

First Year

Fall Semester				Spring Semester					
Course Code	Course Title	Credit Hrs			Course Code	Course Title	Credit Hrs		
		Th	Pr	Total			Th	Pr	Total
CS-114	<a href="#">Fundamentals of Computer Engineering</a>	3	1	4	CS-116	<a href="#">Object Oriented Programming</a>	3	1	4
CS-115	<a href="#">Computer Programming</a>	3	1	4	CS-117	<a href="#">Discrete Structures</a>	3	0	3
EE-120	<a href="#">Basic Electrical Engineering</a>	3	1	4	PH-122	<a href="#">Applied Physics</a>	3	1	4
MT-114	<a href="#">Calculus</a>	3	0	3	EL-103	<a href="#">Basic Electronics</a>	3	1	4
HS-111	<a href="#">Functional English</a>	2	0	2	HS-205	<a href="#">Islamic Studies</a> OR	2	0	2
HS-106	<a href="#">Pakistan Studies</a> OR	1	0	1	HS-209	<a href="#">Ethical Behaviour</a>			
HS-107	<a href="#">Pakistan Studies (For Foreigners)</a>								

Second Year

Fall Semester				Spring Semester					
Course Code	Course Title	Credit Hrs			Course Code	Course Title	Credit Hrs		
		Th	Pr	Total			Th	Pr	Total
CS-218	<a href="#">Data Structures &amp; Algorithms</a>	3	1	4	CS-221	<a href="#">Computer Organization &amp; Design</a>	3	1	4
CS-220	<a href="#">Digital Logic Design</a>	3	1	4	CS-215	<a href="#">Signals and Systems</a>	2	1	3
CS-219	<a href="#">Computer Engineering Workshop</a>	0	1	1	CS-222	<a href="#">Database Management Systems</a>	3	1	4
MT-224	<a href="#">Complex Variables &amp; Fourier Analysis</a>	3	0	3	MT-222	<a href="#">Linear Algebra and Ordinary Differential Equations</a>	3	0	3
EE-217	<a href="#">Circuit Theory</a>	2	0	2	HS-219	<a href="#">Professional Ethics</a>	2	0	2
HS-218	<a href="#">Business Communication</a>	2	1	3					

Third Year

Fall Semester				Spring Semester					
Course Code	Course Title	Credit Hrs			Course Code	Course Title	Credit Hrs		
		Th	Pr	Total			Th	Pr	Total
CS-328	<a href="#">Computer Architecture</a>	3	0	3	CS-301	<a href="#">Microprocessor Based System Design</a>	3	1	4
CS-326	<a href="#">Software Engineering</a>	3	1	4	CS-329	<a href="#">Operating Systems</a>	3	1	4
CS-327	<a href="#">Computer Communication Networks</a>	3	1	4	MT-442	<a href="#">Numerical Methods</a>	3	0	3
CS-323	<a href="#">Artificial Intelligence</a>	3	1	4	EF-305	<a href="#">Engineering Economics and Management</a>	3	0	3
MT-335	<a href="#">Probability &amp; Statistics</a>	3	0	3	CS-3XX	<a href="#">Elective-1</a>	3	1	4

