), Types of views (basic, presentation, slide slotter, notes etc), Inserting – Background, textures, Design Templates, Hidden slides. Auto content wizard, Slide Transition, Custom Animation, Auto Rehearsing
4. Power point test would be conducted. Students will be given model power point presentation which needs to be replicated

Internet and its Applications The instructor needs to tell the how to configure Web Browser and to use search engines by defining search criteria using Search Engines

1. To learn to setup an e-mail account and send and receive e-mails
2. To learn to subscribe/post on a blog and to use torrents for accelerated downloads
3. Hands on experience in online banking and Making an online payment for any domestic bill

Suggested Readings/ Books:

1. IT Tools, R.K. Jain, Khanna Publishing House.
2. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education.
3. Introduction to information technology, Turban, Rainer and Potter, John Wiley and Sons.
4. Problem Solving Cases in Microsoft Excel, Joseph Brady & Ellen F Monk, Thomson Learning.

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Semester **2nd**
Subject Code **BSAP-203C**
Subject Name **Digital Electronics Lab**

Contact Hours **L: 00** **T: 00** **P: 04** **Credits: 02**

Course Outcomes

At the end of this course, student will demonstrate the ability to:

1. Realize logic gates.
2. Realize combinational circuits using logic gates.
3. Realize sequential circuits using logic gates.

List of Experiments:

Task 1: To verify the Truth-tables of all logic gates.

Task 2: To realize and verify the Half & full adder circuits using logic gates.

Task 3: To realize Half & full subtractor circuits using logic gates.

Task 4: To realize Encoder and Decoder circuits

Task 5: To realize Multiplexer circuits

Task 6: To realize 4-bit binary to gray & gray to binary converter.

Task 7: To realize comparator circuit for two binary numbers of 2-bit each.

Task 8: To realize Full adder & full subtractor circuits using encoder.

Task 9: To design Full adder & full subtractor circuits using multiplexer.

Task 10: To design and verify the Truth tables of all flip-flops.

Task 11: To design Mod-6/Mod-9 synchronous up-down counter.

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Semester **2nd**
Subject Code **BSNM-208C**
Subject Name **Physics-II Lab**

Contact Hours **L: 00** **T: 00** **P: 04** **Credits: 02**

Syllabus same as that of 'Physics-II Lab' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical)

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Understand characteristics & working of BJT in different configurations.
2. Understand characteristics & working of MOSFET in circuits.
3. Design working circuits based on diodes, BJTs and MOSFETs in different circuits.
4. Measure Modulus of rigidity, spring constant, moment of inertia etc. using different methods.

S.No Experiments

1. To determine the energy band of a semiconductor medium.
2. To study the characteristics of p-n junction diode (Forward and Reverse biased)
3. To study a zener diode as voltage regulator.
4. To study the output waveform of a Half-wave rectifier.
5. To study the output waveform of a Full-wave centre-tapped and bridge rectifier.
6. To study Input & output V-I characteristics of NPN/PNP transistors in CE configuration
7. To study Input & output V-I characteristics of NPN/PNP transistors in CB configuration 8 To study Input & output V-I characteristics of NPN/PNP transistors in CC configuration 9 To study the functioning of a BJT as a switch.
8. To study V-I Characteristics of a MOSFET
9. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
10. To establish a relation between angular acceleration α and torque τ, and hence to find out the moment of Inertia of flywheel.
11. Study the dependence of the moment of Inertia on distribution of mass (by noting the time periods of oscillations) using objects of various shape but of same mass.
12. To determine the Young's Modulus of a Wire by Optical Lever Method.
13. To determine the Young's Modulus of a Wire by Searle's method.
14. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.

3rd Semester

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Semester 3rd
Subject Code BSAP-301C
Subject Name Microprocessors
Contact Hours L: 03 T: 00 P: 00 Credits: 03

Course Outcomes: Students will be able to

1. Acquire the knowledge of basic fundamentals of microprocessors, its applications and its technical terminology.
2. Acquire knowledge of detailed study of architecture and pin configuration of 8085 and programming techniques.
3. Interpret the detailed study of programming concepts of 8086 microprocessor, instruction set and various addressing modes.
4. Acquire knowledge of different interfacing devices used with microprocessors.

Module 1: Fundamentals of Microprocessors:

Introduction to Microprocessors: Historical Background and evolution of Microprocessors, Applications of Microprocessors, Microprocessor selection, Concept of: Assembly Language, High Level Language, Low Level Language, Machine Language, Buses and CPU, Input/ Output devices, registers, Instruction Cycle, machine cycles, memory, RISC & CISC processors

Module 2: 8085 Microprocessor

8085 Microprocessor & its internal architecture, Pin configuration, Timing & Signals: control and status signals, interrupts, Instruction Set of 8085: Instruction format, op-codes, mnemonics, Addressing Modes,. Instruction Classification: Data transfer, arithmetic operations, logical operations, branching operation Counters and Time delays, Stack, & subroutine, Programming techniques.

Module 3: 8086 Microprocessor

8086 internal architecture, 8086 system configuration, minimum and maximum mode, memory segmentation, addressing modes, instruction set description, Interrupts

Module 4: Peripheral memory and I/O Interfacing (8 Hours)

Introduction to Peripheral devices: Introductory concepts of 8255- Programmable peripheral interface, 8253/8254 Programmable timer/counter. 8259 programmable Interrupt Controller, 8257 - Direct Memory Access Controller

Suggested Readings/ Books:

1. R. S. Gaonkar, Microprocessor Architecture, Programming and application with 8085, Penram International Publishing Pvt. Ltd.
2. D.V. Hall, Microprocessors and Interfacing: Programming and hardware, Glencoe Publication.
3. Ali Mazidi, J. G. Mazidi, The 8051 Microcontroller and embedded Systems, Pearson Education.
4. K. J. Ayala, The 8051 Microcontroller, Cengage Learning.

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Semester 3rd
Subject Code BSNM-303C
Subject Name Thermal and Statistical Physics

Contact Hours **L: 03** **T: 00** **P: 00** **Credits: 03**

Syllabus same as that of 'Thermal and Statistical Physics" approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical).

Details of the Course

Unit I Thermodynamics: Laws of Thermodynamics: The zeroth law; indicator diagrams, work done, first law, internal energy, Carnot cycle, Carnot's theorem, the second law. Entropy as a thermodynamic variable; reversible and irreversible processes. Principle of increase of entropy. Thermodynamic scale of temperature; its identity with perfect gas scale, impossibility of attaining absolute zero. (10 Lectures)

Unit II Maxwell's equations: application to Clausius-Clapeyron equation and Joule-Thomson effect. Thermodynamic potentials, relation to thermodynamic variables; equilibrium in thermo dynamic systems, simple applications, Thomson and adiabatic cooling, Joule-Thomson expansion; Constancy of U+PV, cooling, liquefaction of gases. Low temperatures: Production and measurement of very low temperatures, adiabatic demagnetization. (10 Lectures)

Unit III Statistical Physics: The statistical basis of thermodynamics: Probability and thermodynamic probability; principle of equal a priori probabilities, probability distribution, its narrowing with increasing n, average properties, fluctuations, micro and macrostates, accessible and inaccessible states. Phase space, division of phase space into cells. (10 Lectures)

Unit IV Thermal Dynamics: Thermal equilibrium between two systems, beta parameter and its identification with (kT)-1, probability and entropy, Boltzmann's entropy relation, statistical interpretation of second law of thermodynamics. Maxwell-Boltzmann statistics, application of M-B statistics to monoatomic gas, principle of equipartition of energy, Bose-Einstein statistics, deduction of Planck's radiation law, derivation of Wiens's displacement law and Stefan's law. Fermi-Dirac statistics, comparison of three types of statistics. (10 Lectures)

Recommended Books:

1. Statistical Physics and Thermodynamics-V.S. Bhatia, Punjab University, Chandigarh, 1977
2. Thermodynamics and Statistical Physics-Khandelwal and Loknathan, Shivlal Agnawala, Agna, 1979
3. Heat and Thermodynamics-Zemansky and Dittman, Mc Graw HillScience/Engineering/Math-7 th edition (Nov,1, 1996)

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Semester 3rd
Subject Code BSNM-304C
Subject Name Optics and Laser

Contact Hours L: 03 T: 00 P: 00 Credits: 03

Syllabus same as that of 'Optics and Laser' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical).

Unit I Interference: Definition and properties of wave front, Temporal and Spatial Coherence, Young's double slit experiment, Lloyd's single mirror and Fresnel's Biprism. Phase change on reflection, Interference in Thin Films: parallel and wedge-shaped films, Newton's Rings: Measurement of wavelength and refractive index, Interferometer: Michelson Interferometer.(10 Lectures)

Unit II Diffraction: Huygens Principle, Fraunhofer diffraction: Single slit. Circular aperture, Rayleigh criterion of resolution, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating, Fresnel diffraction pattern of a straight edge and circular aperture. (10 Lectures)

Unit III Polarization: Plane polarized light, Representation of Unpolarized and Polarized light, Polarization by Reflection, Brewster's law, Malus Law, Polarization by Selective absorption by Crystals, Polarization by Scattering, Polarization by Double Refraction, Nicol Prism.(10 Lectures)

Unit IV Laser: Lasers, Spontaneous emission, Stimulated absorption, Stimulated emission, Einstein coefficients, Einstein relations, Conditions for Laser actions, Population inversion, Different types of Laser Pumping mechanism: Optical Pumping, Electric Discharge and Electrical pumping, Resonators, Two, Three and Four level laser systems, Ruby laser, He-Negas Laser, CO2 laser, applications of laser: Holography, Spectroscopy and laser welding(10 Lectures)

Recommended Books:

1. Optics: A.K. Ghatak (Tata-McGraw Hill), 1992.
2. Fundamentals of Optics: F.A. Jenkins and H.E. White (McGraw Hill), 1981.
3. Introduction to Modern Optics (2nd ed.), G.R. Fowles, Dover, ISBN 0-486-65957-7, 2012.
4. Fundamentals of Optics, F.A. Jenkins & H.E. White, McGraw-Hill, 2011.
5. Schaum's Outline of Theory and Problems of Optics, E. Hecht, McGraw-Hill,ISBN 0-07- 027730-3,1998.

