Department of Electronics and Communications Engineering

Andhra University College of Engineering (A)

Andhra University

Visakhapatnam-530003

4 Years B. TECH

Quantum Computing Programme

Scheme of Instruction and Examination with effect from 2025-2026 admitted batch onwards

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

A U COLLEGE OF ENGINEERING (A),

ANDHRA UNIVERSITY

Quantum Computing Programme

SCHEME AND SYLLABI

B.Tech I Year - I Semester
(with effect from 2025-26 admitted Batch)

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
QC1101	BS	Mathematics -I (Partial Differentiation and Multiple Integrals)	4	0	30	70	100	3
QC1102	BS	Physics	4	0	30	70	100	3
QC1103	ES	Electronic Devices and Circuits	4	0	30	70	100	3
QC1104	ES	Computer Programming and Numerical Methods	4	0	30	70	100	3
QC1105	ES	Fundamentals of Quantum Mechanics	4	0	30	70	100	3
QC1106	ES	Electronic Devices and Circuits Lab	0	3	50	50	100	1.5
QC1107	BS	Physics Lab	0	3	50	50	100	1.5
QC1108	ES	Computer Programming and Numerical Methods Lab	0	3	50	50	100	1.5
							Total Credits	**19.5**

B.Tech I Year - II Semester
(with effect from 2025-26 admitted Batch)

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
QC1201	BS	Linear Algebra and Calculus	4	0	30	70	100	3
QC1202	BS	Introduction to Quantum Computing	4	0	30	70	100	3
QC1203	HSS	English	4	0	30	70	100	3
QC1204	ES	Digital Logic Design	4	0	30	70	100	3
QC1205	ES	Data Structures	4	0	30	70	100	3
QCI1206	HSS	English Language Lab	0	3	50	50	100	1.5
QC1207	BS/ES	Data Structures Lab	0	3	50	50	100	1.5
QC1208	ES	Digital Logic Design Lab	0	3	50	50	100	1.5
QC1209	ES	Do It Yourself (DIY) Lab	0	3	50	50	100	1
							Total Credits	**20.5**

B.Tech II Year - I Semester
(with effect from 2025-26 admitted Batch)

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
QC2101	BS	Probability and Statistics	4	0	30	70	100	3
QC2102	PC	Python Programming	4	0	30	70	100	3
QC2103	PC	Quantum Hardware and Error Correction	4	0	30	70	100	3
QC2104	PC	Signals & Systems	4	0	30	70	100	3
QC2105	HSS	Managerial Economics	4	0	30	70	100	3
QC2106	PC	Python Programming Lab	0	3	50	50	100	1.5
QC2107	PC	Quantum Hardware Lab	0	3	50	50	100	1.5
QC2108	PC	Signals & Systems Simulation Lab	0	3	50	50	100	1.5
QC2109	SC	MATLAB Programming	1	2	50	50	100	2
QC2110	MC	Professional Ethics and Universal Human Values	0	0	00	100	100	0
QC2111	MC	NCC/NSS	0	2	-	-	-	0
							Total Credits	**21.5**

B.Tech II Year - II Semester
(with effect from 2025-26 admitted Batch)

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
QC2201	ES	Electromagnetic Field Theory and Transmission Lines	4	0	30	70	100	3
QC2202	PC	Quantum Machines	4	0	30	70	100	3
QC2203	PC	Quantum Computing Systems and Programming	4	0	30	70	100	3
QC2204	PC	Microprocessors and Microcontrollers	4	0	30	70	100	3
QC2205	PC	Introduction to Quantum Sensing	4	0	30	70	100	3
QC2206	PC	Microprocessors and Microcontrollers Lab	0	3	50	50	100	1.5
QC2207	PC	Quantum Computing Lab	0	3	50	50	100	1.5
QC2208	SC	Introduction to Qiskit & IBM Quantum	1	2	50	50	100	2
QC2209	MC	Environmental Science	0	0	00	100	100	0
							Total Credits	**20**
Internship-I (2Months Duration)								

B.Tech III Year - I Semester
(With effect from 2025-26 admitted Batch)

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
QC3101	PC	Introduction to Quantum Materials	4	0	30	70	100	3
QC3102	PC	Classical and Quantum Information Theory	4	0	30	70	100	3
QC3103	PC	Quantum Algorithms	4	0	30	70	100	3
QC3104	PE	**Professional Elective-I**	4	0	30	70	100	3
QC3105	OE	**Open Elective-I**	4	0	30	70	100	3
QC3106	PC	Quantum Algorithms with Python and Qiskit Lab	0	3	50	50	100	1.5
QC3107	PC	Quantum Networks Lab	0	3	50	50	100	1.5
QC3108	SC	Modeling Physical Systems using Quantum Circuits	1	2	50	50	100	2
QC3109	INT	Internship-I			50	50	100	2
Internship-I(2months) done after 2nd Year 2nd Semester to be evaluated during 3rd Year 1st Semester								
							Total Credits	**22**

B.Tech III Year - II Semester
(With effect from 2025-26 admitted Batch)

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
QC3201	PC	Quantum Game Theory	4	0	30	70	100	3
QC3202	PC	Digital Signal Processing	4	0	30	70	100	3
QC3203	PC	Atomic and Molecular Spectroscopy	4	0	30	70	100	3
QC3204	PE	**Professional Elective-II**	4	0	30	70	100	3
QC3205	OE	**Open Elective-II**	4	0	30	70	100	3
QC3206	PC	Spectroscopy Lab	0	3	50	50	100	1.5
QC3207	PC	Digital Signal Processing Lab	0	3	50	50	100	1.5
QC3208	PC	Quantum Game Theory Lab		3	50	50	100	1.5
QC3209	SC	Soft Skills	1	2	50	50	100	2
							Total Credits	**21.5**
Internship-II (2Months Duration)								

B.Tech IV Year - I Semester
(With effect from 2025-26 admitted Batch)

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
QC4101	PE	Professional Elective-III	4	0	30	70	100	3
QC4102	PE	Professional Elective-IV	4	0	30	70	100	3
QC4103	PE	Professional Elective-V	4	0	30	70	100	3
QC4104	OE	Open Elective-III	4	0	30	70	100	3
QC4105	OE	Open Elective-IV	4	0	30	70	100	3
QC4106	HSSE	HSS-Elective	4	0	30	70	100	3
QC4107	SC	Quantum Startups and Tools (Industry Connect)	1	2	50	50	100	2
QC4108	INT	Internship-II			50	50	100	2
Internship-II (2months) done after 3rd Year 2nd Semester to be evaluated during 4th Year 1st Semester								
							Total Credits	**22**

B. Tech IV Year - II Semester
(With effect from 2025-26 admitted Batch)

Course code	Category	Course Title	Internal Marks	External Marks	Total Marks	Credits
QC4201	PROJ	Project work	100	100	200	13
					Total Credits	**13**

<u>Note:</u> It is mandatory to complete one MOOCS Course (12 weeks or more duration) to obtain B.Tech Degree in QC. This can be added in Lieu of any other courses.

PROFESSIONAL ELECTIVES (PE)

1. Quantum Computing for Sustainable Energy Solutions
2. Solid State NMR Spectroscopy
3. Advanced Optoelectronics
4. Quantum Simulation and Quantum Chemistry
5. Quantum Computing in Industrial Automation and Robotics
6. Quantum Mechanics For Nanotechnology
7. Mobile and Cellular Communication (Including 5G & Beyond and Microstrip Antennas)
8. Quantum Cryptography
9. Quantum Communication and Information Systems
10. Quantum Optics
11. Integrated Optoelectronic Devices and Circuits
12. VLSI Design
13. Computer Network Engineering

OPEN ELECTIVES (OE)

1. Discrete Mathematics
2. Algorithms and Complexity
3. MEMS and MOEMS
4. Nano -photonics and Technology
5. Materials Thermodynamics
6. Fundamentals of Microstrip Lines
7. Introduction to Quantum AI &ML
8. Deep Learning Techniques

HSS ELECTIVES (HSSE)

1. Industrial Management & Entrepreneurship.
2. Organizational Behavior.
3. Financial Management for Engineers.

QC1101- MATHEMATICS -I (PARTIAL DIFFERENTIATION AND MULTIPLE INTEGRALS) (BS)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1101	Mathematics -I (Partial Differentiation and Multiple Integrals)	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To transmit the knowledge of Partial differentiation.
- To know of getting maxima and minima of function of two variables and finding errors and approximations.
- To evaluate double and triple integrals, volumes of solids and area of curved surfaces.
- To expand a periodical function as Fourier series and half-range Fourier series.

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

CO1: Find the partial derivatives of functions of two or more variables.

CO2: Evaluate maxima and minima, errors and approximations.

CO3: Evaluate double and triple integrals, volumes of solids and area of curved surfaces.

CO4: To expand a periodical function as Fourier series and half-range Fourier series.

CO5: Have a fundamental understanding of Fourier series and be able to give Fourier expansions of a given function.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Partial Differentiation: Introduction - Functions of two or more variables - Partial derivatives - Homogeneous functions – Euler's theorem - Total derivative - Change of variables – Jacobins. Mean value Theorems (without proofs)

UNIT-II: Applications of Partial Differentiation: Geometrical interpretation -Tangent plane and Normal to a surface -Taylor's theorem for functions of two variables - Errors and approximations -Total differential, Maxima and Minima of functions of two variables -

Lagrange's method of undetermined multipliers - Differentiation under the integral Sign- Leibnitz's rule.

UNIT-III: Multiple Integrals: Introduction - Double Integrals - Change of Order of Integration Double Integrals in Polar Coordinates - Triple Integrals - Change of Variables.

UNIT-IV: Multiple Integrals-Applications: Area enclosed by plane curves - Volumes of solids Area of a curved surface - Calculation of Mass - Center of gravity - Moment of inertia - product of inertia – principal axes- Beta Function - Gamma Function - Relation between Beta and Gamma Functions, Error Function or Probability Integral.

UNIT-V: Fourier series: Introduction - Euler's Formulae - Conditions for a Fourier Expansion Functions having points of discontinuity - Change of Interval - Odd and Even Functions - Expansions of Odd or Even Periodic Functions, Half-Range Series - Parseval's Formula, Practical Harmonic analysis.

Text Books:

1. Scope and Treatment as in "Higher Engineering Mathematics", by Dr. B.S. Grewal, 43rd Edition, Khanna publishers.

Reference Books:

1. Graduate Engineering Mathematics by V B Kumar Vatti., I.K.International publishing house Pvt. Ltd.
2. Advanced Engineering Mathematics by Erwin Kreyszig.
3. A text book of Engineering Mathematics, by N.P. Bali and Dr. Manish Goyal, Lakshmi Publications.
4. Advanced Engineering Mathematics by H.K. Dass. S. Chand Company.
5. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Graw Hill Company.
6. Higher Engineering Mathematics by Dr. M.K.Venkataraman.

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QC1102- PHYSICS (BS)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1102	**Physics**	**4**			**30**	**70**	**100**	**3hrs**	**3**

Course Objectives: The objectives of this course are

- To impart knowledge in basic concept of physics of Thermodynamics relevant to engineering applications.
- To grasp the concepts of physics for electromagnetism and its application to engineering. Learn production of Ultrasonic's and their applications in engineering.
- To Develop understanding of interference, diffraction and polarization: connect it to a few engineering applications.
- To learn basics of lasers and optical fibers and their use in some applications.
- To understand concepts and principles in quantum mechanics and Nanopahse Materials. Relate them to some applications.

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

CO1: Understand the fundamentals of Thermodynamics and Laws of thermodynamics. Understand the working of Carnot cycle and concept of entropy.

CO2: Gain Knowledge on the basic concepts of electric and magnetic fields. Understand the concept of the nature of magnetic materials. Gain knowledge on electromagnetic induction and its applications.

CO3: Understand the Theory of Superposition of waves. Understand the formation of Newton's rings and the working of Michelson's interferometer. Remember the basics of diffraction, Evaluate the path difference. Analysis of Fraunhofer Diffraction due to a single slit.

CO4: Understand the interaction of matter with radiation, Characteristics of Lasers, Principle, working schemes of Laser and Principle of Optical Fiber. Realize their role in optical fiber communication.

CO5: Understand the intuitive ideas of the Quantum physics and understand dual nature of matter. Compute Eigen values, Eigen functions, momentum of Atomic and subatomic particles using Time independent one-Dimensional Schrodinger's wave equation. Understand the fundamentals and synthesis processes of Nanophase materials.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT - I: THERMODYNAMICS

Introduction, Heat and Work, First law of thermodynamics and applications, Reversible and Irreversible process, Carnot cycle and Efficiency, Second law of thermodynamics, Carnot's Theorem, Entropy, Second law in terms of entropy, Entropy and disorder, Third law of thermodynamics (statement only).

UNIT – II: ELECTROMAGNETISM

Concept of electric flux, Gauss's law - some applications, Magnetic field - Magnetic force on current, torque on current loop, The Biot-Savart's Law, B near a long wire, B for a circular Current loop, Ampere's law, B for a solenoid, Hall effect, Faraday's law of induction, Lenz's law, Induced magnetic fields, Displacement current, Maxwell's equations (no derivation), Magnetic materials: Classification of magnetic materials and properties.

Ultrasonics**:** Introduction, Production of Ultrasonics – Piezoelectric and Magnetostriction methods, acoustic grating, applications of ultrasonics.

UNIT – III: OPTICS

Interference: Principles of superposition – Young's Experiment – Coherence - Interference in thin films (reflected light), Newton's Rings, Michelson Interferometer and its applications.

Diffraction: Introduction, Differences between interference and diffraction, Fresnel and Fraunhofer diffraction, Fraunhofer diffraction at a single slit (Qualitative and quantitative treatment).

Polarisation: Polarisation by reflection, refraction and double refraction in uniaxial crystals, Nicol prism, Quarter and Half wave plate, circular and elliptical polarization.

UNIT – IV: LASERS and FIBRE OPTICS

Introduction, characteristics of a laser beam, spontaneous and stimulated emission of radiation, population inversion, Ruby laser, He-Ne laser, Semiconductor laser, applications of lasers.

Introduction to optical fibers, principle of propagation of light in optical fibers, Acceptance Angle and cone of a fibre, Numerical aperture, Modes of propagations, classification of fibers, Fibre optics in communications, Application of optical fibers.

UNIT – V: MODERN PHYSICS

Introduction, De Broglie concept of matter waves, Heisenberg uncertainty principle, Schrodinger time independent wave equation, application to a particle in a box. Free electron theory of metals, Kronig - Penney model (qualitative treatment), Origin of energy band formation in solids, Classification of materials into conductors, semi-conductors and insulators. Nanophase Materials: Introduction, properties, Top-down and bottom-up approaches, Synthesis - Ball milling, Chemical vapour deposition method, sol-gel methods, Applications of nano materials.

TEXT BOOKS:

1. Physics by David Halliday and Robert Resnick – Part I and Part II **-** Wiley.
2. A textbook of Engineering Physics, Dr. M. N. Avadhanulu, Dr. P.G. Kshirsagar - S. Chand
3. Engineering Physics by R.K. Gaur and S.L. Gupta –Dhanpat Rai

Reference Books:

1. Modern Engineering Physics by A.S. Vadudeva
2. University Physics by Young and Freedman

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QC1103 - ELECTRONIC DEVICES AND CIRCUITS (ES)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1103	Electronic Devices and Circuits	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To understand the operation of semiconductor devices.
- To understand DC analysis and AC models of semiconductor devices.
- To apply concepts for the design of Filters, Regulators, Oscillators and Amplifiers for different applications.
- To analyze the theoretical concepts through laboratory and simulation experiments.
- To apply how to implement mini projects using electronic circuit concepts.

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

CO1: Illustrate fundamentals of semiconductor physics for active devices.

CO2: Demonstrate the characteristics of PN Junction diodes and illustrate the functional behavior of different types of special semiconductor devices.

CO3: Examine the V-I characteristics and different BJT amplifier configurations.

CO4: Analyze BJT biasing and low frequency response of the BJT amplifiers.

CO5: Understand the JFET operation and its small signal operation.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Energy band theory of solids and transport phenomenon in semiconductors: Energy Band Theory of Solids Intrinsic and Extrinsic Semiconductors Doping, Doping Materials, Carrier Mobility, Conductivity, Diffusion and continuity equation, Hall – Effect. Semiconductor Diodes Band structure of PN Junction, Quantitative Theory of PN Diode, and Volt – Amp, Characteristics, Temperature Dependence, Transition and Diffusion Capacitance of PN Junction.

UNIT-II: Rectifiers and special diodes: Diode Rectifiers: Half-wave, Full-wave and Bridge Rectifiers with and without Filters, Ripple Factor and Regulation Characteristics, Zener and Avalanche Breakdowns, Tunnel Diode, LED, Schottky Barrier Diode, Varactor Diode, Photo Diode, PIN Diode.

UNIT-III: Transistor Characteristics and Transistor Biasing: Bipolar Junction Transistor NPN and PNP junction Transistor, Characteristics of Current Flow across the Base Regions, Minority and Majority Carrier Profiles, CB, CE and CC Configurations and their Input and Output Characteristics, Comparison of CE, CB, and CC Configurations, Junction Biasing for Saturation, Cutoff and Active Region, α and β Parameters and the relation between them, Biasing circuits, thermal runaway, thermal stability, stabilizations circuits.

UNIT-IV: Transistor at Low Frequencies: Small Signal: Low Frequency Transistor Amplifier Circuits Transistor as an Amplifier, h – parameter model, Analysis of Transistor Amplifier Circuits using h –parameters, CB, CE and CC Amplifier configurations and performance factors, Analysis of Single Stage Amplifier, RC Coupled Amplifiers, Effects of Bypass and Coupling Capacitors. Frequency Response of CE Amplifier, Emitter – Follower, Cascaded Amplifier.

UNIT-V: Field Effect Transistors: JFET and its characteristics, Pinch off Voltage, Drain Saturation Current, MOSFET–Enhancement and Depletion Modes, JFET Configurations, JFET biasing, Small signal models of FET, JFET Common Source amplifier.

Text Books:

1. Integrated Electronics, Analog Digital Circuits and systems, Jacob Millmann and D. Halkias, McGraw Hill.
2. Electronic Devices and Circuits, G.S.N. Raju, I.K. International Publications, New Delhi, 2006.

Reference Books:

1. Adel S. Sedra, Kenneth C. Smith, Arun N. Chandorkar, Microelectronic Circuits, 6/e, Oxford University Press, 2013.
2. Electronic Devices and Circuits 2nd Edition, B. V. Rao and K. Raja Rajeswari, Pearson Education.
3. Electronic Devices and Circuits, K. Venkat Rao, K. Rama Sudha, McGraw Hill education, Edition-2015.
4. Electronic Devices and Circuits Theory, Boylsted and Nashelsky, Prentice Hall Publications.

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QC1104 – COMPUTER PROGRAMMING AND NUMERICAL METHODS (ES)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1104	Computer Programming and Numerical Methods	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To provide complete knowledge of C language.
- To provide students with understanding of code organization and functional hierarchical decomposition with using complex data types.
- To provide knowledge to the students to develop logics this will help them to create programs, applications in C.
- This course aims to identify tasks in which the numerical techniques learned are applicable and apply them to write programs, and hence use computers effectively to solve the task.
- This course provides the fundamental knowledge which is useful in understanding the other programming languages.

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

CO1: Identify basic elements of C programming structures like data types, expressions, control statements, various simple functions and apply them in problem solving.
CO2: Apply various operations on derived data types like arrays and strings in problem solving. **CO3:** Design and implement of modular Programming and memory management using Functions, pointers.
CO4: Apply Structure, Unions and File handling techniques to Design and Solve different engineering programs with minimal complexity.
CO5: Apply Numerical methods to solve the complex Engineering problems.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Introduction to C: Basic structure of C program, Constants, Variables and data types, Operators and Expressions, Arithmetic Precedence and associativity, Type Conversions. Managing Input and Output Operations Formatted Input, Formatted Output.

UNIT-II: Decision Making, Branching, Looping, Arrays & Strings: Decision making with if statement, Simple if statement, The if…else statement, Nesting of if…else statement, the else..if ladder, switch statement, the (?:) operator, the GOTO statement., The while statement, the do statement, The for statement, Jumps in Loops, One, Two-dimensional Arrays, Character Arrays. Declaration and initialization of Strings, reading and writing of strings, String handling functions, Table of strings.

UNIT-III: Functions: Definition of Functions, Return Values and their Types, Function Calls, Function Declaration, Category of Functions: No Arguments and no Return Values, Arguments but no Return Values, Arguments with Return Values, No Argument but Returns a Value, Functions that Return Multiple Values, Nesting of functions, recursion, passing arrays to functions, passing strings to functions, the scope, visibility and lifetime of variables.

UNIT-IV: Pointers: Accessing the address of a variable, declaring pointer variables, initializing of pointer variables, accessing variables using pointers, chain of pointers, pointer expressions, pointers and arrays, pointers and character strings, array of pointes, pointers as function arguments, functions returning pointers, pointers to functions, pointers to structures-Program Applications.

UNIT-V: Structure and Unions: Defining a structure, declaring structure variables, accessing structure members, structure initialization, copying and comparing structure variables, arrays of structures, arrays within structures, structures within structures, structures and functions and unions, size of structures and bit-fields- Program applications.

UNIT-VI: File handling: Defining and opening a file, closing a file, Input/ Output operations on files, Error handling during I/O operations, random access to files and Command Line Arguments- Program Applications

UNIT-VII: Numerical Methods: Solutions of Algebraic and Transcendental Equations, Bisection Method, Newton Raphson Method. Newton's forward and backward Interpolation, Lagrange's Interpolation in unequal intervals. Numerical Integration: Trapezoidal rule, Simpson's 1/3 rules. Solutions of Ordinary First Order Differential Equations: Euler's Method, Modified Euler's Method and Runge-Kutta Method.

Text Books:

1. Programming in ANSI C, E Balagurusamy, 6th Edition. McGraw Hill Education (India) Private Limited.
2. Introduction to Numerical Methods, SS Sastry, Prentice Hall.

Reference Books:

1. Let Us C, YashwantKanetkar, BPB Publications, 5th Edition.
2. Computer Science, A structured programming approach using C", B.A.Forouzan and R.F.Gilberg, " 3rd Edition, Thomson, 2007.
3. The C –Programming Language' B.W. Kernighan, Dennis M. Ritchie, PHI.
4. Scientific Programming: C-Language, Algorithms and Models in Science, Luciano M. Barone (Author), Enzo Marinari (Author), Giovanni Organtini, World Scientific.

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QC1105 – FUNDAMENTALS OF QUANTUM MECHANICS (ES)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1105	Fundamentals of Quantum Mechanics	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Understand wave-particle duality and uncertainty.
- Learn postulates and math of quantum mechanics.
- Solve basic quantum potential problems.
- Apply matrix methods in quantum theory.
- Study angular momentum and hydrogen atom.

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

CO1: Describe quantum concepts like matter waves.

CO2: Use Schrödinger equation and operators.

CO3: Analyze quantum systems with simple potentials.

CO4: Apply matrix formalism and Dirac notation.

CO5: Solve angular momentum and hydrogen atom problems.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT - I: FOUNDATIONS OF QUANTUM THEORY: Wave-Particle Duality: De Broglie Hypothesis, Matter Waves, Group and Phase Velocity; Uncertainty Principle: Heisenberg's Relation and Physical Interpretation; Quantum Postulates: Basic Postulates and Physical Meaning; Schrödinger Equation: Time-Dependent and Time-Independent Forms; Probability Concepts: Probability Density and Current, Normalization.

UNIT - II: OPERATORS AND QUANTUM SYSTEMS: Quantum Operators: Commutation, Expectation Values, Hermitian Operators; Eigen Concepts: Eigenvalues and Eigenfunctions, Orthogonality; Potential Problems: Particle in a Box, Potential Step, Finite Well, Delta Function; Harmonic Oscillator: Schrödinger Equation and Hermite Polynomials; Matrix Mechanics: Bra-Ket Notation, Operator Representations.

UNIT - III: ANGULAR MOMENTUM AND HYDROGEN ATOM: Angular Momentum: Operators, Commutation Relations, Quantum Numbers; Spherical Harmonics: Solutions and Properties; Central Potentials: Schrödinger Equation in 3D; Hydrogen Atom: Radial Equation, Energy Levels, Degeneracy; 3D Harmonic Oscillator: Separation of Variables and Solutions.

UNIT - IV: APPROXIMATION METHODS IN QUANTUM MECHANICS: Perturbation Theory: Non-Degenerate and Degenerate Cases, Applications to Zeeman and Stark Effects; WKB Approximation: Slowly Varying Potentials, Turning Points, Bohr-Sommerfeld Quantization; Bound States: Tunneling and Quantum Wells; Quantum Corrections: Induced Dipole Moment of Hydrogen.

UNIT - V: QUANTUM DYNAMICS AND RELATIVISTIC EQUATIONS: Time-Dependent Perturbation: Fermi's Golden Rule, Sinusoidal Perturbations; Interaction With Radiation: Einstein Coefficients, Spontaneous and Stimulated Emission; Scattering Theory: Born Approximation, Green's Functions, Cross Section; Relativistic Quantum Mechanics: Dirac Equation and Klein-Gordon Equation.

Text Book:

1. S. Gasiorowicz, Quantum Physics, John Wiley, Asia (2000).

References:

1. P. W. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill (1995).
2. F. Schwabl, Quantum Mechanics, Narosa (1998).
3. L. I. Schiff, Quantum Mechanics, McGraw-Hill (1968).
4. E. Merzbacher, Quantum Mechanics, John Wiley, Asia (1999).
5. B. H. Bransden and C. J. Joachain, Introduction to Quantum Mechanics, Longman (1993).

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QC1106 - ELECTRONIC DEVICES AND CIRCUITS LAB (ES)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1106	Electronic Devices and Circuits Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- To Study semiconductor diodes; verify their characteristics and applications of diodes as regulators, rectifiers.
- To Measure the V-I characteristics of various devices that are used in the electronic equipment.
- To Verify functionality through V-I characteristics of active devices like BJT, JFET, MOSFETS and their applications.
- To Determine the gain of CE amplifier

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

CO1: Comprehend the depth of semiconductor devices like diodes, transistor, JFET, MOSFETs characteristics.

CO2: Measure voltage, frequency and phase of any waveform using CRO.

CO3: Generate sine, square and triangular waveforms with required frequency and amplitude using function generator.

CO4: Gain hands on experience in handling electronic components and devices.

CO5: Study and verify various amplifier designs with calculation of impedance and band width.

SYLLABUS

(with effect from 2025-26 admitted Batch)

List of Experiments:

1. Study of CRO and its Applications.
2. Experimental verification of V-I Characteristics of PN Junction Diode and V-I Characteristics of LED.
3. Experimental verification of V-I Characteristics of Zener Diode and Zener Diode regulation characteristics.