Final Year

Fall Semester				Spring Semester					
Course Code	Course Title	Credit Hrs			Course Code	Course Title	Credit Hrs		
		Th	Pr	Total			Th	Pr	Total
CS-419	<a href="#">Digital Signal Processing</a>	3	1	4	CS-438	<a href="#">Computer System Modelling</a>	3	0	3
CS-431	<a href="#">Digital System Design</a>	3	1	4	CS-432	<a href="#">Distributed Computing</a>	2	1	3
CS-425	<a href="#">Entrepreneurship for Computer Engineers</a>	3	0	3	HS-405	<a href="#">Organizational Behaviour</a>	3	0	3
CS-4XX	<a href="#">Elective-2</a>	2	0	2	CS-4XX	<a href="#">Elective-3</a>	2	1	3
CS-406	<a href="#">*Computer Engineering Project</a>	0	3	3	CS-406	<a href="#">Computer Engineering Project</a>	0	3	3
CS-3XX	<a href="#">Elective - 1 (3+1)</a>	CS-4XX	<a href="#">Elective - 2 (2+0)</a>	CS-4XX	<a href="#">Elective - 3 (2+1)</a>				
CS-330	<a href="#">Digital Communication Systems</a>	CS-433	<a href="#">Internet Computing</a>	CS-426	<a href="#">Computer System Security</a>				
CS-324	<a href="#">Machine Learning</a>	CS-434	<a href="#">Bioinformatics</a>	CS-436	<a href="#">Computer Vision</a>				
CS-325	<a href="#">Software Development &amp; Testing</a>	CS-435	<a href="#">Software Project Management</a>	CS-437	<a href="#">Parallel Programming</a>				

\* Duration one academic year: Requires literature survey and preliminary work during this Semester. Final exam is conducted in the last semester.

## First Year

### Fall Semester

#### **CS-114                    FUNDAMENTALS OF COMPUTER ENGINEERING                    (3+1)**

Number Systems; Digital Logic Gates, Classification of Computer Systems; Von Neumann Architecture; Structure and Organization of Computers and Computer Systems; Computer Peripherals; Classification of Software Systems; Introduction to Software Development Process; Levels of Programming Languages; Data Communication and Computer Networking Fundamentals; Introduction to Databases and Information Systems; Introduction to Operating Systems; Pseudo-programming; Recent Trends in the field of Computer Engineering, Augmented Reality, Virtual Reality, IoT, Big Data Computing, Cloud Computing; Society and Information Technology, Ethical issues related to Computers

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#### **CS-115                    COMPUTER PROGRAMMING                    (3+1)**

Introduction to Programming Languages; Language Building Blocks: Variables & Constants, Operators & Expressions, Input/processing/output; Basic Data Types; Decision Control Structures; Loop Control Structures; Arrays and Collections; User-Defined and Built-in Functions; Files; Program Debugging and Testing

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#### **EE-120                    BASIC ELECTRICAL ENGINEERING                    (3+1)**

Fundamentals of Electric Circuits - Charge, Current, Voltage and Power, Voltage and Current Sources, Ohm's Law; Voltage and Current Laws - Nodes, Paths, Loops and Branches, Kirchhoff's Current Law, Kirchhoff's voltage Law, the Single-Loop Circuits, the Single Node-Pair Circuit, Series and Parallel Connected Independent Sources, Resistors in Series and Parallel, Voltage and Current Division.

Basic Nodal and Mesh Analysis - Multi-Nodal Analysis, the Super node, Mesh Analysis, the Super mesh  
Circuit Analysis Techniques - Linearity and Superposition, Source Transformations, Thevenin and Norton Equivalent Circuits,

Maximum Power Transfer, Delta- Wye Conversion

Capacitors and Inductors - Capacitor, Inductor, Inductance and Capacitance Combination

Basic RL and RC Circuits - The Source-Free RL Circuit, Properties of the Exponential Response, the Source-Free RC Circuit, the Unit-Step Function, Driven RL Circuits, Natural and Forced Response, Driven RL Circuits

The RLC Circuit - The Source-Free Parallel Circuit, the over damped Parallel RLC Circuit, Critical Damping, the under damped Parallel RLC Circuit, the Source- Free Series RLC Circuit, the Complete Response of the RLC Circuit, the Lossless LC Circuit

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Constitutional Process: Constitutional and Political developments in Pakistan 1947-1973. Salient features of the Constitutions 1956, 1962 and 1973 and amendments.

Land of Pakistan: Geo-physical conditions, Geo-political and strategic importance of Pakistan, Natural resource, viz: mineral, water and power.