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Semester 3rd
Subject Code BSNM-306C
Subject Name Differential Equations

Contact Hours L: 03 T: 00 P: 00 **Credits: 03**

Syllabus same as that of 'Differential Equations' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical)

Unit	Content
I	Exact differential equations, first order and higher degree equations solvable for x, y and p=dy/dx. Clairaut's form, singular solution as an envelope of general solutions. Geometric meaning of a differential equation, Linear differential equations with constant coefficients. (10 Lectures)
II	Linear differential equations with variable coefficients: Cauchy and Legendre equations, Linear differential equations of second order- transformation of the equation by changing the dependent variable/ the independent variable, methods of variation of parameters and reduction of order (10 Lectures)
III	Partial differential equation: Formation of first and second order equations, linear equation of first order and integral surfaces (10 Lectures)
IV	Lagrange's linear equation. Nonlinear first order partial differential equations: Charpit's method. Classification of higher order partial differential equation. (10 Lectures)
	Recommended Books: 1. W E Boyce and R C DiPrima, Elementary Differential Equations and Boundary ValueProblems, 9th Edition, Wiley, 2009. 2. R K Jain and S R K Iyengar, Advanced Engineering Mathematics, 4th Edition, NarosaPublishing House Pvt LtD, New Delhi, 2012 3. I N Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1957 4. S L Ross, Differential Equations, John Wiley & Sons, 2004 5. M D Raisinghania, Advanced Differential Equations, 19th Edition, S. Chand, 2018

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Semester **3rd**
Subject Code **BSCE-103C**
Subject Name **Problem Solving using C**

Contact Hours **L: 03** **T: 01** **P: 00** **Credits: 04**

Syllabus same as that of '**Problem Solving using C**' approved by Board of Studies of Department of Electronics & Communication Engg for B.Sc. (CAE)

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

1. Express the logical flow used in Programming.
2. Design algorithms for solving various real life problems
3. Implement programs using C.
4. Choose the right data type and statements for programs.
5. Explain various concepts of C programming language.

Unit-I: Logic Development: Data Representation, Flowcharts, Problem Analysis, Decision Trees/Tables, Pseudo code and algorithms. Fundamentals: Character set, Identifiers and Key Words Data types, Constants, Variables, Expressions, Statements, Symbolic Constants. Operations and Expressions: Arithmetic operators, Unary operators, Relational Operators, Logical Operators, Assignment and Conditional Operators, Library functions.

Unit-II: Data Input and Output: formatted & unformatted input output. Control Statements: While, Do–while and For statements, Nested loops, If–else, Switch, Break – Continue statements.

Unit-III: Functions: Brief overview, defining, accessing functions, passing arguments to function, specifying argument data types, function prototypes, recursion. Arrays: Defining, processing arrays, passing arrays to a function, multi– dimensional arrays Strings: String declaration, string functions and string manipulation Program Structure Storage Class: Automatic, external and static variables.

Unit-IV: Structures & Unions: Defining and processing a structure, user defined data types, structures and pointers, passing structures to functions, unions. Pointers: Understanding Pointers, Accessing the Address of a Variable, Declaration and Initialization of Pointer Variables, Accessing a Variable through its Pointer, Pointers and Arrays; File Handling: File Operations, Processing a Data File

Suggested Readings/ Books:

1. Programming in ANSI C, E. Balagurusami, Fourth Edition, Tata McGraw Hill.
2. Programming in C, Third Edition, Stephen G Kochan, Pearson.
3. The C Programming Language, Kernighan & Richie, Second Edition, PHI Publication

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Semester 3rd
Subject Code EVS-101C
Subject Name Environmental Studies
Contact Hours L: 02 T: 00 P: 00 Credits: 02

Course Outcomes:

1. Students will enable to understand environmental problems at local and national level through literature and general awareness.
2. The students will gain practical knowledge by visiting wildlife areas, environmental institutes and various personalities who have done practical work on various environmental Issues.
3. The students will apply interdisciplinary approach to understand key environmental issues and critically analyze them to explore the possibilities to mitigate these problems.
1. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world

UNIT I: Introduction to Environmental Studies

Multidisciplinary nature of Environmental Studies: Scope & Importance; Need for Public Awareness

UNIT II: Ecosystems
Concept of an Ecosystem: Structure & functions of an ecosystem (Producers, Consumers & Decomposers); Energy Flow in an ecosystem: Food Chain, Food web and Ecological Pyramids
Characteristic features, structure & functions of following Ecosystems:

- Forest Ecosystem
- Aquatic Ecosystem (Ponds, Lakes, River & Ocean)

UNIT III: Natural Resources
Renewable & Non-renewable resources:
Forest Resources: their uses, functions & values (Biodiversity conservation, role in climate change, medicines) & threats (Over-exploitation, Deforestation, Timber extraction, Agriculture Pressure), Forest Conservation Act.
Water Resources: Their uses (Agriculture, Domestic & Industrial), functions & values, Overexploitation and Pollution of Ground & Surface water resources (Case study of Punjab), Water Conservation, Rainwater Harvesting,
Land Resources: Land as a resource; Land degradation, soil erosion and desertification
Energy Resources: Renewable & non-renewable energy resources, use of alternate energy resources (Solar, Wind, Biomass, Thermal), Urban problems related to Energy

UNIT IV: Biodiversity & its conservation
Types of Biodiversity: Species, Genetic & Ecosystem, India as a mega biodiversity nation, Biodiversity hot spots and biogeographic regions of India, Examples of Endangered & Endemic species of India, Red data book.

UNIT V: Environmental Pollution & Social Issues
Types, Causes, Effects & Control of Air, Water, Soil & Noise Pollution; Nuclear hazards and accidents & Health risks; Global Climate Change: Global warming, Ozone depletion, Acid rain, Melting of Glaciers & Ice caps, Rising sea levels; Environmental disasters: Earthquakes, Floods, Cyclones, Landslides.

UNIT VI: Field Work

1. Visit to a National Park, Biosphere Reserve, Wildlife Sanctuary
2. Documentation & preparation of a Biodiversity (flora & fauna) register of campus/river/forest
3. Visit to a local polluted site: Urban/Rural/Industrial/Agricultural
4. Identification & Photography of resident or migratory birds, insects (butterflies)
5. Public hearing on environmental issues in a village

Suggested Readings/ Books:

1. Bharucha, E. Text Book for Environmental Studies. University Grants Commission, New Delhi.
2. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
3. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
4. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
5. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
6. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
7. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
8. Down to Earth, Centre for Science and Environment (R)
9. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p
10. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
11. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
12. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection & Laws. Himalaya Pub. House, Delhi 284p.
13. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p.
14. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
15. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
16. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
17. Rao M N. & Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
18. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut
19. Survey of the Environment, The Hindu (M)
20. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)
21. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
22. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p

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Semester 3rd
Subject Code BSNM-308C
Subject Name Physics Lab-III
Contact Hours L: 00 T: 00 P: 04 Credits: 02

Syllabus same as that of 'Physics Lab-III' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical).

At least 08 experiments from the following:

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 study wavelength of sodium light using Newton Rings.
5. To determine the numerical aperture of a given optic fibre and hence to find its acceptance angle.
6. To find the refractive index of a material/glass using spectrometer.
7. To find the refractive index of a liquid using spectrometer
8. To find the velocity of ultrasound in liquid.
9. To determine the specific rotation of sugar using Laurent's half-shade polarimeter.
10. To determine the coefficient of thermal conductivity of a bad conductor using Lee's disc apparatus.
11. To compare heat transfer between different material surface and the black body surface by radiation.
12. To find the emissivity of different material surface.

REFERENCE BOOKS:

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. Engineering Practical Physics, S.Panigrahi & B. Mallick,2015, Cengage Learning India Pvt. Ltd.
4. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
5. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 201, Kitab Mahal.
6. B Sc. Practical Physics, C. L. Arora, S. Chand & Co.
7. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

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Semester 3rd
Subject Code BSCE-104C
Subject Name Problem Solving using C Lab
Contact Hours L: 00 T: 00 P: 04 Credits: 02

Syllabus same as that of '**Problem Solving using C Lab**' approved by Board of Studies of Department of Electronics & Communication Engg for B.Sc. (CAE)

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

1. Select the right statement for the program.
2. Experiment with different input values.
3. Test the output with boundary conditions.
4. Distinguish between various control statements and data types.
5. Implement programs for various problems.

Assignments: Develop all programs in C programming language.

1. Write a program to display your name. Write another program to print message with inputted name.
2. Write a program to add two numbers.
3. Write a program to find the square of a given number.
4. Write a program to calculate the average of three real numbers.
5. Write a program to find ascii value of a character 6. Write a program to find the size of int, float, double and char.
6. Write a program to compute quotient and remainder
7. Write a program to accept the values of two variables.
8. Write a program to find the simple interest, inputs are amount, period in years and rate of interest.
9. Basic salary of an employee is input through the keyboard. The da is 25% of the basic salary while the hra is 15% of the basic salary. Provident fund is deducted at the rate of 10% of the gross salary (bs+da+hra). Write a program to calculate the net salary.
10. Write a program to find area of a circle using pi as constant.
11. Write a program to find volume of a cube using side as input from user.
12. Write a program using various unformatted input functions.
13. Write a program to find area of rectangle and print the result using unformatted output functions.
14. Write a program to find the larger of two numbers.
15. Write a program to find greater of three numbers using nested if.
16. Write a program to find whether the given number is even or odd.
17. Write a program to generate multiplication table using for loop
18. Write a program to generate multiplication table using while loop
19. Write a program to make a simple calculator using switch...case
20. Write a program to find whether the given number is a prime number.
21. Write a program using function to find the largest of three numbers
22. Write a program using function to print first 20 numbers and its squares.
23. Write a program to find the factorial of a given number.
24. Write a program to print the sum of two matrices
25. Write a program to find the length of a string
26. Write a program to copy string using strcpy ()

27. Write a program to compare a string
28. Write a program to reverse a string
29. Write a program to reverse a string
30. Write a program to multiply two numbers using pointers.
31. Write a program to display address of variable using pointers
32. Write a program to show the memory occupied by structure and union
33. Write a program to create student i-card using a structure
34. Write a program to read data from a file from a file
35. Write a program to save employee details in a file using file handling

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Semester **3rd**
Subject Code **BSAP-302C**
Subject Name **Microprocessors-Lab**
Contact Hours **L: 00** **T: 00** **P: 02** **Credits: 01**

Course Objectives:
The main aim of this course is to make the students familiar with microprocessor 8085 Programming and their Applications.