4. Experimental verification of V-I characteristics of Photo diode.
5. Experimentally find DC voltage and ripple factor for Half-wave and full-wave rectifiers.
6. Experimentally find DC voltage and ripple factor for Half-wave and full-wave rectifiers with capacitor filter.
7. Experimentally find h-parameters of BJT in CE configuration from input and output characteristics.
8. Experimentally find h-parameters of BJT in CB configuration from input and output characteristics.
9. Experimentally find Voltage gain, input impedance and output impedance of emitter follower configuration.
10. Plot Drain and transfer characteristics of JFET.
11. Plot frequency response of CE amplifier to find input impedance, Bandwidth and gain.
12. Plot frequency response characteristics JFET in CS configuration.

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QC1107- PHYSICS LAB (BS)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1107	Physics Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- Ability to design and conduct experiments as well as to analyze and interpret.
- Ability to apply experimental skills to determine the physical quantities related to Heat, Electromagnetism and Optics**.**
- The student will learn to draw the relevance between theoretical knowledge and the means to imply it in a practical manner by performing various relative experiments.
- Determine the Thickness for given paper strip by wedge method.

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

CO1: To enable the students to acquire skill, technique and utilization of the Instruments.

CO2: To draw the relevance between the theoretical knowledge and to imply it in a practical manner with respect to analyze various electronic circuits and its components.

CO3: To impart the practical knowledge in basic concepts of Wave optics, Lasers and Fiber optics.

CO4: To familiarize the handling of basic physical apparatus like Venire calipers, screw gauge.

CO5: To understand spectrometers, travelling microscope, laser device, optical fiber, etc.

SYLLABUS

(with effect from 2025-26 admitted Batch)

List of Experiments:

1. Determination of Radius of Curvature of a given Convex Lens By forming Newton's Rings.
2. Determination of Wavelength of Spectral Lines in the Mercury Spectrum by Normal Incidence method.
3. Study the Intensity Variation of the Magnetic Field along axis of Current Carrying Circular Coil.

4. Determination of Cauchy's Constants of a Given Material of the Prism using Spectrometer.
5. Determination of Refractive Index of Ordinary ray μ_o and extraordinary μ_e ray.
6. Determination of Thickness Given Paper Strip by Wedge Method.
7. Calibration of Low Range Voltmeter.
8. Calibration of Low Range Ammeter.
9. Determination of Magnetic Moment and Horizontal Component of Earth's Magnetic Field.
10. Lees Method - Coefficient of thermal Conductivity of a Bad Conductor.
11. Carey Foster's Bridge – Verification of laws of Resistance and Determination of Specific Resistance.
12. Melde's Apparatus – Frequency of electrically maintained Tuning Fork.
13. Photoelectric cell-Characteristics.
14. Planks Constants.
15. Laser- Diffraction.

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QC1108 – COMPUTER PROGRAMMING AND NUMERICAL METHODS LAB (ES)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1108	Computer Programming and Numerical Methods Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- To impart writing skill of C programming to the students and solving problems.
- To write and execute programs in C to solve problems such as Modularize the problems into small modules and then convert them into programs.
- To write and execute programs in C to solve problems such as arrays, files, strings structures and different numerical methods.
- This reference has been prepared for the beginners to help them understand the basic to advanced concepts related to Objective-C Programming languages.

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

CO1: Understand various computer components, Installation of software, C programming development environment, compiling, debugging, and linking and executing a program using the development environment.

CO2: Analyzing the complexity of problems, modularize the problems into small modules and then convert them into programs.

CO3: Construct programs that demonstrate effective use of C features including arrays, strings, structures, pointers and files.

CO4: Apply and practice logical ability to solve the real world problems.

CO5: Apply Numerical methods to solve the complex Engineering problems.

SYLLABUS

(with effect from 2025-26 admitted Batch)

List of Experiments:

1. Write a program to read x, y coordinates of 3 points and then calculate the area of a triangle formed by them and print the coordinates of the three points and the area of the triangle. What will be the output from your program if the three given points are in a straight line?
2. Write a program, which generates 100 random integers in the range of 1 to 100. Store them

in an array and then print the arrays. Write 3 versions of the program using different loop constructs. (e.g. for, while, and do while).

3. Write a set of string manipulation functions e.g. for getting a sub-string from a given position, copying one string to another, reversing a string, adding one string to another.
4. Write a program which determines the largest and the smallest number that can be stored in different data types like short, int, long, float, and double. What happens when you add 1 to the largest possible integer number that can be stored?
5. Write a program, which generates 100 random real numbers in the range of 10.0 to 20.0, and sort them in descending order.
6. Write a function for transposing a square matrix in place (in place means that you are not allowed to have full temporary matrix).
7. First use an editor to create a file with some integer numbers. Now write a program, which reads these numbers and determines their mean and standard deviation.
8. Given two points on the surface of the sphere, write a program to determine the smallest arc length between them.
9. Implement bisection method to find the square root of a given number to a given accuracy.
10. Implement Newton Raphson method to det. a root of polynomial equation.
11. Given table of x and corresponding f(x) values, write a program which will determine f(x) value at an intermediate x value by using Lagrange's interpolation/
12. Write a function which will invert a matrix.
13. Implement Simpson's rule for numerical integration.
14. Write a program to solve a set of linear algebraic equations.

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QC1201- LINEAR ALGEBRA & CALCULUS (BS)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1201	Linear Algebra & Calculus	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Understand the fundamental concepts of matrix algebra including rank, echelon form, and methods to solve systems of linear equations.
- Explore eigenvalues, eigenvectors, and their applications in matrix diagonalization and quadratic form analysis.
- Familiarize with vector spaces, linear transformations, and inner product spaces including orthogonalization techniques.
- Comprehend the concepts of vector calculus involving gradient, divergence, curl, and various integral theorems.
- Apply methods of solving first-order differential equations to real-world applications in engineering and science.

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

CO 1: Determine the rank of a matrix and solve linear systems using Gauss elimination, LU factorization, and Gauss-Seidel methods.

CO 2: Compute eigenvalues and eigenvectors and use the Cayley-Hamilton theorem for matrix inversion and diagonalization.

CO 3: Illustrate vector spaces and linear transformations, and apply the Gram-Schmidt process to obtain orthonormal bases.

CO 4: Evaluate line, surface, and volume integrals, and apply vector calculus concepts in engineering problems.

CO 5: Solve first-order differential equations and apply them to model physical systems such as electrical circuits and cooling laws.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Matrix Algebra: Rank of matrix – Echelon form and Normal form – Solution of Linear Systems of Equations- Consistency of Linear system and Equations – Gauss Elimination method, LU Factorization Method and Gauss Seidel Method. Complex Matrices: Hermitian, Skew- Hermitian, Unitary and Identity matrices.

UNIT-II: Eigen Values, Eigen Vectors and Quadratic Forms: Eigen Values and Eigen Vectors of a matrix – Cayley- Hamilton theorem (without proof) and its applications. Diagonalization of a matrix – Quadratic Forms – Reduction of Quadratic Form to Canonical Form – Nature of a Quadratic Form.

UNIT-III: Vector Spaces, Linear Transformations and Inner Product Spaces: Vector Space, Subspace, Linear Combination of Vectors, Linear Span of a Set, Linear Dependence, Independence, Basis and Dimension. Linear Transformations- Matrix of a LT relative to different basis (only examples). Inner Product Spaces- Orthogonality and Orthonormality – Grams- Schmidt Orthogonalization.

UNIT-IV: Introduction to Tensors and Ordinary Differential Equations of First Order
Introduction, Summation Convention, n-dimensional space - Transformation of coordinates, Definition of scalars (or invariants), KRONECKER DELTA. Tensor (Contravariant, Covariant and mixed Tensors), Order (or Rank) of a Tensor. Covariant and Contravariant Tensor of order One, Second and Higher order Tensors, Symmetric and Skew-Symmetric Tensors. Equality and Null Tensors, Addition and Subtraction of Tensors. Outer product of two Tensors, Contraction of a Tensor, Inner Product of Two Tensors. Equations of the first order and first degree Linear differential equation - Bernoulli's equation - Exact differential equations - Equations reducible to exact equations - Applications: Orthogonal Trajectories.

UNIT-V: Vector Calculus: Vector Differentiation: Introduction- Scalar and Vector Point Functions, General Rules for Vector Differentiation, Gradient, Divergence and Curl. Vector Integration: Line Integrals, Surface Integrals, Volume integrals, Greens Theorem in a plane, Stokes Theorem and Gauss Divergence Theorem (all theorems without proofs).

Text Book:

1. Scope and Treatment as in "Higher Engineering Mathematics", by Dr. B.S. Grewal, 43r[d] edition, Khanna publishers.

Reference Books:

1. Advanced Engineering Mathematics by Erwin Kreyszig.
2. Advanced Engineering by R.K. Jain and S.R.K. Iyengar, Narosa Publishers, 5^{th} Edition.
3. A text book of Engineering Mathematics, by N.P. Bali and Dr. Manish Goyal. Lakshmi Publications.
4. Advanced Engineering Mathematics by H.K. Dass. S. Chand Company.
5. Essential Mathematics for Quantum Computing; A beginner’s guide.Leonard S. WoodyIII, Packt Publishing Ltd.,April, 2022.
6. Linear Algebra- A modern introduction by David Poole, 4^{th} Edition, 2015.
7. A Linear Algebra by J.N. Sharma and A.R. Vasista, 4^{th} Edition, 2009.

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QC1202 – INTRODUCTION TO QUANTUM COMPUTING (BS)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1202	Introduction to Quantum Computing	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Introduce the foundational postulates and mathematical structure of quantum mechanics relevant to computation.
- Explain the behavior of quantum bits (qubits) and their physical implementations.
- Study the structure of quantum states, operations, and correlations.
- Develop understanding of quantum logic circuits and algorithms.
- Familiarize with quantum error correction, fault-tolerance, and emerging quantum technologies**.**

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

CO1: Understand the axioms of quantum theory and contrast classical bits with qubits in various physical systems.

CO2: Analyze quantum states using density matrices, superoperators, and Kraus representations.

CO3: Describe entanglement, Bell's theorems, and reversible computation in quantum circuit models.

CO4: Implement and interpret quantum algorithms including Deutsch, Grover, and Shor’s algorithms.

CO5: Evaluate the role of error correction, NISQ devices, and current trends in quantum technology.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT - I: Foundations of Quantum Theory – Axiomatic Quantum Theory: Quantum States, Observables, Measurement, Hilbert Space, Unitary Transformations, Schrodinger Equation and Unitary Evolution, No Cloning Theorem, Qubits Versus Classical Bits: Spin-

Half Systems, Photon Polarizations, Trapped Atoms and Ions, Artificial Atoms Using Circuits, Semiconducting Quantum Dots, Single and Two Qubit Gates, Solovay–Kitaev Theorem.

UNIT - II: Quantum States and Operations – Pure and Mixed States: Density Matrices, General Quantum Evolution: Super operators, Positive and Completely Positive Trace-Preserving Maps, Kraus Operators, Quantum Correlations: Entanglement, Bell's Theorems.

UNIT - III: Quantum Circuits and Classical Computation – Classical Models: Review of Turing Machines and Complexity, Reversible Computation, Quantum Circuits: Universal Quantum Logic Gates and Circuits.

UNIT - IV: Quantum Algorithms – Early Quantum Algorithms: Deutsch Algorithm, Deutsch–Josza Algorithm, Bernstein–Vazirani Algorithm, Database Search: Grover's Algorithm, Quantum Fourier Transform and Prime Factorization: Shor's Algorithm.

UNIT - V: Error Correction and Quantum Hardware – Quantum Error Correction: Fault-Tolerance, Simple Error Correcting Codes, Current Status of Quantum Computing: NISQ Era Processors, Quantum Advantage Claims, Roadmap for Future Technologies.

Textbooks:

1. Quantum Mechanics for Engineers, 1st Edition – A.B. Bhattacharya & Atanu Nag
2. Quantum Computation and Quantum Information, 10th Anniversary Edition – Michael A. Nielsen & Isaac L. Chuang
3. Quantum Information Science, 1st Edition – Francesco Motta & Riccardo Manenti
4. Introduction to Quantum Computing, 1st Edition – Hui Yung Wong

Reference Books:

1. Quantum Error Correction, 1st Edition – Frank Gaitan
2. Quantum Computing Explained, 1st Edition – David McMahon
3. Quantum Computing and Techniques, 1st Edition – Rajiv Chopra

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QC1203- ENGLISH (HSS)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1203	English	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To enhance understanding of explicit and implicit meanings of a text.
- To introduce new words for diverse context usage.
- To teach writing formats for essays, letters, and presentations.
- To cultivate adaptability and problem-solving for real-world scenarios.

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

CO1: Analyze a given text and discover the various aspects related to language and literature.

CO2: Learn the various language structures, parts of speech and figures of speech.

CO3: Learn time management, ethics and its values.

CO4: Develop one's reading and writing abilities for enhanced communication.

CO5: To apply the topics in real-life situations for creative and critical use.

Topics:

	PROSE	POETRY
UNIT 1	Swami Vivekananda: **The Secret of Work**	Grenville Kleiser: **Stay Calm**
UNIT 2	Katherine Mansfield: ***The Doll's House***	Rabindranath Tagore: **Where the Mind Is Without Fear**
UNIT 3	O. Henry: **The Last Leaf**	Rudyard Kipling: **If**
UNIT 4	Francis Bacon: **Of Studies**	Toru Dutt: **Our Casuarina Tree**
UNIT 5	Mark Twain: **Whitewashing the Fence**	William Ernest Henley: **Invictus**

GRAMMAR, VOCABULARY LISTENING, SPEAKING AND WRITING

	GRAMMAR & VOCABULARY	LISTENING	SPEAKING	WRITING
1	Synonyms & Antonyms	Listening for Context and Specific Information	Introducing Oneself and Others	Punctuation
2	Phrasal Verbs	Listening for Main Idea and Supporting Ideas	Getting Someone's Attention and Interrupting	Formal Letters
3	Idiomatic Expressions	Listening for Global Comprehension	Asking for Information and Giving Information	Note-Making
4	Common Errors I	Listening to Make Inferences	Expressing Opinions, and Agreeing and Disagreeing with Opinions	Essay Writing
5	Common Errors II	Listening for Key Ideas	Telephone Etiquette	E-mail Etiquette

Textbook:
English for Engineers: Theory to Practice. Board of Editors, Orient Blackswan Publishers,India. 2024.

Reference Books:

1. English Grammar in Use by Raymond Murphy
2. Oxford English Grammar Course by Michael Swan
3. Word Power Made Easy by Norman Lewis
4. Cambridge Vocabulary for IELTS by Pauline Cullen
5. The Elements of Style by William Strunk Jr. and E.B. White
6. English Vocabulary in Use by Michael McCarthy and Felicity O'Dell
7. Practical English Usage by Michael Swan
8. The Only Grammar Book You'll Ever Need by Susan Thurman
9. Advanced English Grammar: A Linguistic Approach by Ilse Depraetere and Chad Langford

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QC1204- DIGITAL LOGIC DESIGN (ES)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1204	Digital Logic Design	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To understand Different number systems, digital logic, simplification and minimization of Boolean functions.
- To analyze logic processes and implement logical operations using combinational logic circuits.
- To analyze the characteristics of memory and their classification.
- To design combinational & sequential digital circuits and state machines.
- To understand about programmable logic devices.

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

CO1: Discuss the significance of number systems, conversions, binary codes.

CO2: Apply different simplification methods for minimizing Boolean functions.

CO3: Analyze the design concepts of various combinational circuits.

CO4: Analyze the concepts of sequential logic design.

CO5: Categorize Mealy & Moore models and Design Synchronous Sequential machines.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Number systems and codes: Number systems, Base conversion methods, Complement of numbers, Codes: Binary, Non-binary, Decimal, Alphanumeric, Gray, and Error detecting and error correcting codes. Logic Gates: AND, OR, NOT, NAND, NOR, XOR, EX-NOR and Universal Gates, Minimization of Boolean Functions: Fundamental postulates of Boolean algebra, Basic theorems, Simplification of Boolean equations, Min terms, Max terms, Standard form of Boolean functions. Simplification of functions: Karnaugh map method and Quine-McClusky methods (up to six variables), Multiple Output functions, and incomplete specified functions.

UNIT-II: Combinational Logic-Circuit Design-1: Logic design of combinational circuits: Adders and Subtractions: Binary, BCD, Excess -3 and Look –ahead-carry adder, Code converters, Multiplexers, De multiplexers, Encoders, Decoders and priority encoders, Realization of Boolean functions using multiplexers, De multiplexers and Decoders.

UNIT-III: Combinational Logic-Circuit Design-I1: Design of 4-bit comparator, Parity checker/Generator, Seven segment decoders, Hazards in combinational circuits, Hazard free realizations. Basics of PLDs: Basic structure of PROM, PAL, PLA, CPLD, FPGAs, Realization of Boolean functions with PLDs and their merits and demerits.

UNIT-IV: Sequential circuits: Classification of sequential circuits, SR-latch, Gated latches, Flip flops: RS, JK, D, T and Master slave flip flops, Excitation tables, flip flop conversion from one type to another. Design of counters: Ripple counters, Synchronous counters, asynchronous counters, up-down counters, Johnson counter, ring counter. Design of registers: Buffer registers, Shift registers, Bi directional shift registers, Universal shift register.

UNIT-V: Analysis and design of finite state machines: State assignment, State tables, Equivalent states, Elimination of Redundant states, Determination of state equivalence, Reduction using implication table, and reducing incompletely specified state tables.

Text Books:

1. Switching and finite Automatic theory, ZuiKohari, TMH.

2. Switching theory and logic design by Frederick.J.Hill and Gerald.R.Peterson.

3. Switching theory and logic design, Ananda kumar, PHI.

Reference Books:

1. Fundamentals of Logic Design, Charles.R.Roth, Thomson Publications.

2. Digital Design by Morries Mono, PHI. ECE:

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QC1205 – DATA STRUCTURES (ES)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1205	Data Structures	4			30	70	100	3hrs	3

Course objectives: The objectives of this course are

- Assess how the choice of data structures and algorithm design methods impacts the performance of programs.
- Choose the appropriate data structure and algorithm design method for a specified application.
- Solve problems using data structures such as linear lists, stacks, queues, binary trees, heaps binary search trees, and graphs and writing programs for these solutions.

Course outcomes: At the completion of the course the student will be able to

CO 1: Describe how arrays, records, linked structures, stacks, queues, trees, and graphs are represented in memory and used by algorithm.

CO 2: Demonstrate different methods for traversing trees.

CO 3: Compare alternative implementations of data structures with respect to performance.

CO 4: Discuss the computational efficiency of the principal algorithms for sorting and searching.

CO 5: Understand the concepts of Topological Ordering of nodes, Graph Traversal.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT – I: Introduction to Data Structures: Review of C Programming, Recursive Definition and Processes, Recursion in C, Simulation of Recursion, Efficiency of Recursion, Abstract Data Types, Meaning and Definition of Data Structures, Arrays.

UNIT – II: Stacks: Stack as an Abstract Data Type, Primitive Operations, Implementing Stack Operations using Arrays, Infix, Postfix and Prefix: Definitions, Evaluation and Conversions. Queues: Queue as an Abstract Data Type, Sequential Representation, Types of Queues, Operations, Implementation using Arrays. Linked List: Operations, Implementation of Stacks, Queues and priority Queues using Linked Lists+, Circular Lists: Insertion, Deletion and Concatenation Operations, Stacks and Queues as Circular Lists, Doubly Linked Lists.

UNIT – III: Trees: Binary Trees - Definitions and Operations, Binary Tree Representation: Node Representation, Implicit array Representation, Binary Tree Traversal, Threaded Binary Trees and their Traversal, Trees and their Applications; Tree Searching: Insertion and Deletion of a node from a Binary Search Tree, Efficiency of Binary Search Tree operations.

UNIT - IV: Searching: Basic Searching Techniques: Dictionary as an Abstract Data Type, Algorithmic Notation, Sequential Searching and its Efficiency, Binary Search, Interpolation Search. Sorting: General Background: Efficiency, Asymptotic Notations, Efficiency of Sorting, Bubble Sort and Quick Sort and their Efficiency, Selection Sorting, Binary Tree Sort, Heap Sort, Insertion Sorts, Shell Sort, Address calculation Sort, Merge and Radix Sorts.

UNIT – V: Graphs and Their Application: Definition of Graphs, Representation of Graphs, Transitive closure, Linked Representation of Graphs, Topological Ordering of nodes, Graph Traversal and Spanning Forests, Undirected Graphs and their Traversals, Applications of Graphs, Minimal Spanning Trees.

Textbooks:

1. Data Structures Using C and C++ Yddish Langsam, Moshe J. Augenstein and Aaron M. Tanenbaum, Prentice Hall of India (2nd Edition)

2. Data Structures, Algorithms and Applications with C++, Sahani Mc-Graw Hill

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QC1206 - ENGLISH LANGUAGE LAB (HSS)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1206	English Language Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- To make students recognize the sounds of English through Audio-Visual aids.
- To help students build their confidence and help them to overcome their inhibitions and self- consciousness while speaking in English.
- To familiarize the students with stress and intonation and enable them to speak English effectively.
- To give learners exposure to and practice in speaking in both formal and informal contexts.

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

CO1: Students will be sensitized towards recognition of English sound patterns and the fluency in their speech will be enhanced.

CO2: A student is able to inculcate the habit of good reading and writing skills.

CO3: A study of the communicative items in the laboratory will help students become successful in the competitive world.

CO4: Students will be able to participate in group activities like roleplays, group discussions and debates.

CO5: Students will be able to express themselves fluently and accurately in social as well professional context.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Introduction to Phonetics: The Sounds of English (Speech sound – vowels and consonants) - Stress and Intonation - Accent and Rhythm.

UNIT-II: Listening Skills: Listening for gist and specific information - listening for Note taking, summarizing and for opinions - Listening to the speeches of eminent personalities.

UNIT-III: Speaking Skills: Self-introduction - Conversation Skills (Introducing and taking leave) - Giving and asking for information - Role Play - Just A Minute (JAM) session - Telephone etiquette.

UNIT-IV: Reading and Writing skills: Reading Comprehension – Précis Writing - E-Mail writing - Punctuation.

UNIT-V: Presentation skills: Verbal and non-verbal communication - Body Language - Making a Presentation.

Reference Books:

1. Ashraf Rizvi. Effective Technical Communication. Tata McGraw Hill Education Private Limited, New Delhi.
2. Speak Well. Orient Blackswan Publishers, Hyderabad.
3. Allan Pease. Body Language. Manjul Publishing House, New Delhi.

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QC1207- DATA STRUCTURES LAB (BS/ES)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1207	Data Structures Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of the course are
- To understand and implement fundamental data structures using C.
- To develop skills in applying sorting and searching algorithms.
- To implement linear and nonlinear data structures like stacks, queues, and linked lists.
- To learn tree and graph traversal techniques and their applications.
- To solve real-world problems using appropriate data structures and algorithms.

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

CO1: Implement sorting and searching algorithms using C.

CO2: Perform operations on linear data structures like arrays, stacks, queues, and linked lists.

CO3: Implement and manipulate non-linear data structures such as trees and graphs.

CO4: Apply data structures in solving expressions and polynomial operations.

CO5: Analyze and implement graph algorithms like DFS, BFS, Dijkstra's algorithm.

SYLLABUS

(with effect from 2025-26 admitted Batch)

1. Write a C program for sorting a list using Bubble sort and then apply binary search.
2. Write a C program to implement the operations on single linked list.
3. Write a C program for demonstrate operations on double linked list.
4. Write a C program to implement the operations on priority queues.
5. Write a C program to implement the operations on stacks.
6. Write a C program to implement the operations on circular queues.
7. Write a C program for evaluating a given postfix expression using stack.
8. Write a C program for converting a given infix expression to postfix form using stack.
9. Write a C program for implementing the operations of a dequeue
10. Write a C program for the representation of polynomials using circular linked list and

for the addition of two such polynomials

11. Write a C program to create a binary search tree and for implementing the in order, Pre order, post order traversal using recursion.
12. Write a C program for finding the transitive closure of a digraph.
13. Write a C program for finding the shortest path from a given source to any vertex in a digraph using Dijkstra's algorithm.
14. Write a C program for finding the Depth First Search of a graph.
15. Write a C program for finding the Breadth First Search of a graph

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QC1208- DIGITAL LOGIC DESIGN LAB (ES)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1208	Digital Logic Design Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- To Verify Logic gates.
- To Verify Half adders and full adders.
- To Design ripple counter and synchronous counter.
- To Design shift registers and seven segment display.

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

CO1: Implement logic gates, universal gates and their realization using ICs.

CO2: Able to realize SOP and POS forms and verifying Demorgan's laws.

CO3: Experimentally analyze combinational and sequential circuits using ICs.

CO4: Implement the logic gates, full Adder, Decoder, Encoder, MUX and DeMUX.

CO5: Implement and Analyze Flip-Flops, Shift Register and Counters.

SYLLABUS

(with effect from 2025-26 admitted Batch)

List of Hardware Experiments:

1. Experimentally verify truth tables of different Logic Gates.
2. Experimental realization of Gates by using universal building blocks.
3. Experimental realization of SOP and POS forms.
4. Experimental Verification of Demorgan's Laws.
5. Design and verify Half Adder & Full adder digital circuits for different bit lengths.
6. Function generation by using Decoders & Multiplexers.
7. Experimental Realization of Flip – flops.
8. Experimental 4-bit Ripple counters.
9. Design and verify Mod-8 Synchronous counter.
10. Design and verify Up down counter.
11. Experimental verification of 4 - bit Shift-register.
12. Design and experimental verification of seven segment display.

QC1209- DO IT YOURSELF LAB (DIY) (ES)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC1209	Do It Yourself Lab			3	50	50	100	3hrs	1

QC2101- PROBABILITY AND STATISTICS (BS)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2101	Probability and Statistics	4			30	70	100	3hrs	3

Course objectives: The objectives of this course are

- To provide foundations of probabilistic and statistical analysis
- To provide an understanding on concepts of probability, random variables, probability distributions, sampling, estimation, hypothesis testing, regression, correlation, multiple regression, hypothesis testing, sample test, and curve fitting.
- To explore applications of probabilistic and statistical tools to solve real world problems.

Course outcomes: After completion of the course the student should be able to:

CO1: Define and explain basic concepts in probability theory and how to translate real-world problems into probability models. Solve standard problems that include random variables, discrete and continuous probability distributions

CO2: Apply Sampling techniques.

CO3: Perform Test of Hypothesis and construct a confidence interval to estimate population parameters

CO4: Compute and interpret the results of Correlation Analysis, Multivariate Regression.

CO5: Understand Fundamental concepts and Apply curve fitting techniques.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Probability: Definitions of probability, Addition theorem, Conditional probability, Multiplication theorem, Bayes‟ Theorem of Probability.

Random variables and their properties: Discrete Random Variable, Continuous Random Variable, Probability Distribution, Joint Probability Distributions their Properties, Transformation Variables, Mathematical Expectations, Probability Generating Functions.

UNIT-II: Probability Distributions: Discrete Distributions: Binomial, Poisson Negative Binominal Distributions and their Properties; Continuous Distributions: Uniform, Normal, Exponential Distributions and their Properties.

UNIT-III: Sampling Theory: Sample, Populations, Statistic, Parameter, Standard Error, Sampling Distributions of means and proportions.