Contemporary issues in Pakistan: A brief survey of Pakistan Economy: problems, issues and future prospects.

Pakistani Society and Culture-Broad features with emphasis on youth role in the development of Pakistan.

Literacy and education in Pakistan: problems and issues. State of Science and Technology in Pakistan: A comparison with other countries with special reference to the Muslim world.

Environmental issues in Pakistan: government policies and measures and suggestions for improvement.

Pakistan's role in the preservation of nature through international conventions / treaties

Human Rights in Pakistan: Pakistan's response to human rights issues at national & international levels.

Pakistan's Foreign Policy Urbanization in Pakistan - problems and issues

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## **HS-107            PAKISTAN STUDIES (FOR FOREIGNERS)**

**(1+0)**

Land of Pakistan: Land and People, Strategic Importance, Important and Beautiful Sights: Natural Resources (some portion of Economics of Pakistan)

A Brief Historical Background: A brief historical survey of Muslim Community in the Sub- Continent, British Rule and its Impacts, Indian Reaction, Two-Nation Theory, its Origin and Development, Factors leading towards the Demand of a separate Muslim State, Creation of Pakistan.

Government & Political Development in Pakistan: Constitution of Pakistan, A brief outline, Governmental Structure, Federal and Provincial, Local Government Institutions, Political History and its brief account.

Pakistan & the Muslim World: Relations with Muslim Countries

Language and Culture: Origin of Urdu Language, Influence of Arabic and Persian on Urdu Language and Literature, A short history of Urdu Literature, Dominant Cultural Features

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Theory of Hydrogen Atom, Atomic Spectra, Reduced Mass, De-Broglie Hypothesis, Electron Microscope, Atomic Nucleus and Properties of Nucleus, Radioactive Decay and Radioactive Dating, Radiation Detection Instruments, Nuclear Reactions and Nuclear Reactor.

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### **EL-103 BASIC ELECTRONICS**

**(3+1)**

PN Junction Diode: Introduction. PN junction diode, Unbiased diode, Barrier potential, Diffusion & drift current, Forward & reverse bias, Minority carrier current. Diode models: Ideal, practical & complete, Diode characteristics, Load line, Diode current equation; Capacitive effect on diode operation at high-frequency, Transient current, Temperature effect on diode operation; Diode applications; Rectifier, Switch, Communication, Wave-shaping, Voltage multiplier etc; Breakdown diode, Voltage regulator, Power Supply.

FET: Field effect transistor; Device, Structure & Physical operation of the MOSFET, Current-voltage characteristics; DC analysis of MOSFET circuits, MOSFET as an amplifier and as a switch, biasing in MOS amplifier circuits.

Operational Amplifiers: Terminal characteristics only, ideal op-amp characteristics, inverting and non-inverting configurations, op-amp applications like weighted summer, difference amplifier, instrumentation amplifier, differentiator, integrator, logarithmic amplifier etc; Non ideal characteristics like slewing, DC input offset voltage, input biasing current etc.

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### **HS-205 ISLAMIC STUDIES**