Course Outcomes:
After undergoing this course students will be able to

I. Familiarize with the 8085 Microprocessor kits.
II. Knowledge of 8085 instruction set and ability to utilize it in assembly language programming.
III. Understand the programming and application of Microprocessor 8085.
VI. Know how to Interface various devices to 8085.

LIST OF EXPERIMENTS

List of Experiments using 8085:
1. Study of 8085 and 8086 Microprocessor Kits.
2. Write a program to add two 8-bit number using 8085.
3. Write a program to add two 16-bit number using 8085.
4. Write a program to subtract two 8-bit number using 8085.
5. Write a program to subtract two 16-bit number using 8085.
6. Write a program to multiply two 8 bit numbers by repetitive addition method using 8085.
7. Write a program to sort series using bubble sort algorithm using 8085.
8. Write a program to copy 12 bytes of data from source to destination using 8085.
9. Write a program to find maximum and minimum from series using 8085.
10. Write a program to control speed of DC motor using 8085 microprocessors and 8255 PPI.

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Semester **3rd**
Subject Code **BMPD-301C**
Subject Name **Mentoring and Professional Development**
Contact Hours **L: 00** **T: 00** **P: 02** **Credits: Non-Credit**

Syllabus same as that of '**Mentoring and Professional Development**' B.Tech. ECE-2022

The objective of mentoring will be development of:
- Overall Personality
- Aptitude (Technical and General)
- General Awareness (Current Affairs and GK)
- Communication Skills
- Presentation Skills

The course shall be split in two sections i.e. outdoor activities and class activities. For achieving the above, suggestive list of activities to be conducted are:

Part – A
(Class Activities)
1. Expert and video lectures
2. Aptitude Test
3. Group Discussion
4. Quiz (General/Technical)
5. Presentations by the students
6. Team building Exercises

Part – B (Outdoor Activities)
1. Sports/NSS/NCC
2. Society Activities of various students chapter i.e. ISTE, SCIE, SAE, CSI, Cultural Club, etc.

Evaluation shall be based on rubrics for Part – A & B

Mentors/Faculty incharges shall maintain proper record of students for each activity conducted and the same shall be submitted to the department.

4th Semester

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Semester	**4th**			
Subject Code	**BSAP-401C**			
Subject Name	**Analog Circuits**			
Contact Hours	**L: 03**	**T: 00**	**P: 00**	**Credits: 03**

Syllabus same as approved by Board of Studies of ECE for B.Tech. (ECE) 2022

Course Objective

This course deals design & analytical concepts of various Analog circuits like BJT/FET circuits, feedback amplifiers, oscillators, power amplifiers.

Course Outcomes

At the end of this course student will be able to:

1. Understand the biasing of transistors and analyze BJT/FET amplifiers
2. Analyze various rectifier and amplifier circuits
3. Analyze sinusoidal and non-sinusoidal oscillators
4. Understand various types of Power Amplifiers

Unit 1: Diode and Transistor Amplifier Circuits

Diode Circuits, Amplifiers types: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier; biasing schemes for BJT and FET amplifiers; bias stability; transistor configurations: CE/CS, CB/CG, CC/CD and their features; small-signal analysis; low-frequency transistor models; amplifier analysis: current gain, voltage gain, input resistance and output resistance; amplifier design procedure; low frequency analysis of multistage amplifiers. High frequency transistor models.

Unit 2: Feedback Amplifiers

Feedback topologies: Voltage series, current series, voltage shunt and current shunt feedback; effect of feedback on gain, bandwidth, input & output impedances; concept of stability, gain margin and phase margin.

Unit 3: Oscillators

Introduction, Types of Oscillators, Barkhausen criterion, RC-phase shift, Wien bridge, Hartley, Colpitts, Clapp oscillators and Non-sinusoidal oscillators.

Unit 4: Power Amplifiers

Class A, B, AB and C power amplifiers, their efficiency and distortions; frequency response: single stage, multistage amplifiers and cascade amplifier.

Recommended Books

1. J Millman & A Grabel, *Microelectronics*, McGraw Hill
2. J Millman& C Halkias, *Integrated Electronics*, Tata McGraw Hill
3. A Ramakant, Gayakwad, *Op-Amps And Linear Integrated Circuits*, PHI
4. P Horowitz & W Hill, *The Art of Electronics*, Cambridge University Press
5. AS Sedra & KC Smith, *Microelectronic Circuits*, Saunder's College Publishing

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Semester 4th
Subject Code BSAP-402C
Subject Name Microcontrollers
Contact Hours L: 03 T: 00 P: 00 Credits: 03

Course Objectives:
The objective of the course is to develop an in-depth understanding of the operation of microcontrollers, machine language programming & interfacing techniques. Students will able to interface the microcontroller with the I/O devices to develop simple applications on microprocessor and microcontroller-based systems.

Course Outcomes:
After undergoing this course students will be able to

I. Understand the importance of micro-processors and micro-controllers, detailed study of architecture and pin configuration of 8051
II. Interpret the detailed study of programming concepts of 8051 micro-controller, instruction set and various addressing modes of 8051.
III. Analyze the concept of serial communication and interfacing the external devices with the 8051 Microcontroller
IV. To gain technical know-how about Interfacing 8051 microcontroller to different external devices

Module 1: Introduction to 8051 Microcontroller
Comparison of microprocessor & microcontrollers, Overview of 4,8,16 & 32 bit microcontrollers, microcontroller 8051: architecture, pin configuration, flag-bits and PSW register, input-output ports, register banks and stack; Semiconductor memories: ROM, SRAM, DRAM, concept of cache memory; memory organization

Module 2: 8051 Microcontroller Assembly Language Programming
Assembly language programming; data types and directives; jump loop and call instructions; I/O port programming; addressing modes and accessing memory using various addressing modes; arithmetic instructions and programs; logic instructions and programs; single bit instructions and programming,

Module 3: Interrupts & Serial Communication in 8051 Microcontroller
8051 interrupts; timer/counter programming in the 8051, Universal Synchronous Asynchronous Receiver Transmitter (USART), 8051 connection to RS 232, 8051 serial communication programming

Module 4: Microcontroller 8051 Interfacing
Real World Interfacing of 8051 Microcontroller to LCD, Analog to Digital Converter, Digital to Analog converter , Stepper motor, sensors, keyboard and external memory.

Recommended Text and Reference Books
1. Ali Mazidi, J. G. Mazidi, The 8051 Microcontroller and embedded Systems, Pearson Education.
2. K. J. Ayala, The 8051 Microcontroller, Cengage Learning.
3.D.V. Hall, Microprocessors and Interfacing: Programming and hardware, Glencoe Publication.

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Semester 4th
Subject Code BSAP-403C
Subject Name Engineering Materials
Contact Hours L: 03 T: 00 P: 00 Credits: 03

Course Objectives:
The objective of this course is to provide basic understanding of engineering materials and their mechanical, electrical and magnetic properties.

Course Outcomes:
After undergoing this course students will be able to

I. Understand the importance of engineering materials, their classification and types of defects involved in engineering materials.
II. Analyze the various kinds of mechanical properties such as Stiffness, Ductility, Brittleness, Resilience etc. of materials.
III. Analyze the properties and applications of electrical and magnetic materials and factors affecting electrical resistance of materials.
IV. Understand about selection of engineering materials for a particular application on the basis of their properties.

Unit I: Structure of solids
Classification of engineering materials, Structure - property relationship in engineering materials, Crystalline and non- Crystalline materials. Defects: Point, Line and Surface defects.

Unit II: Mechanical properties of materials
Elastic, Inelastic and Viscoelastic materials, Yielding and yield strength, Stiffness, Ductility, Brittleness, Resilience, Toughness, True stress – true strain relationship, Hardness, Shrinkage, Plastic deformation by twinning and slip, Movement of dislocation, Critical shear stress, Strengthening mechanism and creep

Unit III: Electrical and Magnetic Materials
Factors affecting electrical resistance of materials, Superconductivity, Properties and applications of conducting materials, Properties and applications of semi-conducting materials, Properties and applications of insulating materials; Magnetic materials, soft and hard magnetic materials and their applications; Smart materials: sensors and actuators, piezoelectric, magnetostrictive and electrostatic materials

Unit IV: Materials Selection
Overview of properties of engineering materials, Material selection in design based on properties covering timber, aluminium, glass, polymers and ceramics

Recommended text and Reference Books
1. W.D. Callister, Materials Science and Engineering; John Wiley & Sons
2. W.F. Smith, Principles of Materials Science and Engineering: An Introduction; Tata Mc-GrawHill
3. Raghavan, Introduction to Materials Science and Engineering; PHI
4. S. O. Kasap, Principles of Electronic Engineering Materials; Tata Mc-Graw Hill
5. L. H. Van Vlack, Elements of Material Science and Engineering; Thomas Press

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Semester **4th**
Subject Code **BSNM-403C**
Subject Name **Vibration and Waves**
Contact Hours **L: 03** **T: 00** **P: 00** **Credits: 03**

Syllabus same as that of 'Vibration and Waves" approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical).