Estimation: Point estimation, properties of estimator: consistency, unbiasedness, efficiency, sufficiency. Maximum Likelihood Estimator, Interval Estimation.

UNIT-IV: Testing of Hypothesis: Formulation of Null and alternative hypothesis, critical region, level of significance, errors of sampling, procedure for testing of hypothesis, **Large Sample tests:** Tests of significance for one and two sample means, single and two sample proportions.

Small Sample Tests: Student' t-test-single sample mean, two sample means; F-test: testing equality of variances chi-square Test for goodness of fit.

UNIT-V: Correlation and Regression Analysis: Simple Correlation, Rank Correlation coefficient, multiple correlation. Simple Linear regression and multiple Regression analysis.

Curve fitting: Fitting a straight-line, second-degree parabola, exponential and power curve by the method of principle of least squares.

Text Books:

1. Probability & Statistics for Engineers and Scientists, Walpole, Myers, Myers, Ye. Pearson Education.
2. Probability, Statistics and Random Processes T.Veerarajan Tata McGraw – Hill

Reference Book:

1. Probability & Statistics with Reliability, Queuing and Computer Applications, Kishor S. Trivedi, Prentice Hall of India ,1999

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QC2102- PYTHON PROGRAMMING (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2102	Python Programming	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To develop skills on procedural oriented and object-oriented programming in Python.
- To understand and apply different data wrangling techniques using Python.
- To perform data analysis using python libraries like NumPy, Pandas and exploratory data analysis using Matplotlib.

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

At the end of the course, a student should be able to:

CO1: Acquire programming knowledge on Basics of Python.

CO2: Acquire programming knowledge on Text and File Handling.

CO3: Develop Python programs to Mean, Median, Mode, Correlation.

CO4: Acquire programming knowledge on NumPy, Pandas Library.

CO5: Acquire programming knowledge on Graph Visualizations in Python and Data Analysis using Python.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Introduction to Python: Rapid Introduction to Procedural Programming, Data Types: Identifiers and Keywords, Integral Types, Floating Point Types. Strings: Strings, Comparing Strings, Slicing and Striding Strings, String Operators and Methods, String formatting with str.format. Collections Data Types: Tuples, Lists, Sets, dictionaries, Iterating and copying collections.

UNIT-II: Python Control Structures, Functions and OOP: Control Structures and Functions: Conditional Branching, Looping, Exception Handling, Custom Functions. Python Library Modules: random, math, time, os, shutil, sys, glob, re, statistics, creating a custom module. Object Oriented Programming: Object Oriented Concepts and Terminology, Custom

Classes, Attributes and Methods, Inheritance and Polymorphism, Using Properties to Control Attribute Access.File Handling: Writing and Reading Binary Data, Writing and Parsing Text Files.

UNIT-III: NumPy Arrays and Vectorized Computation: NumPy arrays, Array creation, Indexing and slicing, Fancy indexing, Numerical operations on arrays, Array functions, Data processing using arrays, Loading and saving data, saving an array, Loading an array, Linear algebra with NumPy, NumPy random numbers.

UNIT-IV: Data Analysis with Pandas: An overview of the Pandas package, The Pandas data structure-Series, The Data Frame, The Essential Basic Functionality: Reindexing and altering labels, Head and tail, Binary operations, Functional statistics, Function application Sorting, Indexing and selecting data, Computational tools, Working with Missing Data, Advanced Uses of Pandas for Data Analysis - Hierarchical indexing, The Panel data.

UNIT-V: Data Analysis Application Examples: Data munging, cleaning data, Filtering, merging data, Reshaping data, Data aggregation, Grouping data.

UNIT-VI: Data Visualization: The matplotlib API primer-Line properties, Figures and subplots, Exploring plot types-Scatter plots, Bar plots, Histogram plots, Legends and annotations, Plotting functions with Pandas.

Text Books:

1. Programming in Python 3: A Complete Introduction to Python Language, Mark Summerfield, Second Edition, Addison-Wesley Publications.
2. Python: End-to-End Data Analysis Learning Path, Module 1: Getting Started with Python Data Analysis, Phuong Vothi Hong, Martin Czygan, , Packt Publishing Ltd.

Reference Books:

1. Learning Python, 5th Edition, Mark Lutz, Orielly Publications.
2. Python for Data Analysis, Wes McKinney, Orielly Publications.
3. How to Think Like a Computer Scientist: Learning with Python 3 Documentation 3rd Edition, Peter Wentworth, Jeffrey Elkner, Allen B. Downey, Chris Meyers.
4. Core Python Programming, Second Edition, Wesley J. Chun, Prentice Hall.

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QC2103- QUANTUM HARDWARE AND ERROR CORRECTION (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2103	**Quantum Hardware and Error Correction**	**4**			**30**	**70**	**100**	**3hrs**	**3**

Course Objectives: The objectives of this course are

- Introduce the fundamental principles of quantum information and computation.
- Understand quantum noise, decoherence, and modeling of quantum channels.
- Explore physical implementations of qubits and quantum hardware characteristics.
- Study quantum error correction codes and stabilizer formalism.
- Learn fault-tolerant quantum computation techniques and surface code implementations.

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

CO1: Describe qubit states, quantum gates, entanglement, and basic quantum circuits.

CO2: Model quantum noise using Kraus operators and analyze decoherence and fidelity.

CO3: Compare physical qubit technologies and interpret qubit coherence and gate performance.

CO4: Apply quantum error correction codes like Shor and Steane using stabilizer formalism.

CO5: Design fault-tolerant circuits and understand surface code-based quantum error correction.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Foundations of Quantum Information: Quantum postulates, qubit states, Bloch sphere, Quantum measurement and entanglement, Quantum gates and universal sets, Bell states, teleportation, and basic quantum circuits.

UNIT-II: Quantum Noise and Quantum Channels: Density matrices, partial trace, Kraus operators and quantum operations, Common noise models: bit-flip, phase-flip, amplitude damping, Fidelity, trace distance, and decoherence, Quantum process tomography.

UNIT-III: Physical Qubit Implementations and Quantum Hardware: Superconducting qubits (transmons, Josephson junctions), Trapped ions, NV centers, quantum dots, Photonic qubits, Coherence times (T_1, T_2), gate fidelity, readout, Pulse-level control: Rabi oscillations, Ramsey fringes, Hahn echo.

UNIT-IV: Quantum Error Correction: Quantum vs classical repetition codes, Knill–Laflamme conditions, 3- and 9-qubit Shor code, Steane and CSS codes, Stabilizer formalism, syndrome extraction, correctable errors, Code distance, logical operations.

UNIT-V: Fault-Tolerant Quantum Computing and Surface Codes: Fault-tolerant quantum circuits, Concatenated codes and error thresholds, Surface codes: lattice structure, decoding, Toric codes and magic state distillation, IBM Quantum hardware simulation with QEC.

Text Books:

1. Quantum Computation and Quantum Information – Michael A. Nielsen & Isaac L. Chuang
2. Quantum Information Theory – Mark M. Wilde
3. Quantum Error Correction – Lidar & Brun

Reference Books:

1. Quantum Computation: Lecture Notes – John Preskill, http://theory.caltech.edu/~preskill/ph219/
2. Learn Quantum Computation using Qiskit – Quantum Hardware Section, https://qiskit.org/textbook/ch-quantum-hardware/quantum-hardware.html

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QC2104- SIGNALS AND SYSTEMS (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2104	Signals and Systems	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To explain signals and systems representations/classifications and also describe the time and frequency domain analysis of continuous time signals with Fourier series.
- Fourier transforms and Laplace transforms.
- To understand Sampling theorem, with time and frequency domain analysis of discrete time signals with DTFS, DTFT and Z-Transform.
- To present the concepts of convolution and correlation integrals and also understand the properties in the context of signals/systems and lay down the foundation for advanced courses.

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

CO1: Understand the process of sampling and the effects of under sampling, Analyze the discrete time signals and system using different transform domain techniques.

CO2: Design and implement LTI filters for filtering different real-world signals.

CO3: Analyze the frequency domain representation of signals using CTFT and DTFT.

CO4: Interpret signals and analyze system response using convolution integral and compute the correlation of signals.

CO5: Apply the Laplace transform and Z- transform for analyzing continuous-time and discrete-Time signals and systems.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Introduction to signals and linear time Invariant systems: Basic signals, elementary signals in continues and discrete domain, classification of signals, useful signal operations, discrete signal models, discrete signal operations, classification of systems, basic system properties, Casual LTI Systems Described by Differential and Difference Equations, unit impulse response of a system, system response to external input, classical solutions of difference equations, system stability.

UNIT-II: Frequency analysis of continuous and discrete signals: Frequency analysis of continuous time signal - Fourier Series Representation of continuous time Periodic Signals, convergence of the Fourier Series, exponential Fourier series, Properties of continuous time Fourier Series, power density spectrum of periodic signals, representation of aperiodic signals, Fourier Transform, transform of some useful functions, Fourier Transform for periodic signals, theorems and properties of Fourier transforms, signal energy.Frequency analysis of Discrete time signal -. Discrete time Fourier series(DTFS), properties of DTFS,power density spectrum of discrete periodic signals, representation of aperiodic signals, discrete time Fourier transform (DTFT),convergence of DTFT, DTFT theorems and properties, energy density spectrum of discrete aperiodic signals.

UNIT-III: Convolution and correlation of signals: System analysis by Convolution, Convolution as a superposition of impulse response, some Convolution relationships, Graphical interpretation of Convolution, Convolution of a function with a unit impulse, Signal comparison, Correlation and Convolution, Some properties of correlation functions, Correlation functions for nonfinite energy signals, Detection of periodic signals in the presence of Noise by correlation, Determination of the waveform of a periodic signal masked by Noise, Extraction of a signal from Noise by filtering.

UNIT-IV: Laplace Transform: Introduction, The Laplace Transform, the region of convergence for Laplace Transforms, The Inverse Laplace Transform, Geometrical evaluation of the Fourier transform from the Pole-Zero plot, Properties of Laplace Transforms, the initial and Final value theorems, Analysis and characterization of LTI systems using the Laplace Transforms.

UNIT-V: Sampling Theorem and Z-transform: sampling theorem, reconstruction of a signal from its samples using interpolation, The effect of Under sampling, aliasing, Discrete time processing of continuous time signals, sampling of Discrete time signals. unilateral Z-Transforms and bilateralZ-Transforms,Properties of Z-Transform, relationship of the Fourier transform to the Z- transform, Inverse Z-Transform by contour integral, power series, partial fraction expansion. decomposing of rational Z-transform, causality and stability, the initial value theorem and final value theorem, some common Z-transform pairs, Analysis and characterization of LTI systems using the Z-Transforms.

Text Books:

1.Signals and Systems, Alan V. Oppenheim, Alan S. Will sky and Ian T. Young, PHI, 2ndEdn.

2.Signal Processing and Linear Systems, B. P. Lathi, Berkeley Cambridge Press.

3. Signals and Systems, K. Raja Rajeswari and B. V. Rao, Prentice Hall of India.

Reference Books:

1. Signals and Systems- Simon Haykin and Van Veen, Wiley 2ndEdn.

2. Signals and Systems – P. Ramesh Babu and R. Ananda Natarajan 3rdEdn.

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QC2105 -MANAGERIAL ECONOMICS (HSS)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2105	Managerial Economics	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To integrate the concept of price and output decisions of firms under various market structure.
- To impart the knowledge of economics as a subject and its importance while business.
- The business decisions are made scientifically on the basis of all available information.
- To familiarize the students with the basic concept of microeconomics.
- To understand the demand and supply analysis in business applications
- To familiarize with the production and cost structure under different stages of production.

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

CO1: To understand the concepts of cost, nature of production and its relationship to Business operations.

CO2: To apply marginal analysis to the "firm" under different market conditions.

CO3: Understands the concept of utility analysis and its limitations.

CO4: To analyze the causes and consequences of different market conditions.

CO5: To integrate the concept of price and output decisions of firms under various market structure.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Significance of Economics and Managerial Economics: Economics: Definitions of Economics- Wealth, Welfare and Scarcity definition Classification of Economics- Micro and Macro Economics. Managerial Economics: Definition, Nature and Scope of Managerial Economics, Differences between Economics and Managerial Economics, Main areas of Managerial Economics, Managerial Economics with other disciplines.

UNIT-II: Demand and Utility Analysis: Demand **-** Definition, Meaning, Nature and types of demand, Demand function, Law of demand -Assumptions and limitations. Exceptional demand curve. Elasticity of demand - Definition, Measurement of elasticity, Types of

Elasticity (Price, Income, Cross and Advertisement), Practical importance of Price elasticity of demand, Role of income elasticity in business decisions, Factors governing Price Elasticity of demand.

Utility Analysis: Utility- Meaning, Types of Economic Utilities, Cardinal and Ordinal Utility, Total Utility, Marginal Utility, the law of Diminishing Marginal Utility and its Limitations**.**

UNIT-III : Theory of Production and Cost analysis: Production - Meaning, Production function and its assumptions, use of production function in decision making; **Cost analysis -** Nature of cost, Classification of costs - Fixed vs. Variable costs, Marginal cost, Controllable vs. Non - Controllable costs, Opportunity cost, Incremental vs. Sunk costs, Explicit vs. Implicit costs, Replacement costs, Historical costs, Urgent vs. Postponable costs, Escapable vs. unavoidable costs, Economies and Diseconomies of scale.

UNIT-IV: Market Structures: Definition of Market, Classification of markets; Salient features or conditions of different markets - Perfect Competition, Monopoly, Duopoly, Oligopoly, Importance of kinked demand curve; Monopolistic Competition.

UNIT-V: Pricing and Business cycles: Pricinganalysis: Pricing - Significance: Different Pricing methods- Cost plus pricing, Target pricing, Marginal cost pricing, Going -rate pricing, Average cost pricing, Peak load pricing, Pricing of joint Products, Pricing over the life cycle of a Product, Skimming pricing Penetration pricing, Mark- up and Mark- down pricing of retailers.

Business cycles - Definition, Characteristics, Phases, Causes and Consequences; Measures to solve problems arising from Business cycles.

Text Books:

1. Sankaran,S., Managerial Economics, Marghan Publications, 2015, Chennai.
2. Aryasri, A.R., Managerial Economics and Financial Analysis, MC Graw Hill Education, New Delhi,2015.

Reference Books:

1. Dwivedi, D.N., Managerial Economics, Vikhas Publishing House Pvt. Ltd. 6th Edition, New Delhi,2004.
2. Dewett, K.K., Modern Economic Theory, S. Chand & Company Ltd., New Delhi, 2005.

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QC2106 - PYTHON PROGRAMMING LAB (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2106	Python Programming Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- familiarize students with key data structures in Python including lists and dictionaries and apply them in context of searching, sorting, text and file handling.
- introduce students to calculation of statistical measures using Python such as measures of central tendency, correlation.
- familiarize students with important Python data related libraries such as Numpy and Pandas and use them to manipulate arrays and data frames.
- introduce students to data visualization in Python through creation of line plots, histograms, scatter plots, box plots and others.
- implementation of basic machine learning tasks in Python including pre-processing data, dimensionality reduction of data using PCA, clustering, classification and cross-validation.

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

CO1: Implement searching, sorting and handle text and files using Python data structures such as lists and dictionaries.

CO2: Calculate statistical measures using Python such as measures of central tendency, correlation.

CO3: Use Python data related libraries such as Numpy and Pandas and create data visualizations.

CO4: Implement basic machine learning tasks pre-processing data, compressing.

CO5: Implement data, clustering, classification and cross-validation.

SYLLABUS

(with effect from 2025-26 admitted Batch)

1. Python Programs on lists & Dictionaries.
2. Python Programs on Searching and sorting.
3. Python Programs on Text Handling.

4. Python Programs on File Handling.
5. Python Programs for calculating Mean, Mode, Median, Variance, Standard Deviation.
6. Python Programs for Karl Pearson Coefficient of Correlation, Rank Correlation.
7. Python Programs on NumPy Arrays, Linear algebra with NumPy.
8. Python Programs for creation and manipulation of DataFrames using Pandas Library.
9. Write a Python program for the following.
    - Simple Line Plots,
    - Adjusting the Plot: Line Colors and Styles, Axes Limits, Labeling Plots,
    - Simple Scatter Plots,
    - Histograms,
    - Customizing Plot Legends,
    - Choosing Elements for the Legend,
    - Boxplot
    - Multiple Legends,
    - Customizing Colorbars,
    - Multiple Subplots,
    - Text and Annotation,
    - Customizing Ticks
10. Python Programs for Data preprocessing: Handling missing values, handling categorical data, bringing features to same scale, selecting meaningful features.
11. Python Program for Compressing data via dimensionality reduction: PCA.
12. Python Programs for Data Clustering.
13. Python Programs for Classification.
14. Python Programs for Model Evaluation: K-fold cross validation.

Reference Books

1. Core Python Programming, Second Edition, Wesley J. Chun, Prentice Hall.
2. Chris Albon, “Machine Learning with Python Cookbook-practical solutions from preprocessing to Deep learning”, O’REILLY Publisher,2018.

3. Mark Summerfield, Programming in Python 3--A Complete Introduction to the Python Language, Second Edition, Additson Wesley.
4. Phuong Vo.T.H , Martin Czygan, Getting Started with Python Data Analysis, Packt Publishing Ltd.
5. Armando Fandango, Python Data Analysis, Packt Publishing Ltd.
6. Magnus Vilhelm Persson and Luiz Felipe Martins, Mastering Python Data Analysis, Packt Publishing Ltd.
7. Sebastian Raschka & Vahid Mirjalili, "Python Machine Learning", Packt Publisher, 2017.

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QC2107 – QUANTUM HARDWARE LAB (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2107	Quantum Hardware Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- Understand fundamental principles of qubits, quantum gates, and measurement.
- Gain practical experience in designing and running quantum circuits.
- Explore and implement key quantum algorithms and protocols.
- Analyze and measure qubit coherence properties using experimental methods.
- Learn pulse-level control techniques for quantum gate calibration.

Course Outcomes (COs): At the completion of the course the student will be able to

CO1: Design and simulate quantum circuits using Qiskit or similar tools.

CO2: Demonstrate entanglement and coherence through lab-based experiments.

CO3: Implement and analyze basic quantum algorithms on simulators or real quantum devices.

CO4: Evaluate qubit fidelity and performance using calibration techniques.

CO5: Apply quantum error correction techniques to mitigate computational errors.

SYLLABUS
(with effect from 2025-26 admitted Batch)

List of Experiments

1. Qubit Initialization & Measurement
2. Coherence & Rabi Oscillations
3. Entanglement Creation
4. Quantum Fourier Transform (QFT)
5. Quantum Error Correction (Repetition Code)
6. Pulse-Level Gate Calibration

7. Simple Quantum Algorithm on Hardware

8. Characterizing Qubit Hamiltonian (Advanced)

9. NV-Center Coherent Control

10. Variational Quantum Eigensolver (VQE)

Hardware/Software Requirements:

Hardware: Laptop/PC (i5 / 8 GB RAM or better), reliable internet, cloud access to IBM Quantum devices; optional lab gear – AWG/microwave source, oscilloscope, photodetector, NV-diamond setup, Arduino/Raspberry Pi.

Software: Python 3.8+, Qiskit, Jupyter Notebook, IBM Q Experience account; common Python libs (NumPy, SciPy, Matplotlib); optional LabVIEW and Arduino IDE.

Reference Books:

1. Quantum Computation and Quantum Information– Michael A. Nielsen & Isaac L. Chuang
2. Quantum Computing: An Applied Approach – Jack D. Hidary (Hands-on guide with practical quantum programming using Qiskit and real hardware.)
3. Quantum Computer Systems: Research for Hardware, Software, and Applications – Frederic T. Chong, Daniel Kudrow, and Diana Franklin (Focuses on the integration of quantum hardware, gate calibration, and software stack.)

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QC2108 - SIGNALS AND SYSTEMS SIMULATION LAB (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2108	**Signals and Systems Simulation Lab**			**3**	**50**	**50**	**100**	**3hrs**	**1.5**

Course Objectives: The objectives of this course are

- To provide back ground and fundamentals of MATLAB tool for the analysis and processing of signals and to generate various continuous and discrete time signals.
- To understand discrete signal design and analysis.
- To provide an overview of signal transmission through linear systems, convolution and correlation of signals and sampling.
- To understand signal representation in digital domain.
- To understand the concept and importance of Fourier and Z-Transforms

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

CO1: Familiarize with MATLAB basics.
CO2: Generation Various Signals and Sequences in MATLAB, including the operations on Signals and sequences.
CO3: Understand Linearity and Time Invariance Properties of a given Systems.
CO4: Find Fourier Transform of a given signal and plotting its magnitude and phase spectrum And also plot Pole-Zero Maps in Z-Plane.
CO5: Verification of Sampling Theorem**.**

SYLLABUS

(with effect from 2025-26 admitted Batch)

LIST OF EXPERIMENTS

1. Basic Operations on Matrices.

2. Write a program for Generation of Various Signals and Sequences(Periodic and), such as Unit impulse, unit step,square, sawtooth,triangular, sinusoidal, ramp and sinc functions.

3. Write a program to perform operations like addition, multiplication scaling,shifting,and folding on signals and sequences and computation of energy and average power.

4. Write a program for finding the even and odd parts of the signal/sequence and real and imaginary parts of the signal.

5. Write a program to perform convolution between signals and sequences.

6. Write a program to perform autocorrelation and crosscorrelation between signals and sequences.

7. Write a program for verification of linearity and timeinvariance properties of a given continuous/discrete system.

8. Write a program for computation of unit samples,unit step and sinusoidal response of the given LTI system and verifying its physical reliability and stability properties.

9. Write a program to find trigonometric and exponential Fourier series coefficients of a rectangular periodic signal.

10. Write a program to find the Fourier transform of a given signal and plotting its magnitude and Phase spectrum.

11. Write a program for Sampling theorem and its verification.

12. Write a program for locating the zeros and poles and plotting the pole-zero maps in Z-plane for the given transfer function.

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QC2109 - MATLAB PROGRAMMING (SC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2109	MATLAB programming	1		2	50	50	100	3hrs	2

Course Objectives: The objectives of this course are

- To understand basic electronic circuits using simulation tools.
- To learn the characteristics of diodes and transistors through MATLAB.
- To design and analyze amplifiers and filters using Simulink.
- To simulate basic instrumentation circuits like op-amps and sensors.
- To build and test digital logic circuits such as counters and multiplexers

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

CO1: Simulate diode and transistor behavior using MATLAB.

CO2: Analyze amplifier and filter circuits using Simulink.

CO3: Design instrumentation circuits with op-amps and sensors.

CO4: Implement and verify digital logic circuits using simulation.

CO5: Use MATLAB and Simulink effectively for circuit analysis and design.

SYLLABUS

(with effect from 2025-26 admitted Batch)

LIST OF EXPERIMENTS

1. Simulation of Diode I-V Characteristics (PN Junction & Zener Diode)
2. Transistor Characteristics: Common Emitter & Common Base Configuration
3. Frequency Response of RC, RL, and RLC Circuits
4. Design and Simulation of BJT Amplifier (CE Configuration)
5. Simulation of Op-Amp as Inverting and Non-Inverting Amplifier
6. Implementation of Instrumentation Amplifier using Op-Amps
7. Temperature Sensor Interfacing and Signal Conditioning
8. Logic Gate Simulation and Truth Table Verification
9. Simulation of 4-bit Binary Counter using Flip-Flops

10. Design and Simulation of 4:1 Multiplexer and 1:4 Demultiplexer
11. Bell State Generation and Measurement
12. Quantum Circuit Simulation using State Vectors

Hardware Required:

1. PC/Laptop with i5 or higher processor
2. Minimum 8 GB RAM
3. Windows 10/11 or Linux (Ubuntu 20.04+)
4. MATLAB installed with required toolboxes
5. Internet (for toolbox download/updates)

Software Required:

1. MATLAB (R2020 or later)
2. Simulink
3. Simspace / Simspace electrical
4. DSP System Toolbox
5. Stateflow
6. Quantum Computing Toolbox

Reference Books:

1. Holly Moore, MATLAB for Engineers, 5th Edition, Pearson.
2. Agam Kumar Tyagi, MATLAB and Simulink for Engineers, 1st Edition, Oxford University Press.

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QC2110 - PROFESSIONAL ETHICS AND UNIVERSAL HUMAN VALUES (MC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2110	Professional Ethics and Universal Human Values					100	100	3hrs	0

Course Objectives: The objectives of this course are

- To recognize the moral values that should guide the Engineering profession.
- To resolve moral issues concerning one's profession.
- To develop and exhibit a set of moral beliefs and attitudes that engineers should inculcate.
- To inculcate social values and morality in one's life.
- To develop awareness about Professional/Engineering Ethics and Human Values.

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

CO1: Apply the conceptual understanding of ethics and values into everyday practice.

CO2: Understand the importance of moral awareness and reasoning in life.

CO3: Acquire professional and moral etiquette that an engineer requires.

CO4: Develop the acumen for self-awareness and self-development.

CO5: Develop cultural tolerance and integrity and Tackle real-life challenges with empathy.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT - I: HUMAN VALUES: Values - Respect - Caring - Sharing - Honesty- Courage –Self-confidence - Communal Harmony Morals – Virtues.

UNIT –II: PROFESSIONAL VALUES: Integrity - Discipline - Valuing time - Cooperation - Commitment - Code of conduct - Challenges in the workplace.

UNIT – III: PROFESSIONAL ETHICS: Overview - Engineering ethics - Moral issues - Profession - Models of professional roles – Responsibility.

UNIT – IV: RESPONSIBILITIES AND RIGHTS: Safety and risk - Collegiality and loyalty - Confidentiality - Occupational crime - Human rights - Employee rights - Intellectual property rights.

UNIT – V: GLOBAL ISSUES: Globalization - Environmental ethics - Computer ethics - Code of ethics - Multinational corporations - Engineers as advisors in Planning and Policy making.

Textbook:

1.R.S. Nagarazan. A Textbook on Professional Ethics and Human Values. New Age International Publishers. 2006.

Reference Books:

1. Premvir Kapoor. Professional Ethics and Human Values. Khanna Publishing House. 2019.

2. B.S. Raghavan. Human Values and Professional Ethics. S.Chand Publications. 2012.

3. R.R. Gaur & Others. A Foundation Course in Human Values and Proff. Ethics. Excel Books. 2009.

4. A. N. Tripathi. Human Values. New Age International (P) Limited. 2009

5. R. Subramanian. Professional Ethics. OUP India. 2013.

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QC2111- NCC/NSS (MC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2111	NCC/NSS			2					0

Course objectives: The objectives of this course are

- To develop discipline, character, brotherhood, the spirit of adventure and ideals of selfless service amongst young citizens.
- To develop youth leadership in the students.
- To induce social consciousness among students through various camp activities.
- To develop skills and physical fitness among students through indoor and outdoor sports, field and track events.

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

CO1: Understand the importance of nation building and individual contribution to the same.

CO2: Integrate physical fitness and mental wellbeing.

CO3: Discover grassroots challenges of community.

CO4: creating societal impact and maintain discipline and team spirit.

CO5: uphold the value of one for all and all for one.