**(2+0)**

Quranic Verses - Tauheed, (Al-Ambiyah-22, Al-Baqarah-163 and 164). Prophethood (Al-Imran- 79, Al-Huda-7, Al-Maidah-3). Here-After (Al-Baqarah-48 and one Hadith). Basic Islamic Practices (Al-Mu'minin-1 and 111, and two Ahadith). Amer-Bil-Ma'Roof Wa-Nahi Anil Munkar. The Concept of Good and Evil; Importance and Necessity of Da'wat-e-Deen (Al- Imran-110). Method of Da'wat-e-Deen (An-Nehl-125, Al-Imran-64, Al-An'an-108, and two Ahadith). Kasb-e-Halal (Taha-81, Al-A'raf-32 and 33, Al-Baqarah-188 and two Ahadith). Huquq-ul-Ibad: Protection of Life (Al-Madinah-32), Right to Property (Al-Nisa-29), Right to Respect and Dignity (Al-Hujrat-11 and 12), Freedom of Expression (Al-Baqarah-256), Equality (Al-Hujarat-13), Economic Security (Al-Ma'ar ij-24 and 25); Employment Opportunity on Merit (An-Nisa-58); Access to Justice (An-Nisa-135); Women's Rights (An-Nehl-97, Al-Ahzab-35, An-Nisa-07); Relation with Non-Muslims (Al-Muhammad-8 and 9, Al-Anfa'al-61 and The Last Sermon of Hajj of Holy Prophet (SAW); Relevant Extracts. Seerat (life) of the Holy Prophet (SAW) - Birth, Life at Makkah, Declaration of Prophet hood, Preaching and its Difficulties, Migration to Madinah, Brotherhood (Mawakhat) and Madinah Charter, the Holy Wars of the Prophet (SAW) (Ghazwat-e-Nabawi), Hujrat-ul-Wida, the Last Sermon of Khutbatulwida (Translation and Important Points). Islamic Civilization - (a) In the Sub Continent: Pre-Islamic Civilizations, the Political , Social and Moral Impact of Islamic Civilizations. (b) In the World: Academic, Intellectual, Social and Cultural Impact of Islamic Civilization.

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**HS-209**

**ETHICAL BEHAVIOUR**

**(2+0)**

Nature, Scope and Methods of Ethics; Ethics and Religion; Ethical Teachings of World Religions; Basic Moral Concepts, Rights and Wrong, Good and Evil; An Outline of Ethical Systems in Philosophy; Hedonism, Utilitarianism, Rationalism and Kant; Self Realization Theories, Intuitionism; Islamic Moral Theory: Ethics of Quran and its Philosophical Basis; Ethical, Precepts from Quran and Hadith and Promotion of Moral Values in Society.

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**MT-224            COMPLEX VARIABLE & FOURIER ANALYSIS****(3+0)**

Infinite Series: Application of convergence tests such as comparison, Root, Ratio, Raabe's and Gauss tests on the behaviour of series.

Complex Variable: Limit, continuity, zeros and poles of a complex function. Cauchy-Reimann equations, conformal transformation, contour integration.

Laplace Integral & Transformation: Definition, Laplace transforms of some elementary functions, first translation or shifting theorem, second translation or shifting theorem, change of scale property, Laplace transform of the  $n$ th order derivative, initial and final value theorem Laplace transform of integrals, Laplace transform of functions  $t^n F(t)$  and  $F(t)/t$ , Laplace transform of periodic function, evaluation of integrals, definition of inverse Laplace transform and inverse transforms, convolution theorem, solutions of ordinary differential and partial differential equations using Laplace transform (I.V.P's & B.V.P's), Z and Inverse Z –transformations, properties of Z - transformation and applications

Fourier series: Introduction to Fourier series. Euler Fourier formulae, even and odd functions, application of Fourier series, Fourier transform and fast Fourier transform and properties with applications.

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**EE-217            CIRCUIT THEORY****(2+0)**

Elementary Transient Analysis - Differential and integral forms of circuit equations, Initial voltage on a capacitor, Initial current in an inductor, First -order circuits, Solution of single first order differential equations, particular and total solution of second order linear time invariant differential equations. Matrix Analysis - Systematic formulation of network equations, Loop variable analysis, State variable analysis, formulation of state equations, source transformations Duality. Elementary Time Functions - Introduction to singularity functions, The impulse functions and response, The unit step function and response, Ramp function, Exponential function & response. Exponential Excitation and the Transformed Network - Representation of excitations by exponentials functions, Single element response, Forced response with exponential excitation, Introduction to the transformed network, Driving point impedance and admittance. Two Port Network - Introduction, Characterization of linear time invariant two-ports by six sets of parameters, Relationship among parameter sets. Networks Functions and Frequency Response - The concept of complex frequency, transform impedance and transform circuits, Network functions. Poles and zeros of network functions, Restrictions on pole and zero transfer function, magnitude and phase.