Unit I Simple and Damped Harmonic Motion: Simple harmonic motion, energy of a SHO, Compound pendulum, Torsional pendulum, Electrical Oscillations, Lattice Vibrations, Transverse Vibrations of a mass on a string, Anharmonic Oscillations. Damped simple harmonic motion, Decay of free Vibrations due to damping, types of damping, Determination of damping coefficients – Logarithmic decrement, relaxation time and Q-factor. Electromagnetic damping. (10 Lectures)

Unit II Forced Vibrations and Resonance: Forced mechanical and electrical oscillator, Transient and Steady State Oscillations, Displacement and velocity variation with driving force frequency, Variation of phase with frequency resonance, Power supplied to forced oscillator by the driving force. Q-factor and band width of a forced oscillator, Electrical and nuclear magnetic resonances. (8 Lectures)

Unit III Coupled Oscillations: Stiffness coupled oscillators, Normal coordinates and modes of vibrations. Inductance coupling of electrical oscillators, Normal frequencies, Forced vibrations and resonance for coupled oscillators, Masses on string-coupled oscillators. (8 Lectures)

Unit IV Waves in Physical Media: Types of waves, wave equation (transverse) and its solution characteristics impedance of a string, Impedance matching, Reflection and Transmission of waves at boundary, Energy of vibrating string, wave and group velocity. (10 Lectures)

Recommended Books:

1. Text Book of Vibrations and Waves: S.P. Puri (Macmillan India), 2004.
2. The Physics of Vibrations and Waves: H.J. Pain (Wiley and ELBS), 1976.

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Semester 4th
Subject Code BSNM-40C
Subject Name Elements of Modern Physics
Contact Hours L: 03 T: 00 P: 00 Credits: 03

Syllabus same as that of 'Elements of Modern Physics" approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical).

Unit I Dual Nature of Waves and Particles: Black body ration, Planck's quantum, Planck'sconstant and light as a collection of photons; Photo Electric effect and Comptonscattering. De Broglie wavelength and matter waves; Davisson-Germer experiment, Problems with Rutherford model-instability of atoms and observation of discrete atomicspectra; Bohr's quantization rule and atomic stability; Wave-particle duality, Heisenberguncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle. Lecture (10)

Unit II Quantum Mechanics: Two slit interference experiment with photons, atoms & particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wavefunction, probabilities and normalization; Probability and probability current densities in one dimension. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example Lecture (10)

Unit III Atomic structure: The nuclear atom, Electron orbits, Atomic spectra, The Bohr Model,Energy level and spectra, Correspondence principle, Nuclear motion, Atomic excitation,Many electron atoms, Exclusion Principle, electron spin, spin orbit coupling, X-ray spectra. Zeeman effect, Stern-Garlach experiment. Lecture (10)

Unit IV Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation ofvelocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector. Lecture (10)

Recommended Books:

1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
2. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson,2009, PHI Learning
3. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003,McGraw Hill
4. Quantum Physics, Berkeley Physics, Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
5. Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning

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Semester **4th**
Subject Code **BSCE-203C**
Subject Name **Object Oriented Programming using C++**
Contact Hours **L: 03** **T: 01** **P: 00** **Credits: 04**

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

1. Outline the role of programming for solving real world problems.
2. Explain Object oriented approach for finding Solutions to various problems with the help of C++ language.
3. Implement computer based solutions to various real-world problems using C++
4. Select the right Object Oriented Concept for optimal solution.
5. Review different solutions for a common problem.

Unit-I Principles of object oriented programming

Introduction to OOP and its basic features, Basic components of a C++, Program and program structure, Compiling and Executing C++ Program. Difference between Procedure Oriented Language(C) and Object Oriented Language

Unit-II Classes & Objects and Concept of Constructors

Defining classes, Defining member functions, Declaration of objects to class, Access to member variables from objects, Different forms of member functions, Access specifiers (Private, public, protected), Array of objects. Introduction to constructors, Parameterized constructors, Copy Constructor, Multiple constructors in class, Dynamic initialization of objects, Destructors

Unit-III Inheritance and Operator overloading

Introduction to Inheritance, Types of inheritance: - Single inheritance, Multiple inheritance, Multilevel inheritance, Hierarchical inheritance, Hybrid inheritance, Defining operator overloading, Overloading of Unary and Binary operators, Rules for overloading operators

Unit-IV Polymorphism and File Handling

Early Binding, Late Binding, Virtual Functions, pure virtual functions, Abstract Classes. Opening and Closing File, Reading and Writing a file

Suggested Readings/ Books:

1. Object Oriented Programming with C++, E. Balagurusami, Fourth Edition, Tata Mc-Graw Hill.
2. Object Oriented Programming in Turbo C++, Robert Lafore, Fourth Edition Galgotia Publications.
3. The C++ Programming Language, Bjarna Stroustrup, Third Edition, Addison-Wesley Publishing Company.
4. Object Oriented Programming Using C++, Salaria, R. S, Fourth Edition, Khanna Book Publishing.

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Semester	**4th**			
Subject Code	**BSAP-404C**			
Subject Name	**Analog Circuits Lab**			
Contact Hours	**L: 00**	**T: 00**	**P: 02**	**Credits: 01**

Syllabus same as that of 'Analog Circuits Lab" approved by Board of Studies of Department of ECE for B.Tech. ECE -2022

Course Objective

This laboratory course deals design & analytical concepts of various analog circuits like BJT/FET circuits, feedback amplifiers, oscillators, power amplifiers.

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. study and verify the characteristics of diodes/BJTs in circuits with proper understanding to their working.
2. Understand frequency response & working of various types of Oscillators.
3. Understand characteristics & working of Power amplifiers.
4. Think and design working circuits based on diodes, BJTs and MOSFETs.

Part-A: Experiments

List of Experiments:

1.To Study the Output waveforms of diode clipper and Diode Clamper circuits.
2.To study BJT amplifier in CE configuration.
3. To study V-I Characteristics of FET/MOSFET.
3.To study Emitter follower circuit.
4. To calculate the frequency and observe the output waveform of RC phase shift oscillator.
5.To measure the frequency and observe the output waveform of Wein bridge oscillator.
6. To measure the frequency and observe the output waveform of Hartley oscillator.
7. To measure the frequency and observe the output waveform of Colpitt's oscillator.
8. To study Output waveform of Class-A Power Amplifier.
9. To study Output waveform of Class-B Power Amplifier.

Part-B: Lab Projects

Every individual student is required design one Lab Project under the supervision of course teacher. Topic of the project may be any from the theory contents and not limited to following list:

1. BJT audio amplifier/power amplifier
2. Any project based on IoT/Arduino platform

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Semester **4th**
Subject Code **BSAP-405C**
Subject Name **Microcontrollers Laboratory**
Contact Hours **L: 00** **T: 00** **P: 02** **Credits: 01**

Course Objectives:
The main aim of this course is to make the students familiar with microcontroller Programming and their applications.

Course Outcomes:
After undergoing this course students will be able to
I. Familiarize with the 8051/8031Micro controller kits.
II. Knowledge of 8051 instruction set and ability to utilize it in assembly language programming.
III. Understand the programming and application of Microcontrollers.
IV. Know how to Interface various devices to 8051.

List of Experiments using 8051:
1. Study of 8051 Micro controller kits.
2. Write a program to add two numbers lying at two memory locations and display the result.
3. Write a program for multiplication of two numbers lying at memory location and display the result.
4. Write a Program to arrange 10 numbers stored in memory location in ascending and descending order.
5. Write a program to convert packed BCD to two ASCII numbers.
6. Write a program to show the use of INT0 and INT1.
7. Write a program of Flashing LED connected to port 1 of the Micro Controller
8. Write a program to generate a Ramp waveform using DAC with micro controller.
9. Write a program to interface the ADC.
10. Write a program to control a stepper motor in direction, speed and numbers of steps.

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Semester **4th**
Subject Code **BSNM-408C**
Subject Name **Physics Lab-IV**
Contact Hours **L: 00** **T: 00** **P: 04** **Credits: 02**

At least 08 experiments from the following:

1. To determine the value of horizontal component of Earth's magnetic field Bh.
2. To determine unknown capacitance by flashing and quenching method.
3. To study the magnetic field of a circular coil carrying current.
4. To find out polarizability of a dielectric substance.
5. To determine the frequency of an electrically maintained tuning fork by
i) Transverse mode of vibration
ii) Longitudinal mode of vibration
6. To find out the frequency of AC mains using electric-vibrator/sonometer.
7. Experiment to study Doppler effect
8. To study V-I characteristic of a Ge-Si junction.
9. Analyze the suitability of a given Zener diode as a power regulator.
10. To study the band gap of a Ge semiconductor.

REFERENCE BOOKS:

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. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
4. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
5. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 201, Kitab Mahal.
6. B Sc. Practical Physics, C. L. Arora, S. Chand & Co.
7. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

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Semester **4th**
Subject Code **BMPD-401C**
Subject Name **Mentoring and Professional Development**
Contact Hours **L: 00** **T: 00** **P: 02** **Credits: Non-Credit**

Syllabus same as that of '**Mentoring and Professional Development**' B.Tech. ECE-2022

The objective of mentoring will be development of:
- Overall Personality
- Aptitude (Technical and General)
- General Awareness (Current Affairs and GK)
- Communication Skills
- Presentation Skills

The course shall be split in two sections i.e. outdoor activities and class activities. For achieving the above, suggestive list of activities to be conducted are:

Part – A
(Class Activities)
1. Expert and video lectures
2. Aptitude Test
3. Group Discussion
4. Quiz (General/Technical)
5. Presentations by the students
6. Team building Exercises

Part – B
(Outdoor Activities)
1. Sports/NSS/NCC
2. Society Activities of various students chapter i.e. ISTE, SCIE, SAE, CSI, Cultural Club, etc.

Evaluation shall be based on rubrics for Part – A & B
Mentors/Faculty incharges shall maintain proper record student wise of each activity conducted and the same shall be submitted to the department.