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QC2201 - ELECTROMAGNETIC FIELD THEORY AND TRANSMISSION LINES (ES)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2201	Electromagnetic Field Theory and Transmission Lines	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To Define the Basic Electrostatic and Magneto static Law Derive the Maxwell's Equation and apply to the basic electromagnetic problem.
- To analyze the boundary conditions, at the interface of two different media and also time varying electric and magnetic fields.
- To explain the wave propagation in different types of mediums and also transmission line fundamentals.
- To demonstrate the smith chart-configuration.

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

CO1: To evaluate the design and problem-solving skills and Able to define electrostatic and magneto static laws

CO2: Able to derive the Maxwell's equations in static and dynamic fields

CO3: Able to describe energy density on electric/magnetic fields' and poynting theorem.

CO4: Able to analyze the EM wave propagation in different mediums

CO5: Able to relate the wave propagation through transmission lines and compute the impedance using smith chart for matching the load impedance.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Electrostatics: Coulomb's Law, Electric Field Intensity – Fields due to Different Charge Distributions, Electric Flux Density, Gauss Law and Applications, Electric Potential, Maxwell's Two Equations for Electrostatic Fields, Energy density, Convection and Conduction Currents, Continuity Equation, Relaxation Time, Poisson's and Laplace's Equations; Capacitance. Magneto statics: Biota-Savart Law, Ampere's Circuital Law and Applications, Magnetic Flux Density, Maxwell's Two Equations for Magneto static Fields, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Inductances and Magnetic Energy.

UNIT-II: Maxwell's Equations: Faraday's Law and Transformer emf, Inconsistency of Ampere's Law and Displacement Current Density, Maxwell's Equations in Different Final Forms and Word Statements. Conditions at a Boundary Surface: Dielectric-Dielectric and Dielectric-Conductor Interfaces. Related Problems.

UNIT-III: Electromagnetic Waves: Wave Equations for Conducting and Perfect Dielectric Media, Uniform Plane Waves, Wave Propagation in Lossless and Conducting Media, Conductors & Dielectrics – Characterization, Polarization, Reflection and Refraction of Plane Waves – Normal and Oblique Incidences for both Perfect Conductor and Perfect Dielectrics, Brewster Angle, Critical Angle and Total Internal Reflection, Surface Impedance. Poynting Vector and Poynting Theorem

UNIT-IV: Transmission Lines: Introduction to Transmission line equations, Primary & Secondary constants Expressions for Characteristic Impedance, Propagation Constant, Phase and Group Velocities, Loss lessness /Low Loss Characterization, Distortion, Loading, SC and OC Lines, Reflection Coefficient, VSWR, $\lambda/8$, $\lambda/4$, $\lambda/2$-line impedance Transformations, Smith Chart – Configuration and Applications.

UNIT-V: Waveguides: Introduction, Rectangular Waveguides, electric and magnetic field patterns in TE10 and TE11 mode configuration, modes of TE wave in rectangular waveguide, field equations, impossibility of TEM wave propagation in waveguides, cutoff frequency of rectangular waveguide, propagation constant, wave impedance, phase velocity, group velocity, dominant mode and degenerate modes, related problems.

Text Books:

1. Electromagnetic Field Theory and Transmission Lines, GottapuSasibhushana Rao, Wiley India Pvt. Ltd., New Delhi, 1st Ed.,2012.

2. Electromagnetics with Applications, Kraus and Flesch, McGraw Hill, 1999.

3. Electromagnetic Field Theory and Transmission Lines, G.S.N. Raju, Pearson Education (Pvt., Ltd., New Delhi, 2005.

Reference Books:

1.Elements of Electromagnetic – Matthew N.O. Sadiku, Oxford Univ. Press, 3rd ed., 2001.

2. Engineering Electromagnetics, W. H. Hayt Jr., McGraw Hill – New York.

3. EM Waves and Radiating Systems, E. C. Jordan, PHI, 1997.

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QC2202 – QUANTUM MACHINES (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2202	Quantum Machines	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Introduce the principles of physical implementation of quantum systems.
- Understand the operation of different types of quantum machines and their control techniques.
- Explore solid-state, atomic, and photonic platforms for quantum hardware.
- Analyze the engineering aspects of building scalable quantum devices.
- Study noise sources and error mitigation techniques for quantum machines.

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

CO1: Explain how quantum mechanics is applied to build physical quantum systems.

CO2: Compare solid-state, photonic, atomic, and circuit-based quantum hardware platforms.

CO3: Demonstrate knowledge of device fabrication and control in quantum hardware.

CO4: Analyze sources of noise and decoherence and apply error mitigation techniques.

CO5: Evaluate the capabilities and limitations of current quantum machines in the NISQ era.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Quantum Devices and Implementations – Basics of Qubits: Spin Qubits, Charge Qubits, Flux Qubits, Superconducting Circuits, Trapped Ions, Neutral Atoms, Photonic Qubits, Quantum Dots, NV Centers.

UNIT-II: Quantum Control and Measurements – Readout Techniques: Qubit Initialization, Single and Two Qubit Gates, Microwave and Laser Control, Quantum Non-Demolition Measurement, QND Amplifiers, Cryogenics and Cooling Methods.

UNIT-III: Device Fabrication and Integration – Engineering Quantum Systems: Fabrication of Josephson Junctions, Lithography and Etching Techniques, On-chip Interconnects, Packaging and Integration, Cleanroom Processes, Hybrid Quantum Systems.

UNIT-IV: Noise and Decoherence in Quantum Systems – Sources and Models: Relaxation and Dephasing Mechanisms, T1 and T2 Times, Crosstalk and Leakage, Noise Spectroscopy, Filtering, Dynamical Decoupling, Quantum Error Mitigation.

UNIT-V: Quantum Machine Architectures and NISQ Systems – Current Technologies: NISQ Processors, Quantum System Design Principles, Quantum Volume, Scalability, Connectivity, Benchmarking, Near-term Applications, Roadmap toward Fault-Tolerant Machines.

Text Books:

1. Michel Devoret and John M. Martinis – Superconducting Qubits: A Short Review.
2. A. Blais, A. Wallraff et al. – Circuit Quantum Electrodynamics, Reviews of Modern Physics.

Reference Books:

1. David DiVincenzo – Physical Implementations of Quantum Computation.

2. M. H. Devoret – Quantum Machines: Measurement and Control of Engineered Quantum Systems.

3. Daniel Esteve – Introduction to Mesoscopic and Superconducting Circuits.

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QC2203 – QUANTUM COMPUTING SYSTEMS AND PROGRAMMING (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2203	Quantum Computing Systems and Programming	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Understand the fundamental principles of quantum mechanics applied to computation.
- Learn the architecture and functioning of quantum computing hardware systems.
- Gain proficiency in designing quantum circuits and algorithms.
- Develop skills in quantum programming using platforms like Qiskit, Cirq, and others.
- Explore real-world applications of quantum computing in cryptography, optimization, and machine learning.

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

CO1: Understand the structure, operation, and constraints of various quantum computing systems.
CO2: Develop quantum circuits for basic quantum algorithms
CO3: Implement and simulate quantum algorithms using tools such as Qiskit, Cirq, or AWS Braket
CO4: Explain core concepts of quantum computing like superposition, entanglement, and interference
CO5: Analyze applications of quantum computing in diverse fields like cryptography, optimization, and AI and address challenges in quantum computing such as noise, error correction, and scalability

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: **Introduction to Quantum Computing:** Differences between classical and quantum computing.

Qubits, superposition, entanglement, and quantum measurement. Mathematical foundations: linear algebra, tensor products, Hilbert spaces.

UNIT-II: Quantum Hardware Systems: Quantum bit realization: superconducting qubits, trapped ions, photonics, neutral atoms. Quantum gates and circuits. Noise, decoherence, and quantum error correction basics. Overview of Noisy Intermediate-Scale Quantum (NISQ) devices.

UNIT-III: Quantum Algorithms: Introduction to quantum parallelism. Quantum circuits for Bell state, teleportation, superdense coding. Deutsch-Jozsa algorithm, Grover's search algorithm. Shor's factoring algorithm. Quantum phase estimation and amplitude amplification.

UNIT-IV: Quantum Programming and Simulations: Quantum programming frameworks: Qiskit, Cirq, PennyLane, AWS Braket. Writing quantum circuits, executing on simulators and real quantum hardware. Hybrid quantum-classical programming models. Example use cases and hands-on coding sessions.

UNIT-V: Applications and Future directions: Quantum machine learning basics. Quantum cryptography: BB84 protocol, post-quantum cryptography. Quantum optimization: QAOA, VQE. Challenges and future trends in quantum computing.

Text Books:

1. Quantum Computation and Quantum Information, Michael A. Nielsen & Isaac L. Chuang.
2. Quantum Computing: An Applied Approach, Jack D. Hidary, Jack D. Hidary
3. Programming Quantum Computers: Essential Algorithms and Code Samples,
4. Quantum Computing for Computer Scientists, Noson S. Yanofsky, Mirco A. Mannucci
5. Learn Quantum Computing with Python and Qiskit, Robert Loredo et al. (IBM)
6. Quantum Machine Learning, Peter Wittek

References:

1. IBM Quantum Lab: https://quantum-computing.ibm.com/
2. Qiskit Learning Platform: https://qiskit.org/learn/

3. Google Cirq: https://quantumai.google/cirq
4. AWS Braket: https://aws.amazon.com/braket/
5. PennyLane for Quantum Machine Learning: https://pennylane.ai/

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QC2204 - MICROPROCESSORS AND MICROCONTROLLERS (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2204	Microprocessors and Microcontrollers	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To know the internal organization, addressing modes and instruction sets of 8086 processor.
- To master the assembly language programming using concepts like assembler directives, procedures, software interrupts etc.
- To familiarize with the 8051 Instruction sets and addressing modes.
- To know the various peripheral devices such as 8255, 8279, 8251 and 8259.

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

CO1: Realize the architecture and working of 16-bit microprocessor 8086.

CO2: Apply assembly language programming skills to perform arithmetic, logical, string, stack and interrupt operations with 8086.

CO3: Understand the interfacing of memory and different peripherals with 8086 microprocessors.

CO4: Outline the architectural features of advanced microprocessors and summarize the basic
concepts of 8051 microcontroller.

CO5: Comprehend the architecture and instruction set of PIC and ARM microcontroller.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: 8086/8088 Microprocessors: Register organization of 8086, Architecture, signal description of 8086, physical memory organization, general bus operation, I/O addressing capability, special purpose activities, Minimum mode, maximum mode of 8086 system and timings, the processor 8088, machine language instruction formats, addressing mode of 8086, instruction set off 8086, assembler directives and operators.

UNIT-II: Programming With 8086 Microprocessors: Machine level programs, programming with an assembler, Assembly language programs, introduction to stack, stack structure of 8086/8088, interrupts and interrupt service routines, interrupt cycle of 8086, non-mask able interrupt and mask able interrupts, interrupt programming.

UNIT-III: Basic And Special Purpose Programmable Peripherals And Their Interfacing With 8086/88: Semiconductor memory interfacing, dynamic RAM interfacing, interfacing i/o ports, PIO 8255 modes of operation of 8255, interfacing to D/A and A/D converters, stepper motor interfacing, control of high power devices using 8255.Programmable interrupt controller 8259A, the keyboard /display controller8279, programmable communication interface 8251 USART, DMA Controller 8257.

UNIT-IV: Advanced Micro Processors: Salient features of 0386DX, architecture and signal description of 80386, register organization of 80386 and addressing modes, data types of 80386, real address mode of 80386, protected mode of 80386, segmentation and Paging, virtual 8086 mode and enhanced mode. Instruction set of 80386.The coprocessor 80387.

UNIT-V: 8051 Microcontrollers: Introduction to microcontrollers, 8051Microcontrollers, 8051pin description, connections, I/O ports and memory organization, MCS51addressing modes and instructions, assembly language programming tools.PIC Microcontrollers and ARM 32-BIT Microcontroller: Overview and features, PIC16Cx/7X instructions, interrupts in PIC 16C61/71, PIC 16F8XX Flash controllers, I/O ports and timers. Introduction to 16/32 Bit processors, ARM architecture and organization, ARM / Thumb programming model, ARM / Thumb instruction set.

Text Books:

1. A.K. Ray, K.M. Bhurchandi," Advanced Microprocessors and Peripherals", Tata McGraw Hill Publications, 2000.

2. N. Sentil Kumar, M. Saravanan, S. Jeevananthan, "Microprocessors and Microcontrollers", OxfordUniversity Press, 2010.

Reference Books:

1. Ajay V Deshmukh," Microcontrollers", TATA McGraw Hill publications, 2012.

2. Krishna Kant, "Microprocessors and Microcontrollers", PHI Publications, 2010.

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QC2205- INTRODUCTION TO QUANTUM SENSING

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2205	Introduction to Quantum Sensing	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Introduce the fundamentals of classical sensing and detection.
- Discuss classical and quantum noise sources and their implications in sensing.
- Explain measurement sensitivity and estimation theory.
- Explore different quantum measurement techniques and quantum limits.
- Survey applications of quantum sensing based on light, entanglement, and atomic systems.

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

CO1: Understand the basics of classical sensing.

CO2: Learn various aspects of quantum measurements.

CO3: Quantify sensitivity in quantum sensing using Fisher information and Cramer-Rao bounds.

CO4: Understand the characterization and detection of quantum states of light.

CO5: Apply quantum sensing techniques in real-world applications like gravimetry and magnetometry.

SYLLABUS

(With effect from 2025-26 admitted Batch)

UNIT - I: Classical Sensing – Photodetection, Classical Noise – Johnson Noise, Telegraph Noise, Flicker or 1/f Noise.

UNIT - II: Sensitivity of Classical Measurements – Classical Fisher Information, Cramer-Rao Bounds, Basics of Information Theory.

UNIT - III: Quantum Measurements – Projective/Orthogonal Measurements, Approximate/Non-Orthogonal Measurements, Weak Continuous Measurements, Error-Disturbance Relations, Standard Quantum Limits, Quantum Non-Demolition Measurements.

UNIT - IV: States of Light – Fock States, Coherent States, Squeezed States, Tomography, Wigner Quasiprobability Distribution, P-Distribution, Husimi Q Function.

UNIT - V: Quantum Photodetection – Square-Law Detectors, Intensity and Quadrature Measurements, Quantum Cramer-Rao Bounds, Applications in Sensing – Single Photon, Entanglement-Based, Atomic and Solid-State Spin-Based (Gravimetry, Magnetometry).

Textbooks:

1. Quantum Measurement and Control – Wiseman and Milburn
2. Quantum Measurement – Braginsky and Khalili

Reference Books:

1. Quantum Information Science – Motta and Manenti
2. Quantum Computing and Techniques – Rajiv Chopra

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QC2206- MICROPROCESSORS AND MICROCONTROLLERS LAB (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2206	Microprocessors and Microcontrollers Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- To study programming based on 8086 microprocessor and 8051 microcontrollers.
- To study 8086 microprocessor-based ALP using arithmetic, logical and shift operations.
- To study modular and Dos/Bios programming using 8086 microprocessors.
- To study to interface 8086 with I/O and other devices.
- To study parallel and serial communication using 8051 microcontrollers.

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

CO1: Build basic assembly language programs based on arithmetic operations using 8086 microprocessors.

CO2: Develop basic assembly language programs based on arithmetic, logical, shift and string operations using MASM32 assembler.

CO3: Execution of DOS/BIOS interrupts with 8086 microprocessors using MASM32 assembler.

CO4: Implementing basic assembly language programs of 8051 microcontroller using KEIL simulator.

CO5: Construct standalone applications by Interfacing I/O peripheral devices with 8086 microprocessors.

SYLLABUS

(with effect from 2025-26 admitted Batch)

List of Experiments:

I.8086 ESA-86/88 KIT PROGRAMMING

1. Write a Program to add two 16-bit numbers stored in two memory locations 2000h and 2002h and store the result in another memory location 2004h.

2. Write a Program to divide two 16-bit numbers stored in two memory locations 2000h and 2002h and store the result in another memory location 2004h.

3. Write a Program to multiply two 16-bit numbers stored in two memory locations 2000h and 2002h and store the result in another memory location 2004h.

4. Write a Program to add two 32-bit numbers stored in two memory locations 2000h and 2004h and store the result in another memory location 2008h.

5. Write a program to find factorial of a given number.

II. 8086 PROGRAMMING USING MASM32 ASSEMBLER

6. Write a program to perform addition operation on two multi byte numbers.

7. Write a program to perform subtraction operation on two multi byte numbers.

8. Write a program to sort a given set of hexadecimal numbers.

9. Write a program to find whether the given string is a palindrome or not.

10. Write a program for inserting an element at a specified location in a given string.

11. Write a program to convert BCD numbers into equivalent binary value. Write a subroutine for the conversion.

12. Write a program to read a keyboard and display the characters on the PC screen using DOS/BIOS commands.

III. 8051 PROGRAMMING USING KEIL SIMULATOR

13. Write a program to generate a square wave of 50% duty cycle at pin P2.1 using timer 0 in mode1.Assume XTAL=11.0592MHz.

14. Write a program to send a message "WELCOME" serially at 9600 baud rate continuously through serial port of 8051.

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QC2207- QUANTUM COMPUTING LAB (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2207	Quantum Computing Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- To understand the principles of quantum computing and quantum information.
- To gain hands-on experience with quantum algorithms and quantum circuits.
- To explore quantum gates, superposition, entanglement, and quantum measurements.
- To develop practical skills using quantum computing simulators and real quantum hardware.
- To prepare students for research and applications in quantum technologies.

Course Outcomes (COs): At the completion of the course the student will be able to

CO1: Implement basic quantum circuits using quantum gates.

CO2: Simulate quantum algorithms like Grover's Search and Shor's Algorithm.

CO3: Understand quantum entanglement and superposition experimentally.

CO4: Use quantum programming frameworks like IBM Qiskit or Microsoft Q#.

CO5: Solve basic computational problems using quantum approaches and Interpret measurement results from quantum experiments accurately.

SYLLABUS

(with effect from 2025-26 admitted Batch)

Tools and Platforms Used:

- IBM Qiskit (Python-based Quantum SDK)
- IBM Quantum Lab / IBM Quantum Experience (Cloud Quantum Computers)
- Microsoft Quantum Development Kit (QDK) with Q#
- Google Cirq (Python-based framework)

- Amazon Braket (Quantum cloud service)
- QuTiP (Quantum Toolbox in Python – for simulation)
- Jupyter Notebook (For coding and simulations)

List of Experiments:

1. Introduction to Quantum Computing Tools – Setting up Qiskit / IBM Quantum Lab.
2. Qubit Representation and Bloch Sphere Visualization.
3. Single-Qubit Gates: X, Y, Z, H, S, T gates – Simulation and implementation.
4. Multi-Qubit Gates: CNOT, SWAP, CCNOT – Entanglement experiments.
5. Bell State Creation and Measurement.
6. Superposition and Interference Experiments.
7. Entanglement Verification using CHSH Inequality.
8. Quantum Teleportation Protocol Implementation.
9. Deutsch-Jozsa Algorithm Simulation.
10. Grover's Search Algorithm Implementation.
11. Shor's Algorithm for Factorization (Simulated).
12. Quantum Fourier Transform and its Applications.
13. Measurement and Error Analysis in Quantum Circuits.
14. Running Quantum Circuits on Real Quantum Hardware (IBM Quantum Experience).

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QC2208 – INTRODUCTION TO QISKIT & IBM QUANTUM (SC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2208	Introduction to QISKIT & IBM Quantum	1		2	50	50	100	3hrs	2

Course Objectives: The objectives of this course are

- Understand the basic principles of quantum computation, including qubits, superposition, and measurement.
- Gain hands-on experience in creating, simulating, and executing quantum circuits using Qiskit.
- Learn to visualize quantum states and operations using Bloch spheres and quantum circuit diagrams.
- Explore quantum gates and their effect on single and multi-qubit systems through practical experiments.
- Acquire the skills to run quantum circuits on both simulators and real quantum hardware via IBM Quantum Experience.

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

CO1: Design and simulate quantum circuits using Qiskit for various quantum operations.

CO2: Demonstrate the behavior of qubits under different quantum gates and visualize quantum states.

CO3: Differentiate between simulated and real quantum hardware outputs and understand hardware-induced noise.

CO4: Analyze multi-qubit systems and perform quantum measurements to observe entanglement and state collapse.

CO5: Apply quantum computing tools to develop a strong foundation for advanced quantum computing applications and research.

SYLLABUS
(with effect from 2025-26 admitted Batch).

List of Experiments

1. Installing Qiskit and Setting Up the Environment
2. Creating and Executing a Basic Quantum Circuit
3. Generating Superposition using Hadamard Gate
4. Two-Qubit Entanglement (Bell State)
5. Bloch Sphere Visualization of Qubit States
6. Measurement and Collapse of Qubit States
7. Applying Multiple Quantum Gates
8. Multi-Qubit Circuit Design and Measurement
9. Swap Gate and Qubit State Exchange
10. Creating and Visualizing Quantum Circuit Diagrams
11. Using Quantum Simulators (Statevector & QASM)
12. Executing Circuits on IBM Quantum Hardware

Hardware/Software Requirements:

Hardware:

- Laptop/Desktop with minimum 4 GB RAM
- Stable internet connection
- Optional: Access to IBM Quantum hardware via cloud

Software:

- Python 3.8 or above
- Qiskit SDK
- Jupyter Notebook
- IBM Quantum Experience account

Reference Books:

1. Nielsen, M. A., & Chuang, I. L. – Quantum Computation and Quantum Information, Cambridge University Press.
2. S. J. Devitt, W. J. Munro, & K. Nemoto – Quantum Error Correction for Beginners, Morgan & Claypool Publishers.

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QC2209- ENVIRONMENTAL SCIENCE (MC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC2209	Environmental Science					100	100	3hrs	0

Course Objectives: The objectives of this course are

- To Familiarize the fundamental aspects of environment and the environmental management.
- To Provide information of some of the important international conventions which will be useful during the future endeavors after graduation.
- To Make realize the importance of natural resources management for the sustenance of the life and the society.
- To Apprise the impact of pollution getting generated through the anthropogenic activities on the environment.
- To Provide the concept of Sustainable Development, energy and environmental management.
- To Impart knowledge on the new generation waste like e-waste and plastic waste.

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

CO1: Knowledge on the fundamental aspects of environment and the environmental management and the knowledge on the salient features of the important international conventions.

CO2: Understanding of the importance of natural resources management for the sustenance of
the life and the society.

CO3: Familiarity on various forms of pollution and its impact on the environment.

CO4: Understand the elements of Sustainable Development, energy and environmental management.

CO5: Knowledge on the new generation waste like e-waste and plastic waste.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Introduction: Structure and functions of Ecosystems-Ecosystems and its Dynamics-Value of Biodiversity-impact of loss of biodiversity, Conservation of bio-diversity. Environmental indicators - Global environmental issues and their impact on the ecosystems.

Salient features of international conventions on Environment: Montreal Protocol, Kyoto protocol, Ramsar Convention on Wetlands, Stockholm Convention on Persistent Organic Pollutants, United Nations Framework Convention on Climate Change (UNFCCC),

UNIT-II: Natural Resources Management: Importance of natural resources management-Land as resource, Land degradation, Soil erosion and desertification, Effects of usage of fertilizer, herbicides and pesticide- watershed management.Forest resources: Use and over-exploitation, Mining and dams – their effects on forest ecosystems and the living beings. Water resources: Exploitation of surface and groundwater, Floods, droughts, Dams: benefits and costs.Mineral Resources: Impact of mining on the environment and possible environmental management options in mining and processing of the minerals.Sustainable resource management (land, water, and energy), and resilient design under the changing environment.

UNIT-III: Environmental Pollution: Local and Global Issues. Causes, effects and control measures. Engineering aspects of environmental pollution control systems.Air pollution: impacts of ambient and indoor air pollution on human health. Water pollution: impacts water pollution on human health and loss of fresh water resources. Soil pollution and its impact on environment. Marine pollution and its impact on blue economy. Noise pollution.

UNIT-IV: Solid waste management: Important elements in solid waste management- Waste to energy concepts. Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act and their amendments. Salient features of Environmental protection Act, 1986.

Sustainable Development: Fundamentals of Sustainable Development– Sustainability Strategies and Barriers – Industrialization and sustainable development. Circular economy concepts in waste (solid and fluid) management.

UNIT-V: Energy and Environment: Environmental Benefits and challenges, Availability and need of conventional energy resources, major environmental problems related to the conventional energy resources, future possibilities of energy need and availability. Solar Energy: process of photovoltaic energy conversion, solar energy conversion technologies and devices, their principles, working and applications, disposal of solar panel after their usage. Biomass energy: Concept of biomass energy utilization, types of biomass energy, conversion processes, Wind Energy, energy conversion technologies, their principles, equipment and suitability in context of India.

UNIT-VI: Management of plastic waste and E-waste: Sources, generation and characteristics of various e- and plastic wastes generated from various industrial and commercial activities; Waste management practices including onsite handling, storage, collection and transfer. E-waste and plastic waste processing alternatives. E-Waste management rules and Plastic waste management rules, 2016 and their subsequent amendments.

Text Books:

1. Bharucha, Erach (2004). Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education, University Grants Commission, New Delhi.
2. Base, M., Xavier, S. (2016). Fundamentals of Environmental Studies, Cambridge University Press, India.
3. Masters, G. M., &Ela, W. P. (1991). Introduction to environmental engineering and science. Englewood Cliffs, NJ: Prentice Hall.
4. Enger, E. and Smith, B., Environmental Science: A Study of Interrelationships, Publisher: McGraw-Hill Higher Education; 12th edition, 2010.

Reference Books:

1. Sharma, P. D., & Sharma, P. D. (2005). Ecology and environment. Rastogi Publications
2. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
3. Clark R.S. (2001). Marine Pollution, Clanderson Press Oxford (TB).
4. Jadhav, H & Bhosale, V.M. (1995). Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
5. MoEF&CC, Govt. of India, CPCB: E-waste management rules, 2016 and its amendments 2018.
6. MoEF&CC, Govt. of India, CPCB: Plastic waste management rules, 2016.

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QC3101 – INTRODUCTION TO QUANTUM MATERIALS (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3101	Introduction to Quantum Materials	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Introduce the basic idea of quantum materials.
- Explain the band theory of solids and its significance in metals, semiconductors, and insulators.
- Discuss magnetism, superconductivity, and associated phenomena relevant to quantum applications.
- Explore properties of modern 2D materials like graphene and transition metal dichalcogenides (TMDCs).
- Introduce topological phases of matter and modern material growth techniques.

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

CO1: Understand the basic concept of quantum materials.

CO2: Learn the fundamentals of band theory and classification of solids.

CO3: Explain key principles of magnetism and superconductivity.

CO4: Gain knowledge of 2D materials and their physical properties.

CO5: Describe topological phases of matter and material growth methods.

SYLLABUS

(With effect from 2025-26 admitted Batch)

UNIT - I: Band Theory Basics – Metals, Semiconductors and Insulators, Band Structure of Solids, Survey of Semiconducting Devices for Quantum Technologies (Electronic, Quantum Optical Devices and Principle of Operation).