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**HS-218            BUSINESS COMMUNICATION**

Foundations of Business Communication: Definitions: communication, organization, business; understanding the need and scope of business, professional and organizational communication, Conditions, properties, process, tools, modes, levels, types of communication; Principles of Effective Communication & Building goodwill (You-attitude, positive emphasis and unbiased language); Listening, non-verbal communication. Communication dilemmas and problems; Feedback and its types; Audience Analysis Oral Communication: Group Discussions and

interpersonal skills, Meetings, Interviews, Making presentations Business & Technical Writing: Types of messages: Formats (Letter and memorandum); Letter and memorandum elements and formats. Three Types of Business Messages (routine, negative and persuasive communications). Organizational Plans: Direct, Indirect & AIDA approach; Writing business messages (e-mails, inquiries, requests, replies, regrets, declining offers, letters, routine messages, etc.); Meetings: notice, agenda and minutes. Job applications and resumes. Research / scientific reports (structure, layout, writing process)

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**MT-222            Linear Algebra & Ordinary Differential Equations****(3+0)**

Linear Algebra: Linearity and linear dependence of vectors, basis, dimension of a vector space, field matrix and type of matrices (singular, non- singular, symmetric, non- symmetric, upper, lower, diagonal), Rank of a matrix using row operations and special method, echelon and reduced echelon forms of a matrix, determination of consistency of a system of linear equation using rank, matrix of linear transformations, Eigen value and Eigen vectors of a matrix, Diagonalization, Applications of linear algebra (Scaling, translation, rotation and projection) with graphical representation.

Introduction to Ordinary Differential Equations (ODE): The Concepts & Terminologies: Order and Degree; Linearity & Non-linearity; A Brief Classification of ODEs; Formulation of ODEs: Concrete Examples; Solutions: General & Particular: Concrete Examples & Applications: Initial Value Problems (IYP) and Boundary Value problems (BVP): A Brief Introduction to Issues related to Existence & Uniqueness of Solutions.

The First Order ODEs: Linear and Non-Linear: Variable Separable Cases & Applications: Growth & Decay Problems, Newton's Law of Cooling, Torricelli's Law, Simple Kinematical Dynamical Applications; Exact and No-Exact ODEs: Solution Procedures and Integrating Factors; the Standard Linear Differential Equation of First Order: Solution Procedures and Applications to RL-Circuits and RC-Circuits, Bernoulli's Equations & Logistical Growth Models. Direction Fields and Euler's and Picard's Iterative Schemes for the 1st Order ODEs,

The Linear Second Order ODEs: Homogeneous and Non-Homogeneous Cases, Linear Second Order Homogeneous ODE with Constant Coefficients: Solution Procedures and the Principle of Linear Superposition and Applications, Mechanical Systems & Electrical Systems, Undamped and Damped Harmonic Oscillators: Linear Second Order Non-Homogeneous ODEs with Constant Coefficients: Solution Procedures and the Principle of General Linear Superposition: Complementary Functions & Particular Solutions, the method of Undetermined Coefficients & Variation of Parameters, Applications: Spring-Mass Systems, Damped & Undamped Harmonic Oscillators with Forcing Terms and their ODEs and Solutions; RCL-Circuits and their ODEs and Solutions; The Physics and Mathematics of the Phenomenon of Resonance in Mechanical & Electrical Systems; Cauchy-Euler ODEs and their Solution Procedures.

Partial Differential Equation: Formation of partial differential equations, Solutions of first order linear and special types of second and higher order differential equations, Homogeneous partial differential equations of order one, Lagrange's multiplier.

Advance Calculus & Vector Calculus: Double & triple integral with application (Area, centroid, moment of inertia) vector differentiation & vector integral with applications, Green & Stokes theorem with applications.