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Semester V **Contact Hours = 21**

S. No	Course Code	Course Title	Compulsory (C)/ Electives (E)	Load Allocation			Marks Distribution		Total	Credits
				L	T	P	Internal	External		
1	BSAP-501C	Analog and Digital Communication	C1	3	0	0	40	60	100	3
2	BSAP-502C	Linear Integrated Circuits	C2	3	0	0	40	60	100	3
3	BSAP-503C	VLSI Technology	C3	3	0	0	40	60	100	3
4	BSAP-5XXC	Department Elective-I	DE1	3	0	0	40	60	100	3
5	BSAP-504C	Analog and Digital Communication Lab	C4	0	0	2	30	20	50	1
6	BSAP-505C	Linear Integrated Circuits Lab	C5	0	0	2	30	20	50	1
7	BXXXXX	OPEN-ELECTIVE	OE1	3	0	0	40	60	100	3
8	BMPD-501C	Mentoring and Professional Development	C6	0	0	2	Satisfactory/Un-satisfactory			Non-credit
		Total		**15**	**0**	**6**	**260**	**340**	**600**	**17**
Total Credits										**17**

Semester VI **Contact Hours = 22**

S. No	Course Code	Course Title	Compulsory (C)/ Electives (E)	Load Allocation			Marks Distribution		Total	Credits
				L	T	P	Internal	External		
1	BSNM-603C	Nuclear and Particle Physics	C1	3	0	0	25	50	75	3
2	BSAP-601C	Optical Communication	C2	3	0	0	40	60	100	3
3	BSAP-6XXC	Department Elective-II	DE2	3	0	0	40	60	100	3
4	BSAP-6XXC	Department Elective-III	DE3	3	0	0	40	60	100	3
5	BSAP 602C	MATLAB Lab-II	C3	0	0	4	60	40	50	2
6	BSAP-603C	Minor Project & Seminar	C4	0	0	4	60	40	100	2
7	BMPD-601C	Mentoring and Professional Development	C5	0	0	2	Satisfactory/Un-satisfactory			Non-credit
		Total		12	0	10	265	310	525	16
Total Credits										**16**

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A Four-Years Degree Program

Department Elective Courses

List of Department Electives

Department Elective-I (Sem-5)	
Course Code	**Course Title**
BSAP-511C	Information Theory & Coding
BSAP-512C	Sensors and Transducers
BSAP-513C	Biomedical Instrumentation
Department Elective-II (Sem-6)	
Course Code	**Course Title**
BSAP-611C	Computer Networks
BSAP-612C	Wireless Communication
BSAP-613C	Wireless Sensor Networks
Department Elective-III (Sem-6)	
Course Code	**Course Title**
BSAP-614C	Digital Signal Processing
BSAP-615C	Internet of Things
BSAP-616C	Artificial Intelligence

5th Semester

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Semester 5th
Subject Code BSAP-501C
Subject Name Analog and Digital Communication
Contact Hours L: 03 T: 00 P: 00 **Credits: 03**
Course Type: Core Theory

Course Objective

This is one of the fundamental courses meant to know the concepts of Analog as well as Digital Communication and understand the working of common communication techniques.

Course Outcomes

At the end of this course students will demonstrate the ability to:

1. Understand concepts of AM & FM transmission and reception.
2. Understand pulse code modulation and its modified techniques such as DM, adaptive DM and DPCM.
3. Acquire knowledge of digital carrier modulation and demodulation techniques.

Unit 1: Analog Communication

Electromagnetic Spectrum, Need of modulation. Introduction to Amplitude Modulation, Frequency Modulation, Phase Modulation, Mathematical representation of AM and Power relation in AM waves, Mathematical representation of FM, Frequency Spectrum of FM waves, Amplitude Modulation: Transmission and Reception of DSB, SSB and VSB, FM generation and reception.

Unit 2: Digital Communication

Analog to Digital: Need, Sampling process, Pulse Amplitude modulation and Concept of Time division multiplexing, Pulse code modulation (PCM), Differential pulse code modulation. Delta modulation and demodulation, Adaptive and Sigma Delta Modulation, Noise considerations in PCM, Digital Multiplexers. Baseband Pulse Transmission: Inter symbol Interference and Nyquist criterion.

Unit 3: Digital Modulation Techniques

Phase Shift Keying, Frequency Shift Keying, Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.

Recommended Books

1. Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3. Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill, 2001.
4. Wayne Tomasi, Electronic Communication System Fundamentals through Advanced, Pearson Education

Note: At least one question must be set from each unit/course outcome.

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester 5^{th}
Subject Code BSAP-502C
Subject Name Linear Integrated Circuits
Contact Hours L: 03 T: 00 P: 00 Credits: 03

Course Objective

To teach the basic concepts in the design of electronic circuits using linear integrated circuits and their applications.

Course Outcomes

At the end of this course student will be able to:

CO#	Course outcomes
CO1	Analyze different differential amplifier configurations and its current stabilization.
CO2	Classify ICs and define the stages of Op-amp, its electrical parameters
CO3	Various open loop and close loop configurations of an Op-Amp
CO4	Identify and explain the various applications of an Op-amp

Detailed Contents

Unit-I: Differential and Cascade Amplifiers:

Introduction, Differential Amplifier, Differential Amplifier Circuit Configuration, Dual Input-Balanced output Differential Amplifier, Dual Input-Unbalanced output Differential Amplifier, Single Input-Balanced output Differential Amplifier, Single Input-unbalanced output Differential Amplifier with their DC and AC analysis, Constant current bias, Cascaded differential Amplifier Stages, Level Translator

Unit-II: Introduction to Operational Amplifiers:

Block diagram of a typical Op-Amp, Schematic symbol, integrated circuits and their types, IC package types, Pin Identification and temperature range, Characteristics and performance parameters of an Op-Amp, Ideal Op-Amp, Equivalent circuit of an Op-Amp, Ideal voltage transfer curve, Practical Op-Amp: Input offset voltage, Input bias current, Input offset current, total output offset voltage, Thermal drift,Noise, Common Mode configuration and common mode rejection Ratio.

Unit-III: Open loop and close loop configurations:

Open loop configurations: Differential, Inverting & Non Inverting, Feedback configurations : Voltage series, voltage shunt, current series ,current shunt

Unit-IV: Applications of Op-Amp:

DC and AC amplifiers, Peaking Amp, Summing, Scaling and Averaging Amp, Instrumentation Amplifier, V to I and I and to V converter, Active filters: First order LP Butterworth filter, First order HP Butterworth filter, Band pass filter, Band reject filters, All pass filter, Basic comparator, Zero crossing detector, Schmitt trigger, window detector, Peak Detector, Sample and Hold Circuit.

Reference Books & Text Books:

1. RamakantA.Gayakwad, OP-AMP and Linear IC's, Prentice Hall / Pearson Education.
2. Robert F.Coughlin, Frederick F.Driscoll, Operational Amplifiers and Linear Integrated Circuits, PHI
3. D.Roy Choudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd.
4. William D.Stanley, Operational Amplifiers with Linear Integrated Circuits, Pearson Education
5. B.S.Sonde, System design using Integrated Circuits , New Age Publication
6. S.Salivahanan & V.S. KanchanaBhaskaran, Linear Integrated Circuits, TMH

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester 5th
Subject Code BSAP-503C
Subject Name VLSI Technology
Contact Hours L: 03 T: 0 P: 00 Credits: 03

Course Objective
This course offers a profound understanding of the design of digital VLSI circuits & systems, computer aided simulation and synthesis tool for hardware design.

Course Outcomes
After undergoing this course students will be able to
1. Recognize various VHDL keywords and statements.
2. Design combinational circuits based on various design approaches in VHDL.
3. Design sequential circuits based on various design approaches in VHDL
4. Understand the concepts and various processes related to VLSI
5. Understand the electrical properties of MOS transistors

Unit **Contents**

I. **Introduction**: Hardware description languages, Introduction to VHDL, Classes, Operators, modes, Entity and Architecture declaration, Introduction to behavioural, Dataflow and structural models.

II. **VHDL Statements**: Assignment statements, Process statement, Sequential statements-- Wait statement, IF statement, Case statements, Concurrent statements--selected signal assignment statement, conditional signal assignment statement

III. **Combinational & Sequential Circuit Design**: VHDL models and simulation of combinational circuits: Adder, Subtractor, Multiplexer, Encoder, Decoder, Code converter, Flip-flops, counters

IV. **Introduction to VLSI & Review of MOS Devices** - IC Technology – MOS, PMOS, NMOS, CMOS technologies-Oxidation, Lithography, Diffusion, Ion implantation, MOS Structure, Enhancement & Depletion Transistor

V. **Basic Electrical Properties :** MOS device design equations Ids-Vds relationships, Threshold Voltage, gm, gds, Figure of merit, Pass-transistor, NMOS Inverter and Transfer characteristics, pull up and pull down ratios of NMOS

Reference Books:

1. "A VHDL Primmer": Bhasker; Prentice Hall 1995
2. "Digital System Design using VHDL":Charles. H. Roth; PWS(1998)
3. "Digital Design & Modelling with VHDL & Synthesis" : KC Chang; IEEE Computer Society Press.
4. "VDHL-Analysis & Modelling of Digital Systems": Navabi Z; McGraw Hill
5. "Introduction to Digital Systems": Ercegovac. Lang & Moreno; John wiley(1999)
6. " Fundamentals of Digital Logic with VHDL Design": Brown and Vranesic; TMH(2000)
7. "Principle of CMOS VLSI Design" :Weste and Eshrighian Pearson Education, 2001.
8. *"Basic VLSI Design"* :Pucknell D A and Eshraghian K: Prentice Hall India, New Delhi (2003).

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester	**5th**			
Subject Code	**BSAP-5XXC**			
Subject Name	**Department Elective-I**			
Contact Hours	**L: 03**	**T: 00**	**P: 00**	**Credits: 03**

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester	**5th**			
Subject Code	**BSAP-504C**			
Subject Name	**Analog and Digital Communication Lab**			
Contact Hours	**L: 00**	**T: 00**	**P: 02**	**Credits: 01**

Course Objective: This laboratory course deals with the Hands-on experiments related to the study and investigate the outputs of various Analog and digital modulation techniques.

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Study and verify the characteristics and output waveforms of AM & FM.
2. study and compare noise in AM and FM systems
3. investigate the output responses of PAM, PCM, PSK, FSK, MSK.