UNIT - II: Correlated Systems and Magnetism – Para and Ferromagnetism Basics, Magnetic Measurements, Hall Effect, Magnetoresistance, Faraday and Kerr Effects.

UNIT - III: Superconductivity – BCS Theory, Ginzburg Landau Theory, Josephson Effect – AC and DC Josephson Effects, Survey of Superconducting Devices for Quantum Technologies.

UNIT - IV: 2D Materials – Graphene and its Properties (Single and Few Layers), Transition Metal Dichalcogenides – Electronic and Optical Properties.

UNIT - V: Topological Phases of Matter – Basics of Topology, Geometric Phases - Berry Phase, Aharonov-Bohm Effect, Topological Phases of Matter, Survey of Material Growth Techniques – Molecular Beam Epitaxy, Chemical Vapor Deposition, MOVPE, Pulsed Laser Deposition, Crystal Growth Techniques.

Textbooks:

1. Engineering Physics – A.B. Bhattacharya & Atanu Nag

Reference Books:

1. Condensed Matter Physics – Marder.

2. Introduction to Superconductivity – Michael Tinkham

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QC3102 - CLASSICAL AND QUANTUM INFORMATION THEORY (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3102	Classical And Quantum Information Theory	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To introduce the basics of quantum bits, gates, and circuits.
- To explain how quantum measurements are performed and interpreted.
- To teach protocols like superdense coding and quantum teleportation.
- To study important quantum algorithms and information theory concepts.
- To understand quantum data compression, error correction, and cryptography.

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

CO1: Students will understand and apply quantum gates and circuits.

CO2: Students will be able to describe and perform different quantum measurements.

CO3: Students will explain and implement basic quantum communication protocols.

CO4: Students will apply quantum algorithms and understand quantum information concepts.

CO5: Students will analyze quantum compression, error correction, and cryptographic

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT- I: Quantum Bits and Basic Quantum Gates: Quantum bits, basic computations with 1-qubit quantum gates, Pauli matrices or I, X, Y, Z-gates, Hadamard matrix gate or H-gate, quantum gates with multiple qubit inputs and outputs, quantum circuits, non cloning theorem.

UNIT-II: Quantum measurements: Quantum measurements and types, quantum measurements in the orthonormal basis, Projective or von-Neumann measurements, POVM measurements, quantum measurements on joint states.

UNIT-III: Qubit measurements, superdense coding, and quantum teleportation: Measuring single quits, measuring n-qubits, Bell state measurement, superdense coding, quantum teleportation, distributed quantum computing.

UNIT-IV: Quantum Algorithms and Information Theory: Deutch-Joza, quantum Fourier transform, and Grover quantum database search algorithms, Shor's factorisation algorithm. Von Neumann entropy, Relative, joint, and conditional entropy, and mutual information, quantum communication channel and Holevo bound.

UNIT-V: Quantum Data Compression, Error Correction, and Cryptography: Quantum Data Compression, Error Correction, and Cryptography**,** Quantum data compression and fidelity. Schumacher's quantum coding theorem, quantum Channel noise and channel capacity, Quantum error correction, Quantum cryptography: Electromagnetic waves, polarization states, photons, and quantum measurements, the BB84 protocol, the B92 protocol, the EPR protocol.

Text Books

1. Classical and Quantum Information Theory: An Introduction for the Telecom Scientist, E Desurvire, Cambridge University Press
2. Quantum Computation and Quantum Information, Michael A. Nielsen & Isaac L. Chuang, Cambridge University Press.

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Q3103- QUANTUM ALGORITHMS (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3103	Quantum Algorithms	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Understand the mathematical foundations of quantum mechanics and qubit representation.
- Learn basic and intermediate quantum algorithms and their computational advantages.
- Explore quantum error correction techniques and quantum cryptographic protocols.
- Study practical quantum systems, simulation tools, and noise/error mitigation.
- Gain exposure to advanced quantum topics and emerging quantum computing frameworks.

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

CO1: Represent quantum states and gates using linear algebra and implement basic circuits.

CO2: Analyze and implement foundational quantum algorithms like Deutsch–Jozsa and Grover's.

CO3: Apply quantum Fourier transform and Shor's algorithm for complex problem-solving.

CO4: Demonstrate understanding of quantum error correction and cryptographic protocols like BB84.

CO5: Use simulators (e.g., Qiskit) to design circuits and explore variational or hybrid quantum algorithms.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Quantum Fundamentals & Qubits: Linear operators, Hermitian and unitary matrices, Qubits and Bloch sphere, superposition, tensor products, Quantum gates: Pauli (X, Y, Z), Hadamard, Phase, T, CNOT, controlled-U, Basics of quantum circuits and reversible computation.

UNIT-II: Quantum Algorithms I – Basics: Deutsch's algorithm and Deutsch–Jozsa generalization, Bernstein–Vazirani, Simon's problem, Quantum parallelism and oracles

UNIT-III: Quantum Algorithms II – Search & Factoring: Grover's algorithm (amplitude amplification, speed-up), Quantum Fourier transform (QFT), phase estimation, Shor's algorithm for integer factorization

UNIT-IV: Error Correction & Cryptography: Quantum error-correcting codes: 3-qubit bit-flip, Shor's 9-qubit code, Basics of quantum cryptography and quantum key distribution, Security primitives: BB84 protocol, one-time pad, RSA overview

UNIT-V: Advanced Topics & Practical Implementations: Open quantum systems: density matrices, Kraus maps (IITB PH-534), Error mitigation strategies: Rabi, Ramsey, dynamical decoupling (EE-801), Hands-on with circuit simulators: Qiskit or MATLAB/Python frameworks, Exploratory topics: superdense coding, teleportation, Variational Quantum Algorithms

Textbooks:

1. Parag K. Lala – Quantum Computing: A Beginner's Introduction (McGraw Hill, 2020)
2. Chris Bernhardt – Quantum Computing for Everyone (MIT Press, 2020)

Reference Books:

1. Nielsen & Chuang – Quantum Computation and Quantum Information (Cambridge, 2010)
2. Scott Aaronson – Quantum Computing Since Democritus (Cambridge Univ. Press, 2013)
3. N. David Mermin – Quantum Computer Science: An Introduction (Cambridge, 2007)
4. Lecture notes from PH-534 (IITB) — Open quantum systems, entanglement, quantum algorithms (phyiitb.blogspot.com)
5. EE-801 course overview — measurement+control protocols, error correction strategies (ee.iitb.ac.in)
6. Tutorial series with Qiskit (e.g., Koch, Alsing) — coding workflows for algorithms (arxiv.org)

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QC3104 - Professional Elective-I

(Note: Refer Annexure-I for Syllabus details)

QC3105 - Open Elective-I

(Note: Refer Annexure-II for Syllabus details)

QC3106 - QUANTUM ALGORITHMS WITH PYTHON AND QISKIT LAB (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3106	**Quantum Algorithms with Python and Qiskit Lab**			**3**	**50**	**50**	**100**	**3hrs**	**1.5**

Course Objectives: The objectives of this course are

- Understand the fundamentals of quantum computing through simulation.
- Develop hands-on skills using Python and Qiskit to implement quantum algorithms.
- Visualize and interpret quantum states, gates, and measurements.
- Simulate key quantum algorithms like Deutsch-Jozsa, Grover's, and QFT.
- Explore noise models, error mitigation, and hybrid quantum-classical algorithms.

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

CO1: Implement and simulate single- and multi-qubit circuits using Qiskit.

CO2: Analyze quantum state evolution and measurement outcomes.

CO3: Design and test basic quantum algorithms like Deutsch-Jozsa and Grover's.

CO4: Evaluate quantum hardware performance metrics (T_1, T_2, Quantum Volume).

CO5: Apply VQE/QAOA for solving small optimization or chemistry problems.

SYLLABUS
(with effect from 2025-26 admitted Batch)

List of Experiments:

1. Python & Qiskit Setup
2. Single-Qubit Gates & Bloch Sphere
3. Multi-Qubit States & Entanglement
4. Quantum Measurements & Sampling
5. Deutsch-Jozsa Algorithm

6. Grover's Search Algorithm
7. Quantum Fourier Transform (QFT)
8. Shor's Factoring Algorithm
9. Quantum Teleportation
10. Error Mitigation Techniques
11. Device Characterization (T_1, T_2, Quantum Volume)
12. VQE / QAOA for Optimization

Hardware/Software Requirements:

Hardware:

- Laptop/Desktop with minimum 8 GB RAM
- 64-bit operating system (Windows/macOS/Linux)
- Internet connection (for cloud access to IBM Quantum systems)
- Optional: GPU support for accelerated simulations

Software:

- Python 3.8 or above
- Qiskit SDK
- Jupyter Notebook or JupyterLab
- IBM Quantum Experience account
- Supporting libraries: NumPy, Matplotlib, Seaborn, SciPy, qiskit-aer, qiskit-ibmq-provider

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QC3107 - QUANTUM NETWORKS LAB (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3107	Quantum Networks Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- To introduce the foundational principles of quantum networking and entanglement.
- To simulate key quantum communication protocols such as teleportation and QKD.
- To understand quantum repeaters, entanglement routing, and network topology.
- To evaluate the performance of quantum channels under noise and loss.
- To explore advanced concepts like entanglement swapping, distillation, and secret sharing.

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

CO1: Simulate entanglement-based communication protocols like teleportation and BB84.

CO2: Analyze entanglement swapping and fidelity in quantum channels.

CO3: Design and evaluate multi-node quantum network topologies using QuNetSim.

CO4: Implement quantum secret sharing and entanglement distillation protocols.

CO5: Compare classical vs quantum communication paradigms in terms of security and efficiency.

SYLLABUS

(with effect from 2025-26 admitted Batch)

List of Experiments:

1. Entanglement Generation.
2. Quantum Teleportation.
3. Entanglement Swapping.
4. QKD using BB84 Protocol.

5. QKD using E91 Protocol.
6. Multi-Hop Quantum Communication via Repeaters.
7. Quantum Channel Fidelity Analysis.
8. Quantum Routing Simulation.
9. Classical vs Quantum Communication.
10. Quantum Network Topology Design.
11. Entanglement Distillation.
12. Quantum Secret Sharing

Hardware/Software Requirements:

Hardware:

- Laptop/Desktop with minimum 8 GB RAM
- 64-bit operating system (Windows/macOS/Linux)
- Internet access for cloud-based quantum communication simulations
- Optional: High-speed internet for real-time IBM Q execution and network simulations

Software:

- Python 3.8 or above
- Qiskit SDK with qiskit-quantum_info, qiskit-aqua, and qiskit-ibmq-provider
- Jupyter Notebook or JupyterLab
- IBM Quantum Experience account
- Simulation Tools: QuNetSim, NetSquid (for advanced quantum network simulations)
- Supporting libraries: NumPy, Matplotlib, Seaborn, SciPy, Network

Reference Books:

1. **M. A. Nielsen & I. L. Chuang** – *Quantum Computation and Quantum Information*, Cambridge University Press.
2. **Mark M. Wilde** – *Quantum Information Theory*, Cambridge University Press.
3. **C. H. Bennett & G. Brassard** – *Quantum Cryptography and Secret-Key Distillation*, Foundations of Physics (Springer, collected papers).

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QC3108 - MODELING PHYSICAL SYSTEMS USING QUANTUM CIRCUITS (SC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3108	Modeling Physical Systems Using Quantum Circuits	1		2	50	50	100	3hrs	2

Course Objectives: The objectives of this course are

- Understand fundamental quantum phenomena through simulation.
- Gain practical experience with quantum gates, algorithms, and circuits.
- Explore quantum effects like tunneling, decoherence, and entanglement.
- Simulate quantum algorithms using Qiskit and Python tools.
- Analyze quantum system behavior under noise and real-world constraints.

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

CO1: Simulate and visualize single- and multi-qubit systems using Qiskit.

CO2: Implement and test basic quantum algorithms like VQE, QFT, and Grover's.

CO3: Analyze effects of decoherence, noise, and quantum measurements.

CO4: Model physical quantum systems such as harmonic oscillators and the Ising model.

CO5: Evaluate performance and fidelity of quantum communication and computation protocols.

SYLLABUS

(with effect from 2025-26 admitted Batch)

List of Experiments

1. Simulating Single Qubit Evolution using Bloch Sphere
2. Simulating Quantum Harmonic Oscillator
3. Variational Quantum Eigensolver (VQE) Simulation

2. Simulation of Quantum Phase Estimation (QPE) Algorithm
3. Simulating Tunneling Effect in Quantum Systems
4. Quantum Fourier Transform Simulation
5. Simulating Quantum Random Walks
6. Simulating Grover's Search Algorithm
7. Quantum Zeno Effect Simulation
8. Simulation of Ising Model using Qiskit Nature
9. Simulating Quantum Teleportation with Noise
10. Decoherence and Noise Channel Simulation

Hardware / Software Requirements:

Hardware Requirements:

- Laptop/Desktop with 8 GB RAM or more
- 64-bit OS (Windows/macOS/Linux)
- Internet connection

Software Requirements:

- Python 3.8+
- Qiskit SDK
- Jupyter Notebook
- Libraries: NumPy, Matplotlib, SciPy, Qiskit Nature (for physics/chemistry), Qutip (optional)

Reference Books:

1. **Johannes Kretchmer** – *Quantum Mechanics with Qiskit: Simulating Quantum Systems in Python*, Packt Publishing.
2. **Nielsen, M. A. & Chuang, I. L.** – *Quantum Computation and Quantum Information*, Cambridge University Press.

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QC3201- QUANTUM GAME THEORY (PC)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3201	Quantum Game Theory	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Understand the foundational principles of classical game theory, including strategy classification, Nash equilibria, and outcome optimization techniques
- Learn to extend classical game theory concepts into the quantum domain, incorporating principles of superposition, entanglement, and quantum operators to explore novel strategic possibilities.
- Develop the ability to formulate and analyze quantum game protocols, identify quantum Nash equilibria
- Explore advanced applications and research directions of quantum game theory
- Integrate interdisciplinary perspectives by connecting quantum game theory with fields such as quantum computing, economics, and information theory to foster a broader understanding of strategic interactions in quantum systems.

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

CO1: Explain and apply the core concepts of classical game theory, including players, strategies, payoff matrices, and Nash equilibria, both in pure and mixed strategies.

CO2: Demonstrate how quantum mechanics alters classical game structures, using superposition, entanglement, and unitary operators

CO3: Design and implement quantum game protocols and strategies, identifying quantum equilibria

CO4: Critically assess the practical applications of quantum game theory and explore emerging directions and challenges in quantum strategy research.

CO5: Synthesize knowledge from quantum mechanics, classical game theory, and strategic modeling to propose innovative solutions and interdisciplinary applications in real-world quantum systems.

SYLLABUS
(with effect from 2025-26 admitted Batch)

UNIT I: Introduction to Classical Game Theory: Basic definitions: players, strategies (pure and mixed), payoffs, outcomes. Types of games: cooperative vs. non-cooperative, zero-sum vs. non-zero-sum, simultaneous vs. sequential. Normal form (matrix games) and extensive form. Prisoner's Dilemma, Battle of the Sexes, Matching Pennies. Dominant strategies and dominated strategies. Nash Equilibrium: definition, existence, and examples. Pareto optimality. Mixed strategies and Nash Equilibrium in mixed strategies.

UNIT II: Quantum Mechanics for Game Theory: Introducing quantum strategies to classical game structures. Encoding classical choices into quantum states. The role of entanglement and superposition in modifying game outcomes. Eisert-Wilkens-Lewenstein (EWL) Scheme: A pioneering framework for quantum games. Entanglement as a resource for players. Analyzing the Prisoner's Dilemma in the EWL framework.

UNIT III: Quantum Game Protocols and Strategies: General structure of a quantum game: initialization, strategy application, measurement. Role of entanglement in creating new strategic possibilities. Quantum "cheating" and its implications. Quantum Strategies and Operators: Players' strategies as unitary operators. The space of quantum strategies. Identifying quantum Nash Equilibria.**:** Quantum Battle of the Sexes: how quantum strategies alter the game's outcome. Quantum Matching Pennies: Overcoming Classical Limitations. Other quantum versions of classical games (e.g., Minority Game, Inspection Game).

UNIT IV: Advanced Topics in Quantum Game Theory: Extending game theory to more than two players in the quantum domain. Challenges and opportunities with increased entanglement. Conditions for the existence of quantum advantages. Exploring cooperation in quantum games. Quantum correlations and their impact on cooperative outcomes. The effect of noise and decoherence on quantum game outcomes. Modeling realistic quantum game scenarios.

UNIT V: Applications and Future Directions: Quantum communication protocols and security (e.g., quantum key distribution as a game). Quantum algorithms for strategic decision-making. Potential in economics, finance, and social sciences (modeling strategic interactions with quantum effects). Brief overview of experimental efforts to realize quantum games (e.g., using photons or superconducting circuits). Dynamics of strategy evolution in a quantum context. Quantum replicator equations.

Text Books:

1. Eisert, J., Wilkens, M., & Lewenstein, M. (1999). Quantum Games and Quantum Strategies. Physical Review Letters, 83(15), 3077.
2. Axelrod, R. M. (1984). The Evolution of Cooperation. Basic Books. (For classical game theory foundation)
3. Nielsen, M. A., & Chuang, I. L. (2010). Quantum Computation and Quantum Information. Cambridge University Press. (For quantum mechanics background)

References:

- Piotrowski, E. W., & Sładkowski, J. (2003). Quantum games. Chaos, Solitons & Fractals, 14(11), 1693-1702.
- Flitney, A. P. (2009). Quantum Game Theory. Journal of Physics: Conference Series, 188(1), 012001.
- Wang, J., et al. (2020). Quantum game theory: A review. Frontiers in Physics, 8, 30.

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QC3202 - DIGITAL SIGNAL PROCESSING (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3202	Digital Signal Processing	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To Analyze the Discrete Time Signals and Systems.
- To understand the various implementations of digital filter structures.
- To know the importance of FFT algorithm for computation of Discrete Fourier Transform.
- To learn the FIR and IIR Filter design procedures.
- To know the applications of DSP.

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

CO 1: Apply the concepts of difference equations to Analyze the discrete time systems

CO 2: Make use of the FFT algorithm for solving the DFT of a given signal.

CO 3: Analyze the Digital IIR & FIR filter design for different specifications.

CO 4: Analyze the Digital FIR filter design for different specifications.

CO 5: Understand the signal Processing concepts in various applications.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT – I: Discrete - Time Signals and Systems: Discrete - Time Signals – Sequences, Linear Shift – Invariant Systems, Stability and Causality, Linear Constants – Coefficient Difference Equations, Frequency Domain Representation of Discrete – Time Signals and Systems.

UNIT – II: Applications of Z – Transforms: System Functions H(z) of Digital Systems, Stability Analysis, Structure and Realization of Digital Filters, Finite Word Length Effects.

UNIT – III: Discrete Fourier Transform (DFT): Properties of the DFS, DFS Representation of Periodic Sequences, Properties of DFT, Convolution of Sequences. Fast –

Fourier Transforms (FFT): Radix – 2 Decimation – In – Time (DIT) and Decimation – In – Frequency (DIF), FFT Algorithms, Inverse FFT.

UNIT – IV: IIR Digital Filter Design Techniques: Design of IIR Filters from Analog Filters, Analog Filters Approximations (Butterworth and Chebyshev Approximations), Frequency Transformations, General Considerations in Digital Filter Design, Bilinear Transformation Method, Step and Impulse Invariance Technique.

UNIT – V: Design of FIR Filters: Fourier series Method, Window Function Techniques, Comparison of IIR and FIR Filters. Applications of FFT in Spectrum Analysis and Filtering, Application of DSP in Speech Processing.

Text Book:

1. Alan V. Oppenheim and Ronald W. Schafer: Digital Signal Processing, PHI.

Reference Books:

1. Sanjit K. Mitra, Digital Signal Processing "A – Computer Based Approach", Tata Mc Graw Hill.
2. Raddar and Rabiner, Application of Digital Signal Processing.
3. S. P. Eugene Xavier, Signals, Systems and Signal Processing, S. Chand and Co. Ltd.
4. Antonio, Analysis and Design of Digital Filters, Tata Mc Graw Hill.

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QC3203 - ATOMIC AND MOLECULAR SPECTROSCOPY (PC)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3203	Atomic And Molecular Spectroscopy	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To understand the basic principles of semiconductor optoelectronic materials, devices, and processes.
- To analyze the physical mechanisms behind optical emission, detection, and amplification in semiconductor devices.
- To explore the design and working of guided-wave structures, optical amplifiers, and laser diodes.
- To study integrated photonic components in silicon photonics platforms and their applications in communication and sensing.
- To evaluate the challenges of CMOS compatibility and integration of optoelectronic components for photonic circuits.

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

CO1: Describe the quantum structure of atoms and explain atomic spectra using LS and JJ coupling schemes.

CO2: Apply selection rules and line shape analysis to interpret atomic and molecular spectral transitions.

CO3: Analyze vibrational, rotational, and electronic spectra using IR, microwave, and UV-Vis techniques.

CO4: Explain the principles of ESR, NMR, MRI, and Mössbauer spectroscopy and interpret their outputs.

CO5: Evaluate advanced techniques such as ion trap mass spectrometry and laser cooling of atoms.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Atomic Structure and Atomic Spectroscopy: One- and multi-electron atoms: energy level structures, Spectroscopic term symbols and energy level notation schemes, Interaction of electromagnetic radiation with atoms, Einstein coefficients (A, B) and selection rules, Line shape functions: natural, Doppler, and collisional broadening, Visible, UV, and X-ray spectroscopy of atoms, Basic instrumentation and applications, Astronomical relevance of atomic spectra

UNIT-II: Molecular Structure and Quantum Models: Fundamentals of molecular structure, Group theory applications in molecular physics, Quantum models: Hückel model for π-systems, Hartree–Fock theory for molecular orbitals, Basics of Density Functional Theory (DFT) for small molecules, Molecular term symbols and energy level notations

UNIT-III: Molecular Spectroscopy: Vibrational, Rotational, and Electronic, Electronic, vibrational, and rotational transitions in molecules, Spectroscopy of diatomic and polyatomic molecules, Visible, IR, and microwave spectroscopy, Instrumentation and selection rules for molecular transitions, Raman spectroscopy: theory, selection rules, and applications

UNIT-IV: Resonance Spectroscopy Techniques: Electron Spin Resonance (ESR): principles, hyperfine interaction, g-factor, Nuclear Magnetic Resonance (NMR): theory, chemical shift, spin-spin coupling, Magnetic Resonance Imaging (MRI): basic physics and applications, Mössbauer spectroscopy: isomer shift, quadrupole splitting, and applications

UNIT-V: Mass Spectrometry and Advanced Techniques: Mass spectrometer fundamentals: ionization methods, mass analyzers, Ion traps: Paul trap, Penning trap, and multipole traps, Fourier Transform Infrared (FTIR) spectroscopy: principles and instrumentation, Applications of FTIR and mass spectrometry in chemical and biological systems

Textbooks:

1. Fundamentals of Molecular Spectroscopy by Banwell (4th edition, TMH)

2. Atomic and molecular spectroscopy: basic aspects and practical applications By Sune Svanberg (4th edition, Springer)

References:

3. Modern spectroscopy By John Michael Hollas (4 th edition, Wiley)

4. Quadrupole ion trap mass spectrometry By Raymond E. March, John F. J. Todd (2 nd edition, Wiley-Interscience).

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QC3204 - Professional Elective-II

(Note: Refer Annexure-I for Syllabus details)

QC3205 - Open Elective-II

(Note: Refer Annexure-II for Syllabus details)

QC3206 - SPECTROSCOPY LAB (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3206	Spectroscopy Lab	0		3	30	70	100	3hrs	1.5

Course Objectives: The objectives of this course are

- To understand the fundamental principles of interaction between electromagnetic radiation and matter.
- To explore the experimental verification of quantum mechanical phenomena using optical, atomic, and molecular spectroscopy techniques.
- To acquire hands-on experience in operating modern spectroscopic instrumentation such as spectrometers, interferometers, lasers, and detectors.
- To develop analytical thinking by interpreting spectral data to extract physical constants and molecular properties.
- To introduce advanced spectroscopic techniques used in current scientific research and industrial applications.

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

CO1: Understand the interaction of electromagnetic radiation with matter through key quantum phenomena.

CO2: Apply spectroscopic methods to measure atomic and molecular energy levels.

CO3: Develop experimental and data analysis skills using modern photonics, laser, and optical instrumentation.

CO4: Correlate spectroscopic results with theoretical predictions from quantum mechanics.

CO5: Interpret complex spectroscopic signatures to derive quantitative information about atomic, molecular, and solid-state systems, bridging theory with experimental observations.

SYLLABUS

(Effective from Admitted Batch of 2025-26)

List of Experiments

1. Photoelectric Effect
2. Compton Scattering
3. Franck–Hertz Experiment
4. Optical Emission Spectra of Hydrogenic Atoms
5. X-Ray Physics
6. Zeeman Effect
7. Optical Pumping of Rb Vapor
8. Raman Spectroscopy
9. 21-cm Radio Astrophysics
10. Mössbauer Spectroscopy
11. Doppler-Free Laser Spectroscopy
12. Pulsed Nuclear Magnetic Resonance: Spin Echoes

Hardware/Software Requirements:

Hardware:

- Laboratory setup with:
    - Photo-detectors and light sources (lasers, lamps)
    - Spectrometers, optical filters, and lenses
    - Rubidium vapor cells, X-ray tubes, and radio antennas (for respective experiments)
    - Oscilloscope, lock-in amplifiers, signal generators
    - NMR setup for pulsed experiments (e.g., spin echoes)
    - High-voltage power supply (for Franck–Hertz, Zeeman effect)
    - Data acquisition system (DAQ cards or digitizers)

Software:

- Python with libraries: NumPy, Matplotlib, SciPy, PyVISA (for instrument control)
- LabVIEW or MATLAB (optional for automation and data analysis)

- DAQ software for interfacing hardware with PC
- Spectroscopy analysis tools (e.g., Origin, SpectraSuite – optional)

Reference Books:

1. Arthur Beiser – Concepts of Modern Physics, McGraw Hill.
2. H. Haken & H.C. Wolf – The Physics of Atoms and Quanta, Springer.
3. B. H. Bransden & C. J. Joachain – Physics of Atoms and Molecules, Pearson Education.

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QC3207 - DIGITAL SIGNAL PROCESSING LAB (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3207	Digital Signal Processing Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- To make familiar with practical implementation of the digital signal processing.
- To develop DSP algorithms for convolution, correlation and DFT.
- To design digital filters.
- To understand audio and image processing.

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

CO 1: Generation and Implementation of discrete time signals and systems.
CO 2: Analyze the Frequency analysis of discrete signals and systems.
CO 3: Design and simulate FIR and IIR filters with different techniques.
CO 4: Analyze noise performance on audio signals.
CO 5: Understand the concepts of Digital Image Processing.