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**HS-219            PROFESSIONAL ETHICS****(2+0)**

Introduction to Professional & Engineering Ethics: Definitions - Ethics, Professional Ethics, Engineering Ethics, Business Ethics; Ethics & Professionalism. Need and scope of Engineering and Professional Ethics through case studies; Development of Engineering Ethics & Major issues in Engineering & Professional Ethics; Moral Reasoning & Ethical Frameworks: Ethical Dilemma; Resolving Ethical dilemmas and making Moral Choices; Codes of Ethics (of local and international professional bodies). Moral Theories: Utilitarianism, Rights Ethics and Duty Ethics,

Virtue Ethics Self-Realization & Self Interest; Ethical Problem Solving Techniques: Line drawing, flow Charting, Conflict Problems; case studies and applications; Contemporary Professional Ethics: Professional Responsibilities; Risk and Safety as an Ethical Concern for Engineers, Workplace Responsibilities and Ethics: Teamwork, confidentiality and conflicts of interest, Whistleblowing, Bribe and gift, risk and cost - benefit analyses, gender discrimination and sexual harassment; Environmental Ethics; Computer Ethics & the Internet; Honesty: Truthfulness, trustworthiness, academic and research integrity

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**CS-323            ARTIFICIAL INTELLIGENCE****(3+1)**

Introduction to AI, Computational Intelligence, Searching Methodologies, First-Order-Logic, Evolutionary Computing: Genetic Algorithms, Evolutionary Strategies, Biology-Inspired Models; Knowledge Representation: Semantic Networks, Frames and Scripts; Reasoning with Imperfect Knowledge, Rule-Based Systems: Modeling, Reasoning Strategies, Conflict Resolution and Rule Matching; Artificial Neural Networks; Vague Notions in Knowledge-Based Systems: Models based on Fuzzy Set Theory; Game Theory, Prospects of Artificial Intelligence.

[\(back\)](#)**MT-335            PROBABILITY AND STATISTICS****(3+0)**

Introduction to Statistics: Introduction, Types of Data & Variables, Presentation of Data, Object, Classifications, Tabulation, Frequency Distribution and their types, Graphical Representation, Simple, Multiple and Component bar diagrams, Pie-chart, Histogram, Frequency polygon and Frequency curves.

Measures of Central Tendency and Dispersion: Statistical Averages, Median, Mode, Quartiles, Range, Moments, Skewness & Kurtosis, Quartile Deviation, Mean Deviation, Standard Deviation, Variance & its coefficient.

Probability: Basic concepts, Permutation & Combination, Definitions of Probability, Laws of Probability, Conditional Probability, Bayes' Rule.

Random Variables and Random Processes: Introduction, Discrete & Continuous Random Variables, Random Sequences and Transformations, Probability Distribution, Probability Density Function, Distribution Function, Mathematical Expectations, Moment Generating Function(M.G.F), Introduction to Random Processes and Time Series, Statistical Averages of Random Processes, Stationary, Auto-Correlation of Wide Sense Stationary Random Processes, Time Averaging, Ergodicity, Markov Chain and Queuing Theory.

Probability Distributions: Introduction, Discrete Probability Distributions, Binomial, Poisson, Hypergeometric & Negative Binomial Distributions, Continuous Probability Distribution, Uniform, Exponential & Normal Distributions.

Sampling and Sampling Distributions: Introduction, Population, Parameter & Statistic, Objects of Sampling, Sampling Distribution of Mean, Standard Errors, Sampling & Non-Sampling Errors, Random Sampling with & without Replacement, Sequential Sampling, Central Limit Theorem.

Statistical Inference and Testing of Hypothesis: Introduction, Estimation, Types of Estimation, Confidence Interval, Tests of Hypothesis, Chi-Square Distribution/Test, One and Two Tails Test.

Simple Regression & Correlation: Introduction