List of Experiments:

1. To study the output waveform of Amplitude Modulation and demodulation.
2. To study the output waveform of Frequency Modulation and demodulation.
3. To Investigate and compare the outputs of SSB, DSB-SC Modulation systems.
4. To study and compare Noise Interference in AM and FM systems.
5. To study the output waveforms of different types of Sampling.
6. To Investigate the Output response of Pulse Code Modulation.
7. To Study Delta modulation and demodulation technique and observe effect of slope overload.
8. To Study the output response of Phase shift keying.
9. To Study the output response of Frequency shift keying.
10. To study the output response of QAM.

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
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Semester	**5th**
Subject Code	**BSAP-505C**
Subject Name	**Linear Integrated Circuit Laboratory**
Contact Hours	**L: 00 T: 00 P: 02 Credits: 01**

Course Objective

The main aim of this course is to make the students familiar with performance, behaviour of linear ICs and their applications..

Course Outcomes

At the end of this course student will be able to:

CO1 Analyze the performance of Integrated Circuits.

CO2 Evaluate the close loop gain of an Op-amp.

CO3 To use Op-amp as summer, Subtractor, filters and various other applications.

List of Experiments

1. To study differential amplifier configurations.
2. To measure the performance parameters of an Op-amp.
3. Application of Op-amp as Inverting and Non Inverting amplifier.
4. To study frequency response of an Op-amp
5. To use the Op-amp as summing, scaling & averaging amplifier.
6. To use the Op-amp as Instrumentation amplifier
7. Application of Op-amp as Low pass, High pass and Band pass 1st order butterworth active filters using Op-amp.
8. Application of Op-amp as Zero Crossing detector and window detector.
9. Application of Op-amp as Schmitt Trigger.

Important Note

From above given list at least 8 experiments will be performed by the students in a group of maximum three in the laboratory.

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
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Semester	**5th**
Subject Code	**BXXX-XXXC**
Subject Name	**To be opted from Open Electives Offered by other departments**
Contact Hours	**L: 03 T: 00 P: 00 Credits: 03**

Course Type: OPEN-ELECTIVE (OE1)

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester **5th**
Subject Code **BMPD-501C**
Subject Name **Mentoring and Professional Development**
Contact Hours **L: 00** **T: 00** **P: 02** **Credits: 00**

Guidelines regarding Mentoring and Professional Development

Course Outcome:

1. Overall Personality
2. Aptitude (Technical and General)
3. General Awareness (Current Affairs and GK)
4. Communication Skills
5. Presentation Skills

The course shall be split in two sections i.e. outdoor activities and class activities. For achieving the above, suggestive list of activities to be conducted are:

Part – A: Class Activities

1. Expert and video lectures
2. Aptitude Test
3. Group Discussion
4. Quiz (General/Technical)
5. Presentations by the students
6. Team building Exercises

Part – B: Outdoor Activities

1. Sports/NSS/NCC
2. Society Activities of various student's chapter i.e. ISTE, SCIE, SAE, CSI, Cultural Club, etc.

Evaluation shall be based on rubrics for Part – A & B Mentors/Faculty in-charges shall maintain proper record student wise of each activity conducted and the same shall be submitted to the department.

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
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Semester 5th
Subject Code BSAP-511C
Subject Name Information Theory and Coding
Contact Hours L: 03 T: 00 P: 00 Credits: 03

Course Type: Department-Elective (DE1)

Course Objective
This course deals with knowledge and importance with understanding of Information Theory and Coding along with coding techniques.

Course Outcomes
After undergoing this course students will be able to:
1. Understand the concept of information and entropy
2. Understand Shannon's theorem for coding
3. Calculation of channel capacity
4. Apply coding techniques

Unit **Contents**

I. **Basic Concepts of Information Theory**: The concept of Amount of Information, Average Information, Entropy, Information rate, Shannon's Theorem, Mutual information; Channel capacity; BSC and other channels, Capacity of a Gaussian Channel, Bandwidth - S/N Trade-off, Introduction to Channel Capacity & Coding, Channel Models, Channel Capacity Theorem, Shannon Limit. Huffman source coding algorithm

II. **Introduction to Error Control Coding:** Linear Block Codes: Introduction to Linear Block codes, Syndrome and Error detection, Minimum distance of block code, Hamming Code. Cyclic Codes: Description of Cyclic codes, Generator and parity check matrices of cyclic codes, error detection decoding of cyclic codes. BCH Codes: Description of codes, Decoding of BCH codes, Implementation of error connection.

III. **Convolution Codes:** Encoding of convolution codes, structural properties of Convolution codes, Distance Properties of convolution codes. Automatic Repeat Request Strategies: Stop and wait, Go back and selective repeat ARQ strategies, Hybrid ARQ Schemes.

IV. **Error Control Coding:** Concatenated Codes and Turbo Codes, Single level Concatenated codes, Multilevel Concatenated codes, Soft decision Multistage decoding, Concatenated coding schemes with Convolutional Inner codes, Introduction to Turbo coding and their distance properties, Design of Turbo codes.

Text/Reference books

1. N.Abramson,InformationandCoding,McGrawHill,1963.
2. M.Mansurpur,IntroductiontoInformationTheory,McGrawHill,1987.
3. R.B.Ash,InformationTheory,PrenticeHall, 1970.
4. ShuLinandD.J.CostelloJr.,ErrorControlCoding,PrenticeHall, 1983.
5. RanjanBose,InformationTheory,CodingandCryptography,TheMcGrawHill,2007.
6. RelatedIEEE/IEEPublications

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester 5th
Subject Code BSAP-512C
Subject Name Sensors and Transducers
Contact Hours L: 03 T: 00 P: 00 Credits: 03

Course Type: Department-Elective (DE1)

Course Objective

The course will introduce the students to various sensors and transducers used for the measurement of various physical quantities.

Course Outcomes:

After undergoing this course, students will be able to

I. Understand the principle and requirements of sensing and transduction.
II. Acquire knowledge of various resistive & inductive transducers along with their working principles.
III. Have understanding of various Capacitive and Thermoelectric sensors.
IV. Acquire knowledge about working of radiation and other miscellaneous sensors and obtain knowledge of applications of different sensors and transducers.

UNIT-I: Introduction

Generalized instrumentation systems, block diagram representation, Difference between sensors and transducers, Basic requirement of transducers, Selection criteria of Transducers, Classification (active/passive, analog/digital), Performance parameters: Sensitivity, accuracy, resolution, linearity, hysteresis, Static and dynamic characteristics. Introduction to signal conditioning (amplifiers, filters)

UNIT-2: Resistive, Capacitive & Inductive Sensors

Resistive: Strain gauges, RTDs, thermistors, potentiometers, **Capacitive:** Proximity sensors, humidity sensors. **Inductive:** LVDT, proximity sensors, eddy current sensors.Strain Gauges: Wire-wound, Foil type, Semi-conductor and capacitive types, Gauge Factor

UNIT-3: Piezoelectric, Optical & Magnetic Sensors

Piezoelectric: **Principle, applications (force, pressure, accelerometers),** Optical: **Photodiodes, LDRs, IR sensors, fiber-optic sensors,** Magnetic: **Hall effect sensors, reed switches.**

UNIT-4: Photo-electric Sensors & Miscellaneous Sensors

Temperature: Thermocouples, RTDs, IC sensors (LM35), Thermostats and Resistance thermometers, **Motion:** Accelerometers (MEMS), gyroscopes, **Position:** Encoders, ultrasonic sensors, GPS, LDR, Photo-emissive cell, Photo-conductive type, photodiodes, Photo-electric Tachometer, Smart sensors, Fibre optic sensors, Film sensors, Nano sensors, Digital Transducers, **Chemical/Bio-sensors**: Gas sensors (MQ series), pH sensors

UNIT-5: Applications of sensors and transducers:

Industrial Automation, Pressure sensors, Monitor hydraulic systems, Proximity sensors, Temperature sensors, Healthcare & Medical Devices, Automotive Systems, Smart Home & IoT: Motion sensors (PIR) for security lighting, Humidity sensors in smart thermostats. Gas leak detectors (MQ sensors) for safety, Environmental Monitoring, Agriculture

Text/Reference books

1. Patranabis. D, Sensors and Transducers, Prentice Hall of India
2. H.K.P. Neubert, Instrument transducers, Oxford University press.
3. A.K. Sawhney, A Course in Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai & Co.
4. S. Renganathan ,Transducer Engineering, Allied Publishers. 5. Murthy.D.V.S, "Transducers and Instrumentation", Prentice Hall of India,

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester	**5th**			
Subject Code	**BSAP-513C**			
Subject Name	**Biomedical Instrumentation**			
Contact Hours	**L: 03**	**T: 00**	**P: 00**	**Credits: 03**

Course Type: Department-Elective (DE1)

Course Objective

The course will introduce the students to various concepts of biomedical instrumentation such as understanding of medical instruments, recorders, imaging and laboratory instruments

COURSE OUTCOMES

1. Gain fundamental knowledge of various medical instruments.
2. Obtain knowledge of different types of bio-medical recorders.
3. Know working of various medical imaging equipment and electrical safety precautionary measurements.
4. To know about various medical laboratory test instruments.

Unit 1. Fundamentals of Medical Instruments:

Fundamentals of medical instrumentation, Sources of biomedical signals ,Generalized medical instrumentation block diagram, Medical electrodes - ECG,EEG,EMG , Defibrillator , Medical transducers: Body temperature, Blood pressure, respiration rate, Classification of Medical instruments based on : Application - (diagnostic, therapeutic, Imaging, analytical), Physiological parameter and bio-potential, Biological system , Different departments in the hospital.

Unit 2. Biomedical Recorders:

Electrocardiograph (ECG) machine: working of ECG machine, Bipolar and unipolar leads used for ECG, Einthoven's triangle, Phono-cardiograph, Electroencephalograph (EEG): 10-20 electrode placement methods, EEG readout device, Electromyograph (EMG) machine, Bio-feedback Instrumentation.