SYLLABUS
(with effect from 2025-26 admitted Batch)

List of Experiments:

(Simulate the following experiments using signal processing simulation software)

1. Sampling theorem, illustration of up sampling in time and frequency domain.
2. Sampling theorem, illustration down sampling in time and frequency domain.
3. Implement
   (a) Linear Convolution of Two Sequences.
   (b) Circular Convolution of Two Sequences.
   (c) Cross-Correlation and Auto-Correlation.
4. FFT of a given (8 point and 16 point) N-point Sequence using
   (a) DIF-FFT (b) DIT-FFT.
5. System Response of Discrete Time Sequences

(a) Impulse (b) Step

6. Spectral Analysis of given Waveforms. And Plot Spectrogram (Frequency v/s Time)

   (a) Sinusoidal (b) Square (c) Audio file.

7. Study of Architecture of DSP Chip-TMS320C6711.

8. Design following IIR Digital Filters using i) Butterworth and ii) Chebyshev designs:

   (a) LPF (b) HPF (c) BPF (d) BSF

9. Design FIR Digital Filters using a) Rectangular window b) Hamming window:

   (a) LPF (b) HPF (c) BPF (d) BSF.

10. Addition of White Gaussian Noise to an Audio file and recover the Signal using Butterworth filters.

11. Perform various operations on Digital Images.

    (a) Cropping (b) rotation (c) histogram (d) binary image

    (e) B to G conversion (f) water marking (g) Adding noise to the image.

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QC3208 - QUANTUM GAME THEORY LAB (PC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3208	Quantum Game Theory Lab			3	50	50	100	3hrs	1.5

Course Objectives: The objectives of this course are

- To introduce students to the principles of quantum information and game theory through hands-on implementation of quantum games on simulators and real quantum processors.
- To provide practical experience in designing, simulating, and analyzing quantum strategies in competitive and cooperative multi-agent settings, using concepts like superposition, entanglement, and quantum measurement.
- To enable students to explore quantum advantage by experimentally comparing classical and quantum game outcomes and studying how quantum correlations influence strategic behaviour.
- To cultivate skills in experimental design, result interpretation, and uncertainty analysis in quantum experiments involving probabilistic and entanglement-driven outcomes.
- To foster research-oriented thinking by encouraging students to develop and test novel quantum game scenarios, enabling exploration of strategic behavior under emerging quantum technologies.

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

CO1: Understand and apply fundamental quantum mechanics concepts like superposition, entanglement, and quantum measurement through experimental quantum games and spectroscopy setups.

CO2: Design, implement, and simulate classical and quantum strategic games using quantum computing platforms (like Qiskit) or physical systems (like NMR or photonic devices).

CO3: Analyze and interpret experimental data to compare classical and quantum outcomes, highlighting quantum advantages in strategy and measurement precision.

CO4: Demonstrate the ability to design and evaluate original quantum game experiments, contributing to current research trends in quantum computing, communication, and decision sciences.

CO5: Develop teamwork and collaborative problem-solving skills by designing and executing multi-agent quantum games, emphasizing communication, strategy optimization, and ethical considerations in quantum-enabled decision-making.

SYLLABUS

(Effective from Admitted Batch of 2025-26)

List of Experiments

1. Two-Player Quantum Penny-Flip Game (NMR / QPU)
2. Quantum Prisoner's Dilemma (NMR)
3. Quantum Minority Game (4 Players, Photonic)
4. CHSH Bell Game
5. Odd-Cycle Coloring Game (Ion-Trap)
6. Quantum Poker (QPU / Qiskit)
7. Quantum Blackjack & Roulette (STAGE Lab)
8. Refereed Bell-State Door Game
9. Quantum Tic-Tac-Toe
10. Bridge Communication Game with Entangled Photons
11. Quantum Gambling Protocol Experiment
12. Quantum Non-Cooperative Games

Hardware and Software Requirements:

Hardware:

- Standard Laptop/Desktop with 8 GB RAM or more
- Quantum Processing Unit (QPU) access (via IBM Quantum, IonQ, or similar platforms)
- Optional experimental setups for specific implementations:
    - NMR kit (for Penny Flip, Prisoner's Dilemma)
    - Photonic lab setup (for entangled photon-based games)
    - Ion-trap simulators or lab (for Odd-Cycle Coloring Game)

Software:

- Python 3.8+
- Qiskit SDK (for circuit-based implementations and simulators)
- Jupyter Notebook
- Libraries: NumPy, Matplotlib, Qiskit, NetworkX, Qutip (optional)
- IBM Quantum Experience account for real-device execution
- Optional tools:
    - Unity or Web interfaces (for game visualizations)
    - Stage Lab tools (if used in experimental game interfaces)

Reference Books:

1. David A. Meyer & Jens Eisert – Quantum Strategies and Game Theory, in Lecture Notes in Physics, Springer.
2. Michael A. Nielsen & Isaac L. Chuang – Quantum Computation and Quantum Information, Cambridge University Press.
3. Chakrabarti, Das, & Chakrabarti – Quantum Games and Quantum Strategies, Springer.

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QC3209 - SOFT SKILLS (SC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC3209	Soft Skills	1		2	50	50	100	3hrs	2

Course Objectives: The objectives of this course are

- To develop skills to communicate clearly.
- To aid students in building interpersonal skills.
- To enhance team building and time management skills.
- To inculcate active listening and responding skills.

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

CO 1: Make use of techniques for self-awareness and self-development.

CO 2: Apply the conceptual understanding of communication into everyday practice.

CO 3: Understand the importance of teamwork and group discussions skills.

CO 4: Develop time management and stress management.

CO 5: Preparation of resume and interviews.

SYLLABUS
(with effect from 2025-26 admitted Batch)

UNIT – I: Introduction to Soft Skills: Communication – Verbal and Non-Verbal Communication - Personal grooming (Etiquette, Attitude, Body Language), Posture, Gestures, Facial Expressions, Eye Contact, Space Distancing, Presentation Skills, Public Speaking, just a Minute (JAM) sessions, Adaptability.

UNIT - II: Goal Setting and Time Management: Immediate, Short term, Long term, Smart Goals, Strategies to Achieve goals, Types of Time, Identifying Time Wasters, Time Management Skills, Stress Busters.

UNIT – III: Leadership and Team Management: Qualities of a Good Leader, Team Dynamics, Leadership Styles, Decision Making, Problem Solving, Negotiation Skills.

UNIT – IV: Group Discussions: Purpose (Intellectual ability, Creativity, Approach to a problem, Tolerance), Group Behaviour, Analysing Performance.

UNIT – V: Job Interviews: Identifying job openings, Covering Letter and CVs / Resumes, Interview (Opening, Body-Answer Q, Close-Ask Q), Telephone Interviews, Types of Questions.

Reference Books:

1. Krannich, Caryl, and Krannich, Ronald L. Nail the Resume! Great Tips for Creating Dynamite Resumes. United States, Impact Publications, 2005.
2. Hasson, Gill. Brilliant Communication Skills. Great Britain: Pearson Education, 2012
3. Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw-Hill Education, 2001.
4. Pease, Allan. Body Language. Delhi: Sudha Publications, 1998.
5. Rizvi, Ashraf M. Effective Technical Communication: India, McGraw-Hill Education. 2010
6. Thorpe, Edgar &Showick Thorpe. Winning at Interviews. 2nd Edition. Delhi: Dorling Kindersley, 2006.

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QC4101 - Professional Elective-III
(Note: Refer Annexure-I for Syllabus details)

QC4102 - Professional Elective-IV
(Note: Refer Annexure-I for Syllabus details)

QC4103 - Professional Elective-V
(Note: Refer Annexure-I for Syllabus details)

QC4104 - Open Elective-III
(Note: Refer Annexure-II for Syllabus details)

QC4105 - Open Elective-IV
(Note: Refer Annexure-II for Syllabus details)

QC4106 - HSS Elective
(Note: Refer Annexure-III for Syllabus details)

QC4107- QUANTUM STARTUPS AND TOOLS (INDUSTRY CONNECT) (SC)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC4107	**Quantum Startups and Tools (Industry Connect)**	1		2	50	50	100	3hrs	2

Course Objectives: The objectives of this course are

- Expose students to cutting-edge quantum platforms and startup ecosystems
- Provide hands-on experience with commercial quantum development tools
- Familiarize students with industry use cases, roadmaps, and trends
- Connect students with live platforms, APIs, and cloud quantum devices

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

CO1: Identify key quantum startups and their product offerings

CO2: Use at least three industrial quantum tools (e.g., Xanadu, Amazon Braket, IBM Q)

CO3: Understand the differences in quantum hardware technologies (superconducting, photonic, ion-trap)

CO4: Execute and test circuits on multiple cloud platforms

CO5: Evaluate industrial quantum applications in areas like finance, logistics, and pharma

SYLLABUS

(with effect from 2025-26 admitted Batch)

LIST OF EXPERIMENTS:

1. Overview of Global Quantum Industry: Startups, corporate labs, market trends
2. Toolchain 1 – IBM Qiskit & IBM Quantum Experience
3. Toolchain 2 – Amazon Braket (D-Wave, IonQ, OQC, Rigetti)

4 Toolchain 3 – Microsoft Azure Quantum & Q#

5 Toolchain 4 – Xanadu & PennyLane for Quantum Machine Learning

6 Toolchain 5 – Classiq, Zapata, Pasqal, QuEra (exposure & walkthroughs)

7 Quantum Hardware Technologies: Photonic (Xanadu), Ion-Trap (IonQ), Superconducting

8 APIs, SDKs, and Deployment on Real Devices (Jobs, Queues, Backend Selection)

9 Startup Case Studies: Financial modeling, chemical simulations, traffic optimization

10 Mini-Project: Use one industrial tool to solve a real-world or academic problem

Hands-On Platforms Covered

- IBM Quantum (Qiskit, Real Hardware Access)
- Amazon Braket (Multi -vendor)
- Microsoft Azure Quantum (QDK, Q#)
- Xanadu (Photonic hardware, PennyLane for QML)
- Classiq (High-level quantum circuit synthesis)
- Zapata Computing / Orquestra (Workflow design for enterprise)

Hardware Required

- Laptop/Desktop (8 GB RAM minimum, 16 GB recommended)
- Internet connection
- Optional GPU (for QML)

Software Required

- Python, Jupyter Notebook / VS Code
- **IBM Qiskit:** qiskit, IBM Quantum Account
- **Amazon Braket:** amazon-braket-sdk, boto3, AWS CLI, AWS Account
- **Azure Quantum:** .NET SDK, qsharp, Visual Studio Code, Azure Account
- **Xanadu & PennyLane:** pennylane, TensorFlow or PyTorch, Strawberry Fields (optional)
- **Classiq / Zapata / Pasqal / QuEra:** Web access, SDKs (if available), Accounts on respective platforms

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QC4201- PROJECT WORK

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
QC4201	Project Work				100	100	200		13

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

CO 1: Apply critical and creative thinking in the design of engineering projects, plan and manage your time effectively as a team.

CO 2: Consider the business context and commercial positioning of designed devices or systems and apply knowledge of the real-world situations that a professional engineer can encounter.

CO 3: Use fundamental knowledge and skills in engineering and apply it effectively on a project and design and develop a functional product prototype while working in a team.

CO 4: Undertake an engineering project under mentorship and timely reflect on your own and peer's technical and non- technical learning.

CO 5: Orally present and demonstrate your product to peers, academics, generally and industry community and manage any disputes and conflicts within and outside your team.

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ANNEXURE-I

PROFESSIONAL ELECTIVES (PE)

1. Quantum Computing for Sustainable Energy Solutions
2. Solid State NMR Spectroscopy
3. Advanced Optoelectronics
4. Quantum Simulation and Quantum Chemistry
5. Quantum Computing in Industrial Automation and Robotics
6. Quantum Mechanics For Nanotechnology
7. Mobile and Cellular Communication (Including 5G & Beyond and Microstrip Antennas)
8. Quantum Cryptography
9. Quantum Communication and Information Systems
10. Quantum Optics
11. Integrated Optoelectronic Devices and Circuits
12. VLSI Design
13. Computer Network Engineering

QUANTUM COMPUTING FOR SUSTAINABLE ENERGY SOLUTIONS (PE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Quantum Computing for Sustainable Energy Solutions	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To introduce the principles of quantum computing and contrast them with classical computing models.
- To explore quantum algorithms (QPE, VQE, QAOA) for solving eigenvalue and optimization problems relevant to energy systems.
- To understand Hamiltonian construction, encoding schemes, and transformations for physical system simulation.
- To apply quantum simulations for modeling chemical, photovoltaic, and energy grid systems.
- To analyze industrial use cases, hardware limitations, and future prospects of quantum computing in clean energy.

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

CO1: Describe the fundamentals of quantum computing, qubit systems, and quantum gates using circuit representations.

CO2: Apply eigenvalue-solving quantum algorithms (QPE, VQE, QAOA) to simulate energy-relevant systems.

CO3: Construct and encode Hamiltonians using second quantization and transformation techniques (Jordan-Wigner, Bravyi-Kitaev).

CO4: Perform quantum simulations of physical and chemical systems for sustainable energy applications.

CO5: Evaluate the challenges, error correction methods, and future industrial potential of quantum computing in clean energy sectors.

SYLLABUS
(with effect from 2025-26 admitted Batch)

UNIT I: Introduction to Quantum Computing Concepts

Review of Classical vs Quantum Computing, Postulates of Quantum Mechanics relevant to quantum computing, Qubits: Bloch sphere representation, multi-qubit systems, Quantum Gates: Pauli matrices, Hadamard, Phase, T, CNOT, Swap, and multi-qubit gates, Quantum Circuits: Representation and measurement, Superposition, entanglement, quantum parallelism, Quantum state measurement and projective measurement, Introduction to quantum programming frameworks (IBM Qiskit / Google Cirq)

UNIT II: Quantum Algorithms for Eigenvalue Problems

Importance of eigenvalue problems in simulating physical systems, Introduction to Quantum Phase Estimation (QPE), Variational Quantum Eigensolver (VQE) for ground-state problems, Quantum Approximate Optimization Algorithm (QAOA) for discrete optimization, Implementation workflow: Problem definition → Hamiltonian mapping → Algorithm selection → Circuit generation → Simulation, Applications in energy simulations: Hydrogen molecule, lithium hydride example

UNIT III: Hamiltonians, Encoding Schemes, and Transformations

Second Quantization: Operator formalism for many-body systems, Construction of Hamiltonians for molecular and lattice systems, Jordan-Wigner Transformation, Bravyi-Kitaev Transformation, Mapping fermionic/bosonic systems to qubits, Trotter-Suzuki decomposition for simulating time evolution, Examples: Hydrogen molecule, 1D Ising model, Hubbard model

UNIT IV: Quantum Simulations for Sustainable Energy Applications

Modeling chemical reaction pathways in sustainable energy (hydrogen production, fuel cells), Simulating electronic properties of photovoltaic materials, Quantum simulations of lattice systems in battery research, Optimizing energy grids using quantum-enhanced algorithms, Coherent averaging and error mitigation techniques, Case studies: Nitrogen fixation simulation, hydrogen molecule bond dissociation, photovoltaic bandgap estimation

UNIT V: Advanced Techniques, Prospects, and Industrial Applications

Quantum error correction and error mitigation overview, Quantum-assisted material discovery frameworks, Magic Angle Simulation and coherent averaging theory basics, Review of DOE, IBM, Google, and EU projects on quantum for clean energy, Limitations of current quantum simulation hardware, Future directions: room-temperature quantum simulations, scalable energy models

Text Books:

1. Nielsen, M. A., & Chuang, I. L. (2010). Quantum Computation and Quantum Information. Cambridge University Press.

2. McArdle, S., et al. (2020). Quantum computational chemistry. *Reviews of Modern Physics*, 92(1), 015003.

References:

- Preskill, J. (2018). Quantum computing in the NISQ era and beyond. *Quantum*, 2, 79.

- Cerezo, M., et al. (2021). Variational Quantum Algorithms. *Nature Reviews Physics*, 3(9), 625-634.

- Cao, Y., et al. (2019). Quantum Chemistry in the Age of Quantum Computing. *Chemical Reviews*, 119(19), 10856–1091.

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SOLID STATE NMR SPECTROSCOPY (PE)
(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Solid State NMR Spectroscopy	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To introduce the fundamental principles of solid-state NMR spectroscopy.
- To understand spin dynamics and nuclear spin interactions using quantum mechanical and vector models.
- To explore experimental techniques like MAS, cross-polarization, and dipolar recoupling.
- To analyze quadrupolar interactions and learn methods for their measurement in solids.
- To interpret chemical shift anisotropies and their correlation with molecular structure using advanced NMR methods.

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

CO 1: Explain the quantum mechanical principles and vector model underlying solid-state NMR.

CO 2: Apply magic-angle spinning and decoupling techniques in NMR experiments for spin–1/2 nuclei.

CO 3: Design and analyze experiments to measure homonuclear and heteronuclear dipolar couplings.

CO 4: Describe the measurement and interpretation of quadrupolar couplings in solid-state NMR.

CO 5: Utilize shielding tensors and chemical shift anisotropies to extract structural and electronic information from solids.

SYLLABUS
(with effect from 2025-26 admitted Batch)

UNIT I: Theory of solid-state NMR:

The basics of solid-state NMR, the vector model of pulsed NMR, the quantum mechanical picture: Hamiltonians and the Schrodinger equation, the density matrix representation and coherences nuclear spin interactions, calculating NMR power patterns, general features of NMR.

UNIT II: Essential techniques for spin–1/2 nuclei:

Introduction, magic-angle spinning (MAS), high-power decoupling, multiple pulse decoupling sequences, average Hamiltonian theory and the toggling frame, cross-polarization, solid or quadrupole echo pulse sequence.

UNIT III: Dipolar coupling, its measurement and uses:

Introduction, techniques for measuring homonuclear dipolar couplings, recoupling pulse sequences, double-quantum filtered experiments, rotational resonance, techniques for measuring heteronuclear dipolar couplings, spin-echo double resonance, rotational-echo double resonance, techniques for dipolar-coupled quadrupolar (spin–1/2) pairs, transfer of population in double resonance, rotational echo, adiabatic passage, double resonance, techniques for measuring dipolar couplings between quadrupolar nuclei, correlation experiments, homonuclear correlation experiments for spin–1/2 systems, homonuclear correlation experiments for quadrupolar spin systems, heteronuclear correlation experiments for spin–1/2, spin-counting experiments, the formation of multiple-quantum coherences, implementation of spin-counting experiments.

UNIT IV: Quadrupole coupling, its measurement and uses:

The quadrupole Hamiltonian, the effect of RF pulses, high-resolution NMR experiments for half-integer quadrupolar nuclei, magic-angle spinning, double rotation, dynamic-angle spinning, multiple quantum magic-angle spinning, other techniques for half-integer quadrupolar nuclei, quadrupole nutation.

UNIT V: Shielding and chemical shift:

The relationship between the shielding tensor and electronic structure, measuring chemical shift anisotropies, magic-angle spinning with recoupling pulse sequences, variable angle spinning experiments, magic-angle turning, two-dimensional separation of spinning sideband patterns.

Text Books/References

1. M. J. Duer, Solid State NMR Spectroscopy: Principles and Applications, Blackwell Science Ltd.

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ADVANCED OPTOELECTRONICS (PE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allot. Marks		Total Marks	Ext. Exam Time	Credit
					Int.	Ext.			
	Advanced Optoelectronics	**4**			**30**	**70**	**100**	**3 hrs**	**3**

Course Objectives: The objectives of this course are

- Understand the fundamental physics of light–matter interaction and semiconductor materials used in optoelectronic devices.
- Analyze the working principles of key optoelectronic components like LEDs, laser diodes, photo-detectors, and solar cells.
- Gain knowledge of optical fiber systems and their role in modern communication technologies.
- Explore the design and functioning of lasers and integrated photonic devices.
- Study emerging technologies such as Nano-photonics, quantum wells, and optoelectronic integration for advanced applications.

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

CO1: Explain the quantum and semiconductor physics underlying optoelectronic devices.

CO2: Design and evaluate the performance of light-emitting and light-detecting devices.

CO3: Apply optical fiber principles for analyzing communication link parameters and losses.

CO4: Differentiate various types of lasers and describe their construction and applications.

CO5: Investigate recent advances in optoelectronics for use in photonics, imaging, sensing, and biomedical fields.

SYLLABUS
(with effect from 2025-26 admitted Batch)

UNIT I: Fundamental Concepts & Semiconductor Physics: Quantum mechanics basics (photoelectric effect, Compton scattering, wave–particle duality, Schrödinger equation), Electronic band structure, direct vs. indirect semiconductors, density of states, Fermi level, carrier statistics, drift & diffusion, Semiconductor junctions: p–n diode, Schottky and Ohmic contacts, recombination/generation mechanisms.

UNIT II: Optoelectronic Devices: Optical transitions: absorption, spontaneous & stimulated emission, excitons, recombination rates, Light-emitting devices: LEDs, laser diodes (rate equations, threshold, modes), Photodetectors: PIN, avalanche photodiodes (APD), responsivity, noise, bandwidth Solar cells, phototransistors, and CCDs

UNIT III: Fiber Optic Communication: Fiber fundamentals: total internal reflection, acceptance angle, numerical aperture, Modes in fibers: single-mode vs multi-mode, dispersion types (intermodal, intramodal), attenuation, scattering, non-linear effects, Power launching, coupling efficiency, bending losses, Receiver physics: BER, signal/noise, receiver sensitivity, eye diagrams, coherent vs direct detection

UNIT IV: Laser Technology & Photonics: Laser fundamentals: Einstein coefficients, population inversion, optical cavities, Types of lasers: gas (He–Ne, CO_2), solid-state (Nd:YAG), dye lasers, semiconductor lasers, Beam properties: coherence, monochromaticity, brightness, speckle, safety, Photonic components: optical amplifiers, modulators, integrated photonic circuits

UNIT V: Emerging Topics & Systems: Low-dimensional systems: quantum wells, wires, dots, heterojunctions, Nanophotonics and plasmonics, Integrated optoelectronics: optoelectronic ICs, optical sensors, electro-absorption modulators, Applications: optical imaging, optical metrology, free-space optics, biomedical optoelectronics

Textbooks:

1. P. Bhattacharya – Semiconductor Optoelectronic Devices
2. R. Gaur & S.L. Gupta – Optoelectronics
3. A.K. Ghatak & K. Thyagarajan – Optical Electronics.

Reference Books:

1. B.E.A. Saleh & M.C. Teich – Fundamentals of Photonics
2. John M. Senior – Optical Fiber Communications: Principles and Practice
3. S.O. Kasap – Optoelectronics and Photonics: Principles and Practices.
4. A. Yariv & P. Yeh – Photonics: Optical Electronics in Modern Communications
5. Ghatak & Lokanathan – Quantum Mechanics: Theory and Applications

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QUANTUM SIMULATION AND QUANTUM CHEMISTRY (PE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allot. Marks		Total Marks	Ext. Exam Time	Credit
					Int.	Ext.			
	Quantum Simulation and Quantum Chemistry	**4**			**30**	**70**	**100**	**3 hrs**	**3**

Course Objectives: The objectives of this course are

- Understand quantum mechanics fundamentals and their application in chemistry.
- Learn approximation techniques used in solving quantum chemical systems.
- Explore electronic structure methods for molecules and materials.
- Introduce quantum simulation algorithms like VQE and QPE.
- Gain practical experience with computational and quantum tools in chemistry.

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

CO1: Apply Schrödinger's equation to model atomic and molecular systems.

CO2: Use approximation methods like Hartree-Fock and perturbation theory for electronic structure calculations.

CO3: Analyze molecular bonding using MO and VB theories.

CO4: Implement quantum algorithms (VQE, QPE) to simulate chemical systems.

CO5: Utilize computational tools (Qiskit, Psi4) for solving real-world chemical problems.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT I: Fundamentals of Quantum Chemistry: Postulates of quantum mechanics**,** Schrödinger equation and its applications to simple systems**,** Operators, observables, commutation relations**,** Particle in a box, rigid rotor, harmonic oscillator**,** Hydrogen atom: radial and angular solutions.

UNIT II: Approximation Methods in Quantum Chemistry: Variational principle and applications, Perturbation theory: first and second-order corrections, Hartree-Fock theory and self-consistent field methods, Slater determinants, spin orbitals, Pauli exclusion.

UNIT III: Molecular Structure and Bonding: Molecular orbital theory: LCAO-MO approach, Hückel theory of conjugated systems, Hybridization, VB theory vs MO theory, Electron density, orbitals, and energy diagrams.

UNIT IV: Quantum Simulations in Chemistry: Quantum computing for chemistry: qubits, gates, measurement, Mapping molecules to qubits: Jordan–Wigner & Bravyi–Kitaev, Variational Quantum Eigensolver (VQE), Quantum Phase Estimation (QPE) for ground-state energies.

UNIT V: Computational Tools and Applications: Density Functional Theory (DFT), post-Hartree-Fock methods, Basis sets: STOs, GTOs, Pople basis sets, Quantum simulation frameworks: Qiskit Chemistry, OpenFermion, Psi4, Applications in spectroscopy, reaction mechanisms, catalysis.

Textbooks:

1. A.K. Chandra – Introductory Quantum Chemistry.
2. K. Prasad – Quantum Chemistry.
3. R.K. Prasad – Quantum Chemistry.

Reference Books:

1. I. N. Levine – Quantum Chemistry.
2. Donald A. McQuarrie – Quantum Chemistry.
3. Frank Jensen – Introduction to Computational Chemistry.
4. Tannor, D.J. – Introduction to Quantum Mechanics: A Time-Dependent Perspective.
5. Jensen, Hans Eyring, Walter – Quantum Chemistry.

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QUANTUM COMPUTING IN INDUSTRIAL AUTOMATION AND ROBOTICS (PE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Quantum Computing in Industrial Automation and Robotics	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To introduce the basic principles and math behind quantum computing.
- To bridge quantum computing with control systems and automation theory.
- To explore quantum algorithms applicable to robotics and optimization.
- To provide hands-on understanding through simulation tools like Qiskit.
- To evaluate future potential and real-world industrial applications.

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

CO1: Differentiate classical and quantum computing paradigms.

CO2: Model quantum circuits and simulate them for basic operations.

CO3: Apply quantum algorithms for robotic control and automation systems.

CO4: Use quantum simulators for solving industrial optimization problems.

CO5: Analyze trends and research in quantum robotics and automation.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT I: Overview of robot subsystems: Basics of classical vs quantum computing, Qubits, superposition, entanglement, and measurement, Quantum gates and circuits, Overview of robot subsystems, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT II: Mathematical Foundations: Linear algebra: vectors, matrices, eigenvalues, Hilbert space and tensor products, Unitary operations and inner products, Quantum states and operators, Quantum logic and reversible computation.

UNIT III: Quantum Algorithms for Automation: Quantum Phase Estimation (QPE), Grover's Search and its use in pathfinding/robotics, Variational Quantum Algorithms (VQE, QAOA) for control systems, Shor's Algorithm for secure industrial networks.

UNIT IV: Robotics and Industrial Automation Concepts: Introduction to automation systems & robot kinematics, Sensors, actuators, motion control, Optimization problems in robotics, Integration of ML & quantum algorithms in robot decision-making, Real-time systems and feedback in quantum-enhanced control, Robot subsystems: Sensors and Actuators; Image Processing and Computer Vision, Robotic Control Systems.

UNIT V: Quantum Simulation Tools & Applications: Introduction to RoboAnalyzer: DH Parameters Visualization • Forward Kinematics; Inverse Kinematics; Forward Dynamics; Inverse Dynamics • Building Virtual Robot Module Qiskit, Pennylane, Cirq, and OpenQASM, Quantum simulation of robotic arm trajectories, Quantum-enhanced SLAM (Simultaneous Localization & Mapping), Quantum robotics in warehouse logistics and process optimization, Future of quantum robotics in Industry 5.0.

Textbooks

1. V. K. Pachghare – Introduction to Quantum Computing
2. Rajiv Kumar – Quantum Computing Fundamentals
3. S. K. Saha: "Introduction to Robotics", Tata McGraw Hill Education Pvt. Ltd., New Delhi.

Reference Books

1. R. K. Mittal, I. J. Nagrath: "Robotics and Control", Tata McGraw-Hill Publishing Company Ltd.
2. J. J. Graig: "Introduction to Robotics – Mechanics and Control", 2nd edition, Pearson Education, Inc.
3. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee: "ROBOTICS – Control, Sensing, Vision, and Intelligence".
4. Roboert J. Schilling: "Fundamentals of Robotics – Analysis & Control", Prentice-Hall of India Pvt. Ltd. 8. S. R. Deb and S. Deb, "Robotics Technology and Flexible Automation", Second Edition, Tata McGraw Hill Education Pvt, Ltd., New Delhi
5. B.V. Ramana: Higher Engineering Mathematics", Tata Mc Graw Hill Company.
6. Benjamín Hernández – Quantum Machine Learning for Robotics.

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QUANTUM MECHANICS FOR NANOTECHNOLOGY (PE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Quantum Mechanics For Nanotechnology	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To understand the foundation of the Schrödinger equation and its mathematical formulation including operator mechanics, eigenfunctions, and commutation relations.
- To analyze quantum mechanical systems exhibiting confinement and tunneling and relate them to modern quantum devices.
- To explore the time evolution of quantum systems using different quantum mechanical pictures and apply it to two-state systems.
- To study the algebra of angular momentum and identical particles and develop understanding of quantum statistics and spin addition.
- To examine the principles of quantum scattering and introduce foundational quantum computing concepts such as qubits, quantum gates, and algorithms.

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

CO1: Understand and apply the mathematical framework of quantum mechanics, including Hermitian operators, commutation relations, and the formulation of Schrödinger's equation.
CO2: Analyze quantum phenomena like confinement and tunneling and relate these concepts to the operation of nanoscale and tunneling-based quantum devices.
CO3: Simulate and interpret the time evolution of quantum systems through Schrödinger, Heisenberg, and interaction pictures and study quantum transitions.
CO4: Apply angular momentum theory and quantum statistics to multi-particle systems, including spin algebra and Clebsch-Gordon coefficients
CO5: Evaluate quantum scattering processes and demonstrate basic quantum computation principles, including qubit manipulation and quantum algorithm implementation.

SYLLABUS
(with effect from 2025-26 admitted Batch)

UNIT I: The Schrödinger's Equation and Its Mathematical Implication: Development of Time Dependent Schrödinger's equation, statistical interpretation of wave function, normalization of wave function, conservation of total probability, dynamical variables and Hermitian operators, position, and linear and angular momentum operators, commutation relations, Ehrenfest theorem, Heisenberg uncertainty principle, time independent Schrödinger equation, properties of energy eigenfunctions, expansion postulate.

UNIT II: Bound States and Quantum Tunneling: Free particle, momentum eigenfunctions, energy levels of a particle, infinite square well in one, two, and three dimensions, density of states, confined carriers, electron wave propagation in devices, quantum confinement, penetration of a barrier, tunnel effect, basic principles of a few effective devices – resonant tunnel diode, superlattice, quantum wire and dot.

UNIT III: Quantum Dynamics: Time development of the wave function, time evolution operator, Schrödinger, Heisenberg, and interaction pictures of quantum dynamics, time evolution, free particle wave packet, one-dimensional harmonic oscillator, two-state quantum systems.

UNIT IV: Angular Momentum: Rotation operators, angular momentum operators, commutation rules, eigenvalues of angular momentum operator, matrix representations, addition of two angular momenta, Clebsch-Gordon coefficients.

UNIT V: Identical Particles, Scattering Theory and Quantum Computation: System of identical particles, symmetrization of wave functions, exchange interactions, free electrons in a metal, Fermi gas, mutual scattering of two particles, separation of Schrödinger equation in laboratory and center of mass frames, scattering of a wave packet, Born approximation, validity, partial wave analysis, phase shift, quantum theory of scattering, differential and total cross sections, scattering amplitude, derivation using Green's functions, Born approximation, scattering by spherically symmetric potentials. Quantum bits, single qubit gates, multiple qubits, controlled-NOT gate, SWAP gate, Toffoli gate, Bell states, no-cloning theorem, quantum teleportation, Deutsch's algorithm, Deutsch–Jozsa algorithm, quantum Fourier transform.

Text Books:

1. B.H. Bransden and C.J. Joachain, “Quantum Mechanics”, Pearson, 2007.
2. David J. Griffiths, “Introduction to Quantum Mechanics”, Pearson, 2009.
3. Richard L. Liboff, “Introductory Quantum Mechanics”, Pearson, 2003.
4. Mark Lundstrom, “Fundamentals of Carrier Transport”, Cambridge University Press, 2000.
5. Yoav Peleg, Reuven Pnini, Elyahu Zaarur, and Eugene Hecht, “Schaum’s Outline of Quantum Mechanics” , Tata McGraw Hill, 2010.
6. Eugen Merzbacher, “Quantum Mechanics”, John Wiley & Sons, 1999.

Reference Books:

1. P.M. Mathews and K. Venkatesan, “Quantum Mechanics”, Tata McGraw Hill, 2010.
2. Ajoy Ghatak and S. Lokanathan, “Quantum Mechanics”, Macmillan, 2009.

MOBILE AND CELLULAR COMMUNICATION

(Including 5G & Beyond and Microstrip Antennas) (PE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Mobile and Cellular Communication (Including 5G & Beyond and Microstrip Antennas)	**4**			**30**	**70**	**100**	**3hrs**	**3**

Course Objectives: The objectives of this course are

- To provide an overview of the evolution of mobile and cellular communication systems from 1G to 5G.
- To impart knowledge on the fundamental cellular concepts such as frequency reuse, cell splitting, and sectoring.
- To introduce multiple access techniques and evaluate their performance in mobile systems.
- To study the technologies and architecture of 2G, 3G, and 4G mobile systems including standards like CDMA, WCDMA, and LTE.
- To understand the key features, principles, and challenges of 5G mobile communication systems and error correction mechanisms.

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

CO1: Explain the fundamental principles and evolution of mobile and cellular communication systems.

CO2: Apply the concepts of cellular geometry, frequency reuse, and sectoring to improve mobile network coverage and capacity.

CO3: Compare different multiple access techniques (FDMA, TDMA, CDMA) and evaluate their spectral efficiencies.

CO4: Distinguish between various wireless technologies (2G to 4G) and analyze their limitations and advancements.

CO5: Describe the architecture, features, and error correction techniques used in 5G wireless communication systems.

SYLLABUS
(with effect from 2025-26 admitted Batch)

UNIT I: Introduction to Mobile and Cellular Communication Systems

Introduction to Mobile and Cellular Communication Systems, Generations of wireless mobile systems, Cellular Geometry, Introduction to cellular concept, Principle of Operation of a Cellular Mobile system, Call transfer operation to/from one mobile phone to another mobile, Analog and Digital Cellular Mobile Systems, Multiple Access Schemes, Existing Mobile Communication Technologies.

UNIT II: Cellular Geometry, Frequency Reuse, Cell Splitting and Sectoring

Introduction, Cellular Geometry, Frequency Reuse, Improving Coverage and Capacity in Cellular Systems, Cell Splitting, Sectoring, Range Extension by the use of Repeaters, Microcell Zone concept, Picocell Zone Concept

UNIT III: MAC Techniques and Spectral Efficiencies

Multiple Access Techniques for Wireless Communication and Advanced Transceiver Schemes, capacity and spectral Efficiency of FDMA, TDMA and CDMA.

UNIT IV: Wireless Generations Technologies up to 3G and **4G**

3G Air interface technologies, 3G spectrum, Internet Speeds of 2G, 2.5G and 3G Technologies, Limitations of 3G, CDMA, CDMA2000, WCDMA, Comparison of WCDMA and CDMA2000.

4G Evolution, Objectives of the projected 4G, Advantages of 4G network technology over 3G, Applications of 4G, 4G Technologies, Smart Antenna Techniques and Limitations of 4G.

UNIT V: 5G Communications

Introduction, Principle of operation of 5G Technology, Key parameters and Technical Specifications of 5G, Description of 5G technologies, 5G cellular system Error Correction Techniques

Text Book:

1. Gottapu Sasibhushana Rao, Raj Kumar Goswami, M.N.V.S.S Kumar

“Mobile and Cellular Communication (Including 5G & Beyond and Microstrip Antennas)”, Paramount Book Distributors, 2025.

References:

1. "Wireless Communications: From Fundamentals to Beyond 5G" by Andreas F. Molisch, published by Wiley (IEEE Press) 8 December 2022
2. N. Ojaroudi Parchin, Ed., ‘Advanced Wireless Communications and Mobile Networks - Current Status and Future Directions’. Intech Open, May 29, 2025. doi: 10.5772/intechopen.1006224.

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QUANTUM CRYPTOGRAPHY (PE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Quantum Cryptography	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Understand quantum mechanics and their application in cryptography
- Cover quantum key distribution (e.g. BB84, E91), quantum-resistant classical algorithms, and quantum cryptanalysis
- Learn quantum circuit design, algorithm implementation (Shor, Grover), QKD protocols, and hands-on work with tools like Qiskit
- Survey the latest in quantum cryptography, commercial QKD systems, and open research challenges
- Evaluating the security of cryptographic systems against quantum adversaries and understanding the implications of quantum attacks on classical cryptographic schemes

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

CO1: Understand and apply quantum mechanical concepts relevant to information security

CO2: Explain how quantum key distribution works and how it differs from classical key distribution

CO3: Analyze and evaluate QKD protocols such as BB84 and E91

CO4: Examine the security proofs and limitations of quantum cryptography

CO5: Explore the implementation challenges and current technological solutions and contrast quantum cryptography with classical cryptography and post-quantum cryptography.

SYLLABUS
(with effect from 2025-26 admitted Batch)

UNIT I: Foundations of Quantum Mechanics for Cryptography: Qubits, superposition, and entanglement, Quantum states and density matrices, Measurement in quantum mechanics, No-cloning theorem and its relevance to cryptography**.** Classical encryption and key distribution, Symmetric vs. asymmetric cryptography, Computational vs. unconditional security, Limitations of classical cryptography against quantum attacks.

UNIT II: Quantum Key Distribution (QKD) Basics: Introduction to QKD, BB84 Protocol – Principles, Steps, and Security, E91 Protocol – Entanglement-based QKD, B92 and other variants. Security proofs and eavesdropping detection.

UNIT III: Practical Aspects of Quantum Cryptography Quantum channels: Fiber optics and free-space communication, Photon sources and detectors, Error correction and privacy amplification, Real-world implementations and case studies (e.g., China's Micius satellite)

UNIT IV: Advanced Quantum Cryptography Protocols: Device-independent QKD**,** Measurement-device-independent QKD**,** Continuous-variable QKD**,** Quantum secret sharing and quantum bit commitment (limitations)

UNIT V: Quantum Attacks and Post-Quantum Cryptography: Quantum attacks on classical cryptography (Shor's algorithm, Grover's algorithm)**,** Differences between quantum cryptography and post-quantum cryptography**,** Lattice-based, hash-based, code-based post-quantum cryptography**,** Hybrid quantum-classical security systems**,** Quantum internet and quantum networks**,** Quantum repeaters and scalability**,** Regulatory, ethical, and security challenges.

Textbooks:

1. "Quantum Computation and Quantum Information" by Michael A. Nielsen and Isaac L. Chuang – Cambridge University Press. *(Standard textbook for quantum information science)*
2. "Quantum Cryptography and Secret-Key Distillation" by Gilles Van Assche – Cambridge University Press.

References:

1. "An Introduction to Quantum Communication Networks: Or, How Shall We Communicate in the Quantum Era?" by Mohsen Razavi – Morgan & Claypool
2. "Quantum Cryptography and the Future of Cyber Security" by Peter Zeilinger (Selected papers and essays)
3. "Quantum Information" by Stephen Barnett – Oxford University Press.

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QUANTUM COMMUNICATION AND INFORMATION SYSTEMS (PE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	**Ext.**			
	Quantum Communication and Information Systems	**4**			**30**	**70**	**100**	**3hrs**	**3**

Course Objectives: The objectives of this course are

- Master the mathematical foundations for quantum communication—linear algebra, Hilbert spaces, density operators, and entropy measures (e.g., Shannon, von Neumann).
- Understand quantum states, measurements, and channels, including noise (decoherence), POVMs, and quantum error correction.
- Explore quantum communication protocols—e.g., superdense coding, teleportation, BB84, E91, and multipartite key agreement
- Analyze quantum algorithms relevant to communication and security—Deutsch–Jozsa, Grover's, Shor's
- Gain practical skills using quantum circuit modeling and simulation tools like Qiskit.

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

CO1: Apply advanced math (vectors, matrices, entropies) to describe and analyze quantum systems.

CO2: Model qubits, composite systems, and noise using density matrices, POVMs, and entropy concepts.

CO3: Construct and simulate quantum circuits for teleportation, superdense coding, QKD, and error correction.

CO4: Implement basic quantum algorithms (Deutsch, Grover, Shor) and evaluate their implications for communication and security.

CO5: Evaluate and compare quantum communication protocols, understanding their security proofs and practical limitations.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT I: Mathematical & Quantum Foundations Quantum States & Measurements: Linear algebra for qubits, density operators, entropy, quantum noise/decoherence, Pure/mixed states, POVMs, Bloch sphere, no-cloning theorem, entanglement

UNIT II: Quantum Communication Protocols and Algorithms: Superdense coding, teleportation, BB84, E91, conference key agreement, Deutsch, Deutsch–Jozsa, Grover, Shor, QFT basics

UNIT III: Quantum Error Correction & Channels: Error models, Hamming codes, fault tolerance, privacy amplification.

UNIT IV: Security & Implementations QKD security analysis (finite-key, device independence), practical channels, simulators

UNIT V: Quantum communication (Advanced Topics): Multipartite protocols, quantum conferencing, noise channels and their properties.

Text Books:

1. Quantum Computation and Quantum Information" by Michael A. Nielsen & Isaac L. Chuang
2. Quantum Information Theory by Mark M. Wilde
3. Quantum Information and Quantum Optics: An Introduction by Peter Lambropoulos and David Petrosyan.

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QUANTUM OPTICS (PE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Quantum Optics	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Introduce the quantization of the electromagnetic field and its implications in modern optics.
- Explore theoretical and experimental aspects of optical coherence and interference.
- Study various phase-space representations of quantum states of light.
- Understand the interaction between light and matter using classical, semi-classical, and quantum models.
- Analyze decoherence mechanisms using open quantum system models and master equations.

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

CO1: Learn to quantize the electromagnetic field.

CO2: Understand and analyze experimental techniques in photonics such as photon bunching and quantum interference.

CO3: Gain knowledge of phase-space representations like Wigner and Q functions.

CO4: Explore classical, semi-classical, and quantum models of light-matter interaction including the Rabi and Jaynes-Cummings models.

CO5: Develop the ability to model decoherence in quantum systems using master equations.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT - I: Quantization of the Electromagnetic Field – Number States, Coherent States, Squeezed States, Hanbury-Brown and Twiss Experiments – Photon Bunching, Photon Anti Bunching, Hong-Ou-Mandel Interference.

UNIT - II: Theory of Optical Coherence – Young's Double Slit Experiment and First Order Coherence, Coherence Functions of Arbitrary Order, Normal Ordering, Symmetric Ordering and Anti-Normal Ordering of Operators, Interferometry.

UNIT - III: Phase-Space Representations of States of Light – Wigner Distribution, P-Distribution, Husimi Q Function.

UNIT - IV: Light-Matter Interaction – Classical Model of Light-Matter Interaction, Semi-Classical Model of Light-Matter Interaction, Quantum Light-Matter Interaction, Rabi Model, Jayne's-Cummings Model.

UNIT - V: Open Quantum Systems – Fermi Golden Rule, Born-Markov Lindblad Master Equation.

Textbooks:

1. Engineering Physics – A.B. Bhattacharya & Atanu Nag
2. Introductory Quantum Optics – Gerry and Knight

Reference Books:

1. Quantum Optics – Walls and Milburn
2. Quantum Optics – Girish Agrawal
3. Quantum Measurement and Control – Wiseman and Milburn

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INTEGRATED OPTOELECTRONIC DEVICES & CIRCUITS (PE)
(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Integrated Optoelectronic Devices & Circuits	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To understand the basic principles of semiconductor optoelectronic materials, devices, and processes.
- To analyze the physical mechanisms behind optical emission, detection, and amplification in semiconductor devices.
- To explore the design and working of guided-wave structures, optical amplifiers, and laser diodes.
- To study integrated photonic components in silicon photonics platforms and their applications in communication and sensing.
- To evaluate the challenges of CMOS compatibility and integration of optoelectronic components for photonic circuits.

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

CO1: Explain electronic and optical properties of elemental and compound semiconductors used in optoelectronic devices.

CO2: Apply p-n junction theory to analyze the working of LEDs and photodetectors including quantum efficiency and noise characteristics.

CO3: Design and interpret the functioning of waveguides, semiconductor optical amplifiers, and laser structures including DFB and DBR types.

CO4: Analyze silicon photonic components such as couplers, modulators, filters, and delay lines within an integrated platform.

CO5: Evaluate integration issues between electronic and photonic systems in CMOS-compatible platforms, considering scaling and interconnect challenges.

SYLLABUS
(With effect from 2025-26 admitted Batch)

UNIT-1: Fundamentals of Semiconductor Optoelectronics:

Generic optical systems and building blocks, Elemental vs. compound semiconductors, electronic properties of semiconductors, Optical processes: absorption, emission, radiative &

non-radiative recombination.

UNIT-2: P-N Junction Devices and Light Emission:

P-N junction theory and carrier transport, Light-Emitting Diodes (LEDs): principles and structures, Photodetectors: PIN, avalanche, and MSM detectors, Responsivity, quantum efficiency, noise.

UNIT-3: Waveguides, Lasers, and Optical Amplifiers:

Heterostructures and quantum confinement, Optical waveguides and guided mode analysis, Semiconductor Optical Amplifiers (SOAs), Fabry–Perot and edge-emitting lasers, Coupled mode theory, DBR and DFB laser design.

UNIT-4: Silicon Photonics and Integrated Devices:

Fundamentals of silicon photonics, Passive devices: waveguides, couplers, Mach-Zehnder Interferometers (MZIs), Active devices: modulators, detectors, Tunable filters, optical delay lines, Optical switching circuits on SOI platform.

UNIT-5: Optoelectronic Integration and Applications:

CMOS technology and optoelectronic compatibility, Electrical vs. optical interconnects, Integration challenges and scaling.

Text Books:

1. Semiconductor Optoelectronic Devices – Pallab Bhattacharya, Pearson Education

2. Photonics: Optical Electronics in Modern Communications – Amnon Yariv and Pochi Yeh, Oxford University Press

3. Optoelectronics and Photonics: Principles and Practices – S.O. Kasap, Pearson Education

Reference Books:

1. Fundamentals of Photonics – B.E.A. Saleh and M.C. Teich, Wiley

2. Semiconductor Physics and Devices – Donald A. Neamen, McGraw Hill Education

3. Silicon Photonics: An Introduction – Graham T. Reed and Andrew P. Knights, Wiley

4. Physics of Semiconductor Devices – S.M. Sze and Kwok K. Ng, Wiley

5. Integrated Optics: Theory and Technology – Robert G. Hunsperger, Springer.

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VLSI DESIGN (PE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	VLSI Design	**4**			**30**	**70**	**100**	**3hrs**	**3**

Course Objectives: The objectives of this course are

- VLSI technology
- circuit design processes with stick diagrams and layout diagrams.
- VLSI circuit
- scaling of MOS circuits with sub system design and layout

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

CO 1: Describe the basic concepts of VLSI technology.

CO 2: Demonstrate circuit design processes with stick diagrams and layout diagrams.

CO 3: Understand the aspects of design tools, testability and practical design for guidelines.

CO 4: Demonstrate basic circuit concepts.

CO 5: Summarize scaling of MOS circuits with sub system design and layout.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT - I: Review of microelectronics and an introduction to MOS technology: Introduction to IC technology, MOS and related VLSI technology, NMOS, CMOS, BiCMOS Technologies, Thermal aspects of processing, Production of E beam marks.

UNIT – II: MOS and BiCMOS circuit design processes: MOS layers, Stick diagrams, Design rules, and layout, 2 & 1.2 micro meter CMOS rules, Layout diagrams, Symbolic diagram. Basic Circuit concepts - Sheet resistance, Area capacitances of layers, Delay unit, Wiring Capacitances, Choice of layers. Scaling of MOS Circuits -Scaling models, Scaling function for device parameters, Limitations of scaling.

UNIT – III: Sub system design and Layout: Architectural issues, Switch logic, Examples of Structural design (Combinational logic). Sub system design process Design of ALU subsystem, some commonly used storage elements, Aspects of design tools, Design for testability, Practical design for test guidelines, Built in self-test, CMOS project-an incrementor / decrementer, a comparator for two n-bit numbers. Ultra-fast systems, Technology development, MOSFET based design.

UNIT – IV: Introduction to Embedded Systems: Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software in a System, Examples of Embedded Systems, Embedded Systems on Chip, Complex Systems Design and Processors, Design Process in Embedded System, Formalization of System Design, Design Process and Design Examples, Classification of Embedded Systems, Skills required for an Embedded System Designer.

UNIT – V: Embedded Software Development Process and Tools: Introduction to Embedded Software Development Process and Tools, Host and Target Machines, Linking and Locating Software, Getting Embedded Software into the Target System, Issues in Hardware-Software Design and Co-design

Text books:

1. Basic VLSI Design by Douglas A, Pucknell, Kamran Eshraghian, Prentice-Hall, l996, 3rd Edition.
2. Embedded Systems Architecture, Programming and Design, second edition by Raj Kamal, Tata McGraw Hill Publication (Chapter 1, Chapter 13)

Reference Books:

1. Mead, C.A and Conway, LA, “Introduction to VLSI Systems”, Addison-Wesley, Reading, Massachusetts, l980.

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COMPUTER NETWORK ENGINEERING (PE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Computer Network Engineering	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To describe how computer networks are organized with the concept of layered approach.
- To implement a simple LAN with hubs, bridges and switches.
- To analyze the contents in a given Data Link layer packet, based on the layer concept.
- To design logical sub-address blocks with a given address block.
- To describe how routing protocols work.

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

CO 1: Understand the concepts of Network Topologies, structures, layers, physical layer Guided Transmission media and Multiplexing concepts.

CO 2: Understand how the Media Access control problem solved in a network using multiple access protocols.

CO 3: Detect and analyze the Datalink layer Framing, Error control Techniques and protocols in a network.

CO 4: Make use of the Network Layer routing algorithms, congestion control algorithms to perform better network communication.

CO 5: Analyze the internet Transport layer protocols and application layer services.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT – I: Introduction: Uses of Computer Networks, Network Structure, Architectures, Services, Standardization, Functions of Various Network Layers, Network examples. Physical layer -Theoretical Basis for Data Communication, Transmission Media, Analog and Digital Transmission, Transmission and Switching ISDN.

UNIT – II: Medium Access Sub-layer: LAN, MAN, Protocol, ALOHA, IEEE Standard for 802 for LANs, Fiber Optic Networks, Satellite Networks.

UNIT – III: Data Link layer: Design Issues, Error Detection and Correction, Protocols and their Performance, Specifications and Examples.

UNIT -IV: Network layers: Design Considerations, Difference between Gateway, Ethernet Switch, Router, Hub, Repeater, Functions of Router, Congestion Control Internetworking and Examples, Details of IP addressing schemes, TCP/IP Protocol details.

UNIT – V: The Transport Layer: The Transport Service, Elements of Transport Protocols, The Internet Transport Protocols; UDP, The Internet Transport Protocols; TCP. The Application Layer -The Domain Name System, Electronic Mail, The World Wide Web.

Text Books:

1. Data Communications and Networking by Behrouz A. Forouzan, 2nd Edition, Tata McGraw Hill.

Reference Books:

1. Computer Networks, A. S. Tannenbaum, PHI – New Delhi.
2. Computer Networking Terminology Products and Standards, R. P. Suri and J. K. Jain, Tata McGraw Hill.

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ANNEXURE-II
OPEN ELECTIVES

1. Discrete Mathematics
2. Algorithms and Complexity
3. MEMS and MOEMS
4. Nano -photonics and Technology
5. Materials Thermodynamics
6. Fundamentals of Microstrip Lines
7. Introduction to Quantum AI &ML
8. Deep Learning Techniques

DISCRETE MATHEMATICS (OE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Discrete Mathematics	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To understand mathematical arguments using logical connectives and quantifiers and verify the validity of logical flow of arguments using propositional, predicate logic and truth tables.
- To understand about permutations and combinations.
- To understand various types of relations and to study about Boolean Algebra.
- To study the graphs, graph isomorphism and spanning trees.

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

CO1: Solve the basic principles of Logics and Proofs.

CO2: Analyze the fundamental algorithms and construct simple mathematical proofs.

CO3: Solve problems related to counting and advance counting techniques.

CO4: Solve different kinds of problems related to Relations and simplify digital logic circuits.

CO5: Acquire knowledge to solve network problems using graph theory and determine minimal spanning tree of a given graph.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: The Foundations-Logic and Proofs: Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers Rules of Inference, Introduction to Proofs, Proof Methods and Strategy, Basic Structures-Sets, Functions, Sequences and Sums: Sets, Set Operations, Functions, Sequences and Summations.

UNIT-II: The Fundamentals-Algorithms, the Integers and Matrices: Algorithms, The Growth of Functions, Complexity of Algorithms, The Integers and Division, Primes and Greatest Common Devisors, Integers and Algorithms, Applications of Number Theory, Matrices. **Induction and Recursion:** Mathematical Induction, Strong Induction and Well-

Ordering, Recursive Definitions and Structural Induction, Recursive Algorithms, Program Correctness.

UNIT-III: Counting: The Basics of Counting, The Pigeonhole Principle, Permutations and Combinations, Binomial Coefficients, Generalized Permutations and Combinations, Generating Permutations and Combinations. **Advanced Counting Techniques:** Recurrence Relations, Solving Linear Recurrence Relations, Divide-and-Conquer Algorithms and Recursion Relations, Generating Functions, Inclusion-Exclusion, and Applications of Inclusion-Exclusion.