Unit 3. Medical Imaging Equipment and Electrical Safety:

Working of different types of medical imaging equipment : X-ray machine, Characteristics of X-Ray, generation of an X-Ray, CT-Scan machine, Properties of ultrasound and its applications in medical instrumentation Echoencephalography machine, Echo-cardiograph machine, Colour Doppler ultrasound machine, Significance of electrical danger, Physiological effects of electrical current, Ground shock hazard, and methods of accident prevention

Unit 4. Medical Laboratory Instruments:

Introduction of pathological (clinical) test Instruments for medical diagnosis**,** Blood Cell Counter**,** Bio chemistry analyser, Auto analyzer. Blood gas analyzer.

Text and Reference Books

1. Handbook of Biomedical instrumentation, "R S Khandpur", TMH
2. Biomedical instrumentation and measurement, "Cromwell", PHI
3. Introduction to Biomedical instrumentation, "S G Khalekar".
4. Handbook of Biomedical instrumentation, "Webster".

6th Semester

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester	**6th**			
Subject Code	**BSNM-603C**			
Subject Name	**Nuclear and Particle Physics**			
Contact Hours	**L: 03**	**T: 0**	**P: 00**	**Credits: 03**

Syllabus is same as that of '**Nuclear and Particle Physics**' approved by Board of Studies of Department of Applied Sciences for B.Sc. (Non-Medical) 6th semester, . Copy attached as Annexure-I(a).

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester 6th
Subject Code BSAP-601C
Subject Name Optical Communication
Contact Hours L: 03 T: 00 P: 00 Credits: 03

Course Objective

This course's primary objective is to understand the important concepts related to Optical Fibres and Communication.

Course Outcomes

At the end of this course, the student will be able:

1. To understand the basics of Optical Communication and different Optical fibres.
2. To demonstrate and measure different degradations of Fibres.
3. To learn about the fundamentals and design issues of Optical Transmitters and Receivers
4. To be aware of different Light wave systems.

Units	Contents
I	**Introduction:** Need of Fibre Optic Communications, Light wave System Components; Optical Fibre as a Communication Channel, Maxwell's Equations, Optical Fibres: Multi mode Fibre, Graded Index Fibres, Single-Mode-Fibres, Dispersion in Single-Mode Fibres; Group Velocity Dispersion, Material Dispersion, Wave guide Dispersion, Polarization-Mode Dispersion, Fibre Losses; Attenuation Coefficient, Material Absorption, Rayleigh Scattering, Nonlinear Optical effects; Stimulated Light Scattering, Nonlinear Phase Modulation, Four Wave Mixing, Fibre Manufacturing; Design Issues, Fabrication Methods, Cables and Connectors.
II	**Optical Transmitters:** Basic Concepts; p-n Junction diodes, Non-radiative and radiative-Recombination, Light Emitting Diodes; Power-current Characteristics, LED spectrum, Lasers: Spontaneous and Stimulated Emissions, DFB Lasers, Fabry-Perot Laser, Vertical Cavity Semiconductor Lasers, Laser Characteristics.
III	**Optical Receivers:** Basic concepts, p-i-n Photo Diodes, Avalanche Photo Diode, MSM Photo detector, Receiver Design, Receiver Noise: Noise mechanism, Receiver sensitivity; Bit error rate, Minimum Receiver Power, Sensitivity Degradation.
IV	**Light Wave Systems:** System Architecture; WDM Light wave systems, Loss-limited Light wave systems, Dispersion-limited Light wave systems, Power Budget.

Recommended Books:

1. Djafar K. Mynbeav, Fibre-Optics Communications Technology, Pearson 2001.
2. Senior J. Optical Fibre Communications, Principles & Practice, PHI 1985.
3. Keiser G., Optical Fibre Communication, Mc Graw-hill 2008.
4. Govind P. Agrawal, Fibre Optics Communication Systems, John Wiley & Sons (Asia) Pvt. Ltd 1998.

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester	**6th**			
Subject Code	**BSAP-6XXC**			
Subject Name	**Department Elective-II**			
Contact Hours	**L: 03**	**T: 00**	**P: 00**	**Credits: 03**

Shaheed Bhagat Singh State University, Ferozepur
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Semester	**6th**			
Subject Code	**BSAP-6XXC**			
Subject Name	**Department Elective-III**			
Contact Hours	**L: 03**	**T: 00**	**P: 00**	**Credits: 03**

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester 6th
Subject Code BSAP-602C
Subject Name MATLAB Lab-II
Contact Hours L: 00 T: 00 P: 04 Credits: 02

Course Objective

This laboratory course deals with the Hands-on experiments related to the study of Digital Signal Processing and its applications.

Course Outcomes: At the end of this course student will demonstrate the ability to:

1. Write programs to develop various signals and standard sequences
2. Develop programs to verify signal operations and various transforms
3. Develop programs to understand various applications of DSP
4. Understanding the use of MATLAB for solving problems of mathematics and physics.

List of Experiments:

Perform the following exercises using MATLAB

1. To develop elementary signal function modules (m-files) for unit sample, unit step, exponential and unit ramp sequences.
2. To develop program modules based on operation on sequences like signal Shifting, signal folding, signal addition and signal multiplication.
3. Implementation of Linear Convolution
4. To Find DFT of given time DT Signal
5. Program to find Z transform of a given signal
6. Digital Filter Design – FIR and IIR filters concepts understanding
7. Fractal Generation by generating the Mandelbrot set using loops and complex numbers.
8. Study of Matrix Operations & Eigen values
9. Model the trajectory of a projectile under gravity using ODEs.
10. Plot the electric field lines for multiple charges
11. Loading of Image, video and sound Files in MATLAB
12. Image, Video and Sound File operations

Shaheed Bhagat Singh State University, Ferozepur
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Semester	**6th**			
Subject Code	**BSAP-603C**			
Subject Name	**Minor Project and Seminar**			
Contact Hours	**L: 00**	**T: 00**	**P: 04**	**Credits: 02**

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester	**6th**			
Subject Code	**BMPD-601C**			
Subject Name	**Mentoring and Professional Development**			
Contact Hours	**L: 00**	**T: 00**	**P: 02**	**Credits: 00**

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester	**6th**			
Subject Code	**BSAP-611C**			
Subject Name	**Computer Networks**			
Contact Hours	**L: 03**	**T: 00**	**P: 00**	**Credits: 03**

Course Type: Department-Elective (DE1I)

Course Objective

This course deals with basic concepts of computer networks, the performance of different network media, and different network topologies.

Course Outcomes

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

CO1 Highlight the characteristics of various protocols.
CO2 Define different network technologies and their application.
CO3 Identify Hardware and software components for designing network.
CO4 Compare the performance of different network media
CO5 Implement various configuration settings

Detailed Contents

Unit-I

Data communications concepts: Digital and analog transmissions-Modem, parallel and serial transmission, synchronous and asynchronouscommunication. Modes of communication: Simplex, half duplex, full duplex.
Types of Networks: LAN, MAN, WAN
Network Topologies: Bus, Star, Ring, Mesh, Tree, Hybrid
Communication Channels: Wired transmissions: Telephone lines, leased lines, switch line, coaxial cables-base band, broadband, optical fibertransmission.
Communication Switching Techniques: Circuit Switching, Message Switching, Packet Switching.

Unit-II

Network Reference Models: OSI Reference Model, TCP/IP Reference Model,Comparison of OSI and TCP/IP Reference Models.
Transmission impairments – Attenuation, Distortion, Noise. Multiplexing – Frequency division, Time division, Wavelength division.
Data Link Layer Design Issues: Services provided to the Network Layer, Framing, Error Control (error detection and correction code), Flow Control, Data Link Layer in the Internet (SLIP, PPP)

Unit-III

MAC sub layer: CSMA/CD/CA, IEEE standards
Network Layer: Design Issues, Routing Algorithms: Shortest Path Routing, Congestion Control Policies, Concept of Internetworking.

Unit-IV

Transport Layer: Design issues, Elements of transport protocols – Addressing, Connection establishment and release, Flow control and buffering,Introduction to TCP/UDP protocols.
Session, Presentation and Application Layers: Session Layer – Design issues, remote procedure call. Presentation Layer – Design issues, Data compression techniques, Domain Name System (DNS), E-mail, File Transfer Protocol (FTP)

2. Text Books:

1. Computer Networks, Tanenbaum, Andrew, Fifth Edition, PHI.
2. Data Communication and Networking, Behrouz A. Forouzan, Fourth Edition.
3. Computer Today, S.K. Basandra, First Edition, Galgotia.

3. Reference Books:

1. Data Communication System, Black, Ulysse, Third Edition, PHI.
2. Data and Computer Communications, Stalling, Ninth Edition, PHI.
3. James F. Kurose and Keith W. Ross, “Computer Networking”, PearsonEducation.
4. Douglas E. Comer, “Internetworking with TCP/IP”, Volume-I, Prentice Hall,India.

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester 6th
Subject Code BSAP-612C
Subject Name Wireless Communication
Contact Hours L: 03 T: 00 P: 00 **Credits: 03**
Course Type: Department Elective -II

Course Objective

This is one of the fundamental courses meant to understand the important concepts related to Wireless communication using suitable mathematical models.

Course Outcomes

At the end of this course students will demonstrate the ability to:

1. Understand the basic elements of Cellular Radio Systems and its design
2. Learn about the concepts Digital communication through fading multipath channels
3. Understand various Multiple Access techniques for Wireless communication
4. Know about the Wireless standards and systems

Unit 1: Elements of Cellular Radio Systems Design:

Basic cellular system, Performance criteria, Components and Operation of cellular systems, Planning a cellular system, Analog & Digital cellular systems, Concept of frequency reuse channels, Co-channel interference, Reduction factor, desired C/I for a normal case in an omni directional antenna system, Cell splitting.

Unit 2: Digital Communication through fading multipath channels:

Fading channels and their characteristics- Channel modeling, Digital signaling over a frequency non selective slowly fading channel. Concept of diversity branches and signal paths. Combining methods: Selective diversity combining, Switched combining, Maximal ratio combining, Equal gain combining.

Unit 3: Multiple Access Techniques for Wireless Communications:

Introduction, Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Spread Spectrum Multiple Access, Space Division Multiple Access (SDMA), Packet Radio Protocols; Pure ALOHA, Slotted ALOHA.

Unit 4: Wireless Systems & Standards:

AMPS and ETACS, United states digital cellular (IS- 54 & IS 136), IEEE Standards, Global system for Mobile (GSM): Services, Features, System Architecture and Channel Types, Frame Structure for GSM, Speech Processing in GSM, GPRS/EDGE specifications and features. 3G systems: UMTS & CDMA 2000 standards and specifications. CDMA Digital standard (IS 95): Frequency and Channel specifications, Forward CDMA Channel, Reverse CDMA Channel, Wireless Cable Television.

Unit 5: Evolution of Communication Generations:

Introduction to Bluetooth, Zigbee, LTE-Advance systems, 4G & 5G Mobile techniques and Emerging technologies.

Recommended Books:

1. T.S. Rappaport, Wireless Communications: Principles and Practice, 2nd Edition, Pearson Education Asia, 2010.
2. William C Y Lee, Mobile Cellular Telecommunications, 2nd Edition, MGH, 2004.
3. Raj Pandya, —Mobile and Personal Communication systems and services||, Prentice Hall of India, 2001.
4. Wireless and Digital Communications; Dr. Kamilo Feher (PHI), 1998.

Note: At least one question must be set from each unit/course outcome.

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester	**6th**			
Subject Code	**BSAP-613C**			
Subject Name	**Wireless Sensor Networks**			
Contact Hours	**L: 03**	**T: 00**	**P: 00**	**Credits: 03**

Course Objective

This course's primary objective is to understand the important concepts related to basics of wireless sensor networks, different routing algorithms and the possible security issues.

Course Outcomes

At the end of this course, the student will be able:

1. To learn about the fundamental concepts and applications of WSN networks.
2. To demonstrate different Routing protocols of the WSN networks.
3. To understand the challenges of differentsecurity attacks and security issues ofWSN networks.

Units	Contents
I	**Sensor Networks Introduction and Architectures:** Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, WSN application examples, Single-Node Architecture – Hardware Components, Energy Consumption of Sensor Nodes, Network Architecture – Sensor Network Scenarios, Transceiver Design Considerations.
II	**WSN Networking concept and MAC protocols:**Energy-efficient routing challenges and remedies, MAC Protocols for WSN Networks, low-duty cycle Protocols and Wakeup concepts, Schedule-basedrouting, Hierarchical or Clustering routing protocols,Location-based routing protocols, Hybrid Routing Protocols.
III	**Sensor Network Security-Network Security:** Security in Ad Hoc Wireless Networks - Network Security Requirements. Network Security requirements, issues, and Challenges in security provisioning the Network, Security Attacks. Layer-wise attack in wireless sensor networks, possible solutions for Jamming, tampering, black hole attack, Flooding attack, Key distribution and Management, Secure Routing -SPINS reliability requirements in sensor Networks. Sensor Network Platforms and Tools.

Recommended Books:

1. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols ", Pearson Education, 2008.
2. Labiod. H, “Wireless Adhoc and Sensor Networks”, Wiley, 2008.
3. Li, X, “Wireless ad-hoc and sensor Networks: theory and applications”, Cambridge University Press, 2008. Reference Books
4. Carlos De MoraisCordeiro, Dharma Prakash Agrawal “Ad Hoc & Sensor Networks: Theory and Applications”, world Scientific Publishing Company, 2nd edition, 2011.
5. Feng Zhao and LeonidesGuibas, "Wireless Sensor Networks", Elsevier Publication
6. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.(soft copy available)
7. www.wirelessnetworksonline.com
8. www.securityinwireless.com

Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester 6th
Subject Code BSAP-614C
Subject Name Digital Signal Processing
Contact Hours L: 03 T: 00 P: 00 Credits: 03

Course Objective: The objective of this course is to enable students to understand the concepts underlying Digital Signal Processing

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understanding the concept of various types of signals
2. Understanding the concept of systems
3. Understanding the concept of various transforms used in DSP
4. Understanding the concept of Digital Filters and applications of DSP in various areas

Unit	Contents
I.	**Introduction to Signals**: Basics of Signals, Types of Signals, Periodic and aperiodic signals, Analog and digital signals, Sampling and reconstruction of signals, continuous and discrete time signals, Linear and nonlinear signals, Causal and non-causal signals, Even and odd signals, Signal representations, Basic discrete time signal operations: Shifting, Addition, Subtraction, Multiplication, Convolution
II.	**Introduction to Digital Signal Processing Systems**: Basic elements of digital signal processing systems, System Representations, Unit impulse response, Concepts of stability, causality, linearity, Difference equations, Linear Time Invariant Systems, Implementation of Discrete Time Systems, Basics of Digital Signal Processors
III.	**Introduction of Various Transforms in Signal Processing:**Introduction and need of various transforms, Frequency Response of system, Fourier Series, Fourier Transform, Discrete Time Fourier Transform, Discrete Fourier Transform, Z- Transform
IV.	**Digital Filters and Applications of Digital Signal Processing**:Introduction of Digital Filters, FIR and IIR Filters, Realization of discrete time systems, Applications of DSP, Limitations of Analog signal processing, Advantages of Digital signal processing

Text/Reference books:

1. S.K.Mitra, Digital Signal Processing: A computer based approach.TMH, 2001.
2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms And
4. Applications, Prentice Hall, 1997.
5. L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall, 1992.

Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester 6th
Subject Code BSAP-615C
Subject Name Internet of Things
Contact Hours L: 03 T: 00 P: 00 Credits: 03

Course Objective:
This course will enable the students to understand the concepts of IoT technology, its hardware and software constituents, various design and development issues.

Course Outcomes:
At the end of this course students will demonstrate the ability to:

1. Understand basics of IoT Technology and its applications in various domains.
2. Have knowledge of IoT Hardware, devices and architectural designs.
3. Have understanding of the IoT softwares, programming frameworks and development techniques.
4. Learn about Security, challenges, solutions and vision of the IoT with supporting technologies

Unit	Contents
I	**Basics of IoT Technology and its Applications**: Introduction and History of IoT, Basic building blocks of IoT, Functional blocks, Standards considerations, Applications: Home automation, Industry applications, Surveillance applications, Other IoT applications, Overview of communication and networking technologies in IoT.
II	**IoT Hardware and Architecture:** IoT architecture outline, Physical and logical design of IoT, Service Oriented Architecture, API Oriented Architecture, IoT Sensors, Wearable Electronics, Standard Devices, IoT Resource Management, Data Management and Analytics.
III	**Software and Development Techniques for IoTs**: Introduction to IoT Programming frameworks and languages, Introduction to various IoT tools, Techniques for development of applications through IoT tools, Development of sensor based application through embedded system platforms.
IV	**IoT Challenges and Vision:** Design challenges, Development challenges, IoT reliability, security and privacy issues, Understanding the risks, Modes of attack, Tools for achieving security, Interoperability and its need, Solutions for IoT, Vision of IoT

Recommended Text and Reference Books

1. R K Buyya, V Dastjerdi, Internet of Things, Principles and Paradigms, Morgan Kaufmann Imprint of Elsevier.
2. P Vaher, Learning Internet of Things, PACKT Publishing.
3. O Vermesan, P Friess, Internet of Things- From Research and Innovation to Market Deployment, River Publishers.
4. Vijay Madisetti, Arshdeep Bahga, Internet of Things: A Hands-On Approach, Universities Press.
5. W Dargie, C Poellabauer, Fundamentals of Wireless Sensor Networks: Theory and Practice, John Wiley & Sons.

Shaheed Bhagat Singh State University, Ferozepur
Bachelor of Science (Hons)
Applied Physics (specialization in Electronics)

Semester	**6th**			
Subject Code	**BSAP-616C**			
Subject Name	**Artificial Intelligence**			
Contact Hours	**L: 03**	**T: 00**	**P: 00**	**Credits: 03**

Course Objective:
The objective of this course is to introduce students to the fundamental concepts of Artificial Intelligence (AI), focusing on theoretical foundations, key algorithms, and real-world applications.

Course Outcomes:
At the end of this course students will demonstrate the ability to:
1. Understand the basic principles, goals, and scope of Artificial Intelligence.
2. Comprehend the core techniques of problem-solving, search algorithms, and knowledge representation in AI.
3. Grasp the fundamentals of machine learning, neural networks, and natural language processing.
4. Analyze the ethical implications and societal impact of AI technologies.

Unit	Contents
I.	**Introduction to Artificial Intelligence :** What is intelligence? Foundations of artificial intelligence (AI), Definition and history of AI, Goals and applications of AI, Intelligent agents and their types (simple reflex, model-based, goal-based, utility-based), Turing Test and its significance, Ethical considerations in AI.
II.	**Problem-Solving and Search Techniques:** Problem-solving approaches in AI, State space representation, Uninformed search strategies (BFS, DFS), Informed search strategies (A*, greedy search), Adversarial search (minimax algorithm), Constraint satisfaction problems, AI problems: Toy Problems, Real World problems- Tic-Tac-Toe, Water Jug, Question-Answering, 8-puzzle, 8-Queens problem. Formulating problems, Searching for Solutions
III.	**Knowledge Representation and Machine Learning**: Logical representations (propositional and predicate logic), Semantic networks and frames, Introduction to machine learning: supervised, unsupervised, and reinforcement learning, Decision trees and clustering (conceptual overview)
IV.	**Neural Networks and AI Applications**: Basics of artificial neural networks (ANNs), Perceptrons and multi-layer networks, Natural language processing (NLP) fundamentals, AI applications in robotics, healthcare, and gaming, Limitations and future trends in AI.

Text/Reference books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, 2020.
2. Elaine Rich and Kevin Knight, Artificial Intelligence, McGraw Hill, 1991.
3. Stephen Lucci and Danny Kopec, Artificial Intelligence in the 21st Century, Mercury Learning, 2016.
4. Melanie Mitchell, Artificial Intelligence: A Guide for Thinking Humans, Pelican, 2019.

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