UNIT-IV: Relations: Relations and their properties, n-ary relations, applications, Representation, closure, equivalence relations, Partial orderings and Lattices. **Boolean Algebra:** Boolean Functions, Representing Boolean Functions, Logic Gates, Minimization of Circuits.

UNIT-V: Graphs: Graphs and Graph Models, Graph Terminology and Special Types of Graphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Colouring. **Trees:** Introduction to Trees, Applications of Trees, Tree Traversal, Spanning Trees, Minimum Spanning Trees.

Text Book:

1. Discrete Mathematics & Its Applications with Combinatorics and Graph Theory by Kenneth H Rosen, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

Reference Books:

1. Discrete Mathematics for Computer Scientists & Mathematicians by Joe L. Mott, Abraham Kandel, Theodore P. Baker, Prentice-Hall, India.
2. Discrete Mathematics by Richard Johnson Baug, Pearson Education, New Delhi.
3. Discrete and Combinatorial Mathematics by Ralph. G. Grimaldi, Pearson Education, New Delhi.

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ALGORITHMS AND COMPLEXITY (OE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Algorithms and Complexity	**4**			**30**	**70**	**100**	**3hrs**	**3**

Course Objectives: The objectives of this course are

- Understand fundamental algorithm concepts and asymptotic analysis.
- Learn key algorithm design techniques like divide-and-conquer, greedy, and dynamic programming.
- Apply backtracking, branch & bound to solve combinatorial problems.
- Analyze and implement graph algorithms and network flow techniques.
- Introduce computational complexity, NP-completeness, and approximation/randomized algorithms.

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

CO1: Analyze algorithm efficiency using asymptotic notations and recurrence relations.

CO2: Design and implement algorithms using divide-and-conquer, greedy, and DP strategies.

CO3: Apply backtracking and branch & bound to solve complex optimization problems.

CO4: Solve graph-based problems using BFS, DFS, shortest paths, and flow algorithms.

CO5: Classify problems based on complexity and apply approximation or randomized techniques.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Foundations of Algorithms: Definition of algorithms, Algorithm specifications & properties, Asymptotic analysis: Big-O, Θ, Ω, Solving recurrence relations: Substitution method, Recursion tree, Master's Theorem, Empirical analysis and benchmarking.

UNIT-II: Algorithm Design Techniques – Part I: Divide and Conquer: Merge Sort, Quick Sort, Binary Search, Matrix Multiplication (Strassen's Algorithm), Closest Pair Problem, Greedy Algorithms: Activity Selection, Huffman Coding, Minimum Spanning Tree: Prim's, Kruskal's, Dijkstra's Algorithm

UNIT-III: Algorithm Design Techniques – Part II: Dynamic Programming (DP): Matrix Chain Multiplication, Longest Common Subsequence (LCS), 0/1 Knapsack Problem, Floyd-Warshall Algorithm, Backtracking and Branch & Bound: N-Queens, Subset Sum, Travelling Salesman Problem (TSP), Hamiltonian Cycle.

UNIT-IV: Graph Algorithms & Network Flow: Graph Representations: adjacency list/matrix, BFS & DFS, Topological Sorting, Connected Components, Shortest Paths: Bellman-Ford, Dijkstra, Floyd-Warshall, Union-Find, Disjoint Sets Network Flow: Ford-Fulkerson Algorithm, Bipartite Matching, Max-flow Min-cut Theorem.

UNIT-V: Computational Complexity & Advanced Topics: Complexity classes: P, NP, NP-Complete, NP-Hard, Polynomial-time reductions, Cook-Levin Theorem (conceptual understanding), Proving NP-completeness (SAT, 3-SAT, Vertex Cover, etc.), Introduction to Approximation Algorithms: Vertex Cover, TSP Approximation, Randomized Algorithms: Randomized QuickSort, Min-Cut.

Text Books:

1. Introduction to Algorithms – Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein (CLRS).
2. Algorithm Design – Jon Kleinberg and Éva Tardos.
3. Computer Algorithms – Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran.

Reference Books

1. The Algorithm Design Manual – Steven S. Skiena.
2. Design and Analysis of Algorithms – Anany Levitin.
3. Computational Complexity: A Modern Approach – Sanjeev Arora, Boaz Barak.
4. Algorithms – Robert Sedgewick and Kevin Wayne.

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MEMS AND MOEMS (OE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	MEMS and MOEMS	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Introduce the principles, materials, and fabrication techniques of MEMS and MOEMS.
- Analyze mechanical and transduction behavior of microscale structures.
- Design sensors and actuators suitable for micro/nanosystems.
- Understand MOEMS technologies and their applications in optics and photonics.
- Explore packaging, reliability, and integration challenges for real-world systems.

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

CO1: Explain MEMS/MOEMS fabrication methods and materials selection.

CO2: Model stress–strain behavior and performance of MEMS mechanical structures.

CO3: Design and analyze microsensors/actuators (e.g., piezo, electrostatic).

CO4: Understand optical micro-components like gratings, scanners, gratings in MOEMS.

CO5: Address system-level integration, reliability, and application-specific packaging issues.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT-I: Introduction & Fundamentals: MEMS/MOEMS overview: definitions, history, applications, Scaling laws, multi-disciplinary nature, Materials & substrates: silicon, quartz, polymers, ceramics.

UNIT-II: Micro-fabrication Techniques: Lithography (optical, e-beam, X-ray, focused-ion), etching (wet/dry/DRIE), wafer bonding (anodic, SOI), surface/bulk micromachining Packaging, micro-assembly, reliability studies

UNIT-III: Micro/Nano Sensors & Actuators: Transduction mechanisms: piezoelectric, piezoresistive, electrostatic, magnetic, thermal, optical Devices: accelerometers, gyros, micro-pumps, MOEMS scanners

UNIT-IV: Mechanical Modeling & Scaling Effects: Beam/cantilever mechanics, diaphragms, plates**,** Stress–strain, Young's modulus, compliance**,** Scaling laws in mechanics, fluidics, electrostatics, and heat.

UNIT-V: MOEMS, Applications & Integration: MOEMS: micro-optics, photonic crystals, Bragg gratings, holography, Smart materials: Shape memory alloys, piezo actuators, Integration challenges, interface electronics, RF, Bio-MEMS, packaging.

Textbooks:

1. Chang Liu – Foundations of MEMS, Pearson (Indian ed.)
2. Tai-Ran Hsu – MEMS & Microsystems: Design & Manufacture, TMH.
3. G.K. Ananthasuresh, et al. – Micro & Smart Systems, Wiley India.

Reference Books:

1. Marc Madou – Fundamentals of Microfabrication.
2. Nadim Maluf – Introduction to Microelectromechanical Systems Engineering.
3. M.H. Bao – Micromechanical Transducers.
4. Stephen D. Senturia – Microsystem Design.
5. Thomas B. Jones – Electromechanics & MEMS.

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NANO-PHOTONICS AND TECHNOLOGY (OE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Nano-Photonics and Technology	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Understand how light-matter interactions depend on particle size, from bulk materials to the nanoscale.
- Be familiar with near-field optics and localized surface plasmons.
- Understand the use of photonic crystals as waveguides.
- Learn about optical metamaterials and their application in imaging objects.
- Comprehend the working principles of nanolasers and quantum cascade lasers.

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

CO1: To learn the basics of nanophotonics and how light interacts with matter at the nanoscale.

CO2: To understand how near-field optics and microscopy are used to study nanoscale objects.

CO3: To learn about different types of lasers, including nanolasers and quantum cascade lasers.

CO4: To study how metallic nanostructures are used in plasmonics and optical waveguiding.

CO5: To explore photonic crystals and how they control the flow of light.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT- I: Basics of Nano photonics: Review of Electrodynamics, light-matter interactions, Photons and electrons: similarities and differences, free-space propagation, Confinement of photons and electrons. Localization under a periodic potential: Bandgap, Cooperative effects. Nanoscale optical interactions, Nanoscale confinement of electronic interactions.

UNIT-II: Near-field optics and microscopy: Concepts and devices in nanoscale optics and photonics. Nano-scale and near-field optics, near-field optical probes, near-field scanning optical microscopy, transmission through nanoscale apertures.

UNIT-III: Lasers and quantum lasers: Solid-state lasers and gas lasers, Quantum materials, Quantum confined structures as lasing media, nanolasers, Quantum Cascade Lasers.

UNIT-IV: Plasmonics: Metallic Nanoparticles and Nanorods, Local field enhancement, Subwavelength aperture plasmonics, Plasmonic wave guiding, Applications of metallic nanostructures.

UNIT-V: Photonic crystals: Basic concepts, Features of Photonic crystals, Photonic crystals (0D, 1D, 2D & 3D), silicon, graphene and diamond photonics.

Text Books:

1. Principles of Nano-Optics, Lukas Novotny and Bert Hecht, Cambridge University Press, 2nd Ed., 2012.
2. Nanophotonics, Paras N. Prasad, Wiley-Interscience, 2004

Reference Books:

1. Plasmonics: Fundamentals and Applications, Stefan A. Maier, Springer, 2007.
2. Photonic Crystals: Molding the Flow of Light, J. D. Joannopoulos, Steven G. Johnson, Joshua N. Winn, and Robert D. Meade, Princeton University Press, 2nd Ed., 2008

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MATERIALS THERMODYNAMICS (OE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Materials Thermodynamics	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Learn the first and second laws of thermodynamics.
- Understand thermodynamic functions and equilibrium.
- Study the third law and phase equilibria.
- Analyze gases, solutions, and their properties.
- Explore chemical equilibrium and electrochemistry.

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

CO1: Apply first and second laws to thermal systems.

CO2: Use thermodynamic functions and equations.

CO3: Explain phase equilibria and third law concepts.

CO4: Evaluate properties of gases and solutions.

CO5: Solve problems in chemical and electrochemical equilibrium.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT I: First and Second Law of Thermodynamics: Various forms of Energy, Heat and Work, Conservation of Energy, First Law of Thermodynamics in detail, concept of maximum work, isothermal expansion, reversible, adiabatic expansion, Second Law of Thermodynamics, Entropy and equilibrium, Reversibility, Heat Engine, Statistical Interpretation of Entropy, Boltzmann Equation.

UNIT II: Thermodynamic Functions and Equilibrium: Auxiliary Functions: Enthalpy, Free Energy, Chemical Potential, Maxwell's Equations, Gibbs-Helmholtz Equation, Enthalpy as a Function of Temperature and Composition.

UNIT III: Third Law and Phase Equilibrium: Third Law of Thermodynamics, Phase Equilibrium in a One-Component System, Equilibrium between Vapor and Condensed Phase, and between condensed phases.

UNIT IV: Gases and Solutions: Gases: Ideal, Real, van der Waals, Raoult's Law and Henry's Law, Activity, Gibbs-Duhem Equation, Properties of Ideal and Non-Ideal Solutions, Regular Solutions, Activity, Phase Diagrams of some Binary Systems.

UNIT V: Chemical Equilibria and Electrochemistry: Effect of Temperature and Pressure on the Equilibrium Constant for a gas mixture, Ellingham Diagrams, The Gibbs Phase Rule, Electrochemistry, Concentration and EMF, Standard Reduction Potentials, Pourbaix Diagrams.

Text Books:

1. P.W. Atkins, Physical Chemistry, Oxford University Press.
2. Y.V.C. Rao, An Introduction to Thermodynamics, Universities Press.

Reference Books:

1. Gordon M. Barrow, Physical Chemistry, McGraw Hill.
2. J.M. Smith, H.C. Van Ness, M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, McGraw Hill.

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FUNDAMENTALS OF MICROSTRIP LINES (OE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ex t.			
	Fundamentals of Microstrip Lines	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To review the fundamental principles of RF and microwave transmission lines including parallel plate and high-frequency behavior.
- To introduce the properties and design considerations of planar transmission lines such as microstrip, slotline, and coplanar waveguides.
- To familiarize students with microstrip-based passive components including filters, resonators, and couplers.
- To explore the integration of microwave active devices into microstrip/RF circuit design.
- To provide an understanding of fabrication techniques and practical applications of planar transmission lines in RFICs and antennas.

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

CO1: Understand the analysis and high-frequency behavior of RF and microwave transmission lines.

CO2: Explain the structure, characteristics, and modeling of microstrip, slotline, and coplanar waveguides.

CO3: Design microstrip-based filters, resonators, and directional couplers for RF applications.

CO4: Apply microstrip structures in designing amplifiers, mixers, and other active microwave devices.

CO5: Demonstrate knowledge of fabrication methods and real-world applications of planar transmission lines.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT–I: **Analysis and Design of RF and Microwave Lines** – Review of Transmission Lines, Parallel Plate Transmission Lines, Low-Frequency Solution, High Frequency Solution.

UNIT–II: **Strip Line and Micro Strip Transmission Lines** – Low Frequency Solution, High Frequency Properties of Micro Slot Line, Co Planer Wave Guides, Spiral Inductors – Capacitors.

UNIT–III: **Microstrip/Strip line Based Filters** – Resonators, Plane Shifters, Micro Strip Based Gyrators, Circulators and Isolators, Directional Couplers.

UNIT–IV: **Microwave Active Devices** – Amplifiers, Mixers, Oscillators, Detectors, Switches – Layout Considerations of RF Circuits.

UNIT–V: **Fabrication Techniques and Applications** – Fabrication Aspects of Planar Transmission Lines, Applications in Antennas, Filters, and RFICs.

Text Books:

1. Microwave Engineering – Prof. G.S.N Raju, I.K. International Publication.
2. I.Kneppo and J. Fabian, “Microwave Integrated Circuit”, London: Chapman & Hall, (1994).
3. M.W.Medley, “Microwave and RF circuit: Analysis, Synthesis and Design”, Artech House, (1993).

Reference Books:

1. R.Goyal, “Monolithic Microwave Integrated Circuit: Technology & Design”, Artech House, (1989).
2. Y.Konishi, “Microwave Integrated Circuit”, Dekker, New York: Marcel Dekker, (1991).

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INTRODUCTION TO QUANTUM AI & ML (OE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ex t.			
	Introduction to Quantum AI & ML	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- Introduce core AI/ML methods and concepts.
- Explain the fundamentals of quantum computing.
- Explore quantum algorithms relevant to ML tasks.
- Analyze quantum versions of classical ML models.
- Study hybrid quantum-classical models and applications.

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

CO1: Understand and explain foundational AI/ML algorithms.

CO2: Apply quantum concepts like qubits, gates, and entanglement.

CO3: Implement quantum algorithms using Qiskit.

CO4: Design and evaluate quantum ML models like QSVM and qPCA.

CO5: Develop QNNs and apply quantum algorithms to real-world problems.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT I – Machine Learning and Artificial Intelligence Foundations: Supervised and unsupervised learning, linear and logistic regression, classification (SVM, decision trees), clustering (k-means, hierarchical), neural networks (basics), loss functions, gradient descent, model evaluation metrics.

UNIT II – Quantum Computing for AI Applications: Qubits, Dirac notation, quantum states, quantum gates, superposition and interference, entanglement, quantum measurement, Bloch sphere, no-cloning theorem. Quantum advantage in ML contexts.

UNIT III – Quantum Algorithms for Machine Learning: Quantum-enhanced algorithms: Deutsch-Jozsa, Bernstein-Vazirani, Simon's algorithm, Grover's search, Quantum Fourier Transform (QFT), HHL algorithm for solving linear systems, feature encoding and swap test for ML inputs.

UNIT IV – Quantum Machine Learning Models: Quantum k-means, Quantum PCA (qPCA), Quantum Support Vector Machines (QSVM), Quantum linear regression, Variational Quantum Classifier (VQC), Quantum kernel estimation.

UNIT V – Quantum Deep Learning & Real-World Applications: Hybrid quantum-classical neural networks (QNNs), Variational Quantum Eigensolver (VQE), Quantum Approximate Optimization Algorithm (QAOA), quantum reinforcement learning, applications in finance, medicine, chemistry, and optimization.

Textbooks:

1. Maria Schuld & Francesco Petruccione, Machine Learning with Quantum Computers, Springer, 2021.
2. Peter Wittek, Quantum Machine Learning: What Quantum Computing Means to Data Mining, Academic Press, 2014.
3. Michael A. Nielsen & Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 2010.

Reference Books:

1. Vedran Dunjko & Hans Briegel, Machine Learning & Artificial Intelligence in the Quantum Domain, arXiv:1709.02779 [survey paper].
2. Kristen L. Pudenz, Quantum Machine Learning Algorithms: Foundations and Developments, Wiley.
3. IBM Qiskit Textbook, Learn Quantum Computation using Qiskit (Online: https://qiskit.org/textbook)

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DEEP LEARNING TECHNIQUES (OE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ex t.			
	Deep Learning Techniques	4			30	70	100	3hrs	3

Course Objectives: The objectives of this course are

- To review the fundamentals of machine learning and introduce deep learning concepts.
- To understand the architecture and training of feed forward and deep neural networks.
- To study regularization techniques and optimization methods used in deep learning models.
- To explore advanced architectures such as convolutional neural networks (CNNs).
- To examine sequential models like recurrent neural networks (RNNs) and long short-term memory (LSTM) cells.

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

CO1: Explore feed forward networks and deep neural networks.

CO2: Mathematically understand deep learning approaches and paradigms.

CO3: Apply regularization and optimization techniques in training models.

CO4: Perform complex feature extraction using CNNs.

CO5: Apply RNNs and LSTMs in real-world deep learning applications.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT – I: Introduction to Machine Learning and Deep Learning; Learning Algorithms – Capacity, Overfitting and Underfitting – Hyperparameters and Validation Sets – Estimators – Bias and Variance – Maximum Likelihood Estimation – Bayesian Statistics – Supervised and Unsupervised Learning Algorithms – Stochastic Gradient Descent – Building a Machine Learning Algorithm – Challenges and Motivation for Deep Learning.

UNIT – II: Deep Neural Networks and Training Techniques: Deep Forward Networks – Learning XOR – Gradient-Based Learning – Hidden Units – Architecture Design –

Backpropagation and Other Differentiation Algorithms – Difference Between Learning and Optimization – Challenges in Neural Network Optimization – Basic Optimization Algorithms – Parameter Initialization Strategies – Algorithms with Adaptive Learning Rates.

UNIT – III: Regularization Methods for Deep Learning: Parameter Norm Penalties – Norm Penalties as Constrained Optimization – Regularization and Under-Constrained Problems – Dataset Augmentation – Noise Robustness – Semi-Supervised Learning – Multitask Learning – Early Stopping – Parameter Tying and Parameter Sharing – Sparse Representations – Bagging and Ensemble Methods – Dropout.

UNIT – IV: Convolutional and Recurrent Architectures: Convolutional Networks: Convolution Operation – Motivation – Pooling – Variants of Basic Convolution Function – Structured Outputs – Data Types – Efficient Convolution Algorithms – Unsupervised Features. Sequence Modeling: Recurrent Neural Networks – Unfolding Computational Graphs – Bidirectional RNNs – Encoder-Decoder (Seq2Seq) Architectures – Deep Recurrent Networks – Recursive Neural Networks – Long-Term Dependency Challenges – LSTM and Gated RNNs – Echo State Networks – Leaky Units and Time Scale Strategies.

UNIT – V: Applications and Practical Methodologies: Performance Metrics – Baseline Models – Data Collection Decisions – Hyperparameter Selection – Debugging Strategies – Multi-Digit Number Recognition – Large Scale Deep Learning – Applications in Computer Vision – Applications in Natural Language Processing (NLP).

Text Books:

1. "Deep Learning", Ian Goodfellow, YoshuaBengio and Aaron Courville, published by MIT Press,UK, 2017 Series

2. Deep Learning with Keras: The Textbook by Antonio Gulli and Sujit Pal, PacktPublishing Ltd, Birmingham, UK, April 2017

Reference Books:

1. Deep Learning with TensorFlow, The Textbook by Giancarlo Zaccone, Md. Rezaul Karim, and Ahmed Menshawy, Packt Publishing Ltd, Birmingham, UK, April 2017.

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ANNEXURE-III

HSSE ELECTIVES

1. Industrial Management & Entrepreneurship.
2. Organizational Behavior.
3. Financial Management for Engineers.

INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP (HSSE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Industrial Management and Entrepreneurship	**4**			**30**	**70**	**100**	**3hrs**	**3**

Course Objectives : The objectives of this course are

- To familiarize the students with the concepts of Management.
- To relate the concepts of Management with industrial organizations.
- To explain the factors affecting productivity and how productivity can be increased in an Industrial undertaking.
- To set forth a basic framework for understanding Entrepreneurship.

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

CO 1: Understand the roles, skills and functions of management and distinguish the different types of business organizations.

CO 2: Identify the factors involved in Production Operations Management.

CO 3: Diagnose organizational problems and take suitable decisions.

CO 4: Establish good Human Resource Management practices.

CO 5: Acquire necessary knowledge and skills required for organizing and carrying out entrepreneurial activities.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT – I: Basic Concepts of Management: Management: Definition, Nature and Importance; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management.

UNIT – II: Forms of Business Organizations: Introduction, Types of Business organizations: Private Sector- Individual Ownership, Partnership, Joint stock companies and Co-Operative organizations; Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

UNIT -III: Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis- Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

UNIT – IV: Entrepreneurship: Definition, Characteristics and Skills, Types of Entrepreneurs, Entrepreneur vs. Professional Managers, Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

UNIT – V: Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques, Stages in Project formulation; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

Text Books:

1. Sharma, S.C, and Banga, T.R., Industrial Organization & Engineering Economics, Khanna Publishers, Delhi, 2000.
2. Vasant Desai, The Dynamics of Entrepreneurial Development and Management (Planning for future Sustainable growth), Himalayan Publishing House, 2018.

Reference Books:

1. Aryasri, A.R., Management Science, McGraw Hill Education (India Private Limited New Delhi 2014.
2. Sheela, P. and Jagadeswara Rao, K., Entrepreneurship, Shree Publishing House, Guntur, Andhra Pradesh, 2017.

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ORGANIZATIONAL BEHAVIOR (HSSE)

(Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Organizational Behavior	4			30	70	100	3hrs	3

Course Objectives : The objectives of this course are

- To understand the basic concepts of organizational behaviour, its foundations and importance.
- To enable students to have a basic perspective of Motivation and Motivation theories.
- To acquaint the students about group behavior in organizations, including communication, leadership conflicts and organizational change and how these are linked to, and impact organizational performance.

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

CO 1: Identifying fundamental aspects of organizational dynamics.

CO 2: Evaluate main theories of motivation and formulating suitable motivational strategies.

CO 3: Analyze the behavior of individuals and groups in organizations.

CO 4: Understanding of Leadership theories and Leadership behavior.

CO 5: Apply relevant theories, concepts to address important Organizational Behavior questions.

SYLLABUS

(with effect from 2025-26 admitted Batch)

UNIT – I : Organizational Beaviour : Concept of Organisation- Concept of OrganisationalBehaviour - Nature of Organisational Beaviour - Role of Organisational Beaviour - Disciplines contributing to Organisational Beaviour.

UNIT – II : Motivation : Definition - Nature of Motivation - Role of Motivation - Theories of Motivation :Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and Mc Gregor's Theory X and Theory Y.

UNIT - III: Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness. Leadership -Concept of Leadership - Difference between Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

UNIT – IV : Communication : Manning - Communication Process - Forms of communication : Oral, Written and Non- Verbal communication - Direction of communication : Downward, Upward and Horizontal communication.

UNIT – V : Organisational conflicts : Concept of conflict - Reasons for conflict - Types of Conflict:Intrapersonalconflict, Interpersonalconflict, Intragroupconflict, Intergroupconflict, Inter organisationalconflict - Conflict management. Organisational Change -Nature - Factors in Organisational change -Planned change : Process of planned change - Resistance to change: Factors in resistance to change - Overcoming resistance to change.

Text Books.

1. L.M.Prasad: Organisational Beaviour, Sultan Chand & Sons, New Delhi -110002.
2. K. Aswathappa:OrganisationalBehaviour, Himalaya Publishing House, New Delhi

Reference Books.

1. Stephen Robbins: Organizational Behaviour, Pearsons Education, New Delhi.

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FINANCIAL MANAGEMENT FOR ENGINEERS (HSSE)

Effective from Admitted Batch of 2025-26)

Code	Title	L	T	P	Allotment of Marks		Total Marks	Ext. Exam Time	C
					Int.	Ext.			
	Financial Management for Engineers	**4**			**30**	**70**	**100**	**3hrs**	**3**

Course Objectives: The objectives of this course are

- To provide awareness and understanding of the ways finance helps in reaching business objectives.
- To familiarize with the form, content and analysis of financial statements and the accounting principles and techniques.
- To Identify signals pointing to deterioration in financial condition and analyze the reasons for variances between the actual and budgeted results
- To facilitate in the improvement of organizations' performance by pointing out the importance of cost control, breakeven and variance analysis.
- To equip with the ability to communicate comfortably with Financial Executives and discuss the financial performance of the organization effectively.

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

CO 1: Ability to analyze financial statements.
CO 2: Understanding costs and methods to reduce them.
CO 3: Taking decisions regarding the price of the products services, or both.
CO 4: Understanding of capital budgeting and various capital budgeting techniques.
CO 5: Skill to practice different Budgeting Systems in organizations.

SYLLABUS
(with effect from 2025-26 admitted Batch)

UNIT-I: Accounting concepts and systems - Elements of Financial Statements - trading, profit & loss Statement- Cash Flow Statements - Notes to Accounts - Profits vs. Cash Flows.

UNIT-II: Analysis of Financial Statements - Financial Analysis-Financial Ratios and their Interpretations covering: Profitability Ratios; Liquidity Ratios; Return on Capital Ratios; - Management of Working Capital: Capital and Its Components - Working Capital Cycle - Working Capital Financing.

UNIT-III: Management Decision Making: Cost concepts and its application in Decision Making - Types of cost – Direct& Indirect, Fixed& Variable - Cost Sheet - Cost Volume Profit Analysis - Understanding Cost behavior – Cost concepts and its application in Decision Making - Relevance of Activity Based Costing - Marginal Costing - Make or Buy - Shut down or continue - Sell or process further - Domestic vs. Export Sales.

UNIT-IV: Budgets and Budgetary Control: Different types of Budgets (Departmental, Function based, Cash, Master) - Budgeting systems (ABC / ZBB / Rolling/ Incremental / Planning) - Variance Analysis - Capital Budgeting and Investment Appraisals - Meaning of Capital Budgeting - Relevance of Capital Budgeting - Techniques of Capital Budgeting - Payback Period - Accounting Rate of Return - Net Present Value - Internal Rate of Return - Discounted Payback Period.

UNIT-V: Means of Finance: Financial Instruments - Shares, Debentures, Derivatives - Share Capital Vs. Term Loans - Leasing - Financial Markets - Capital Markets - Stock Exchanges**.**

Suggested Books:

1. Finance for Non-Finance People by Sandeep Goal (2017), Publisher: Taylor and Francis.
2. Finance for Non-Finance Managers by B.K. Chatterjee (1988), Jaico Publishing House, Sold by Amazon.
3. Finance for Nonfinancial Managers: Finance for Small Business, Basic Finance Concepts (Accounts and Finance) by Murugesan Ramaswamy (2021), Repro Books-On-Demand.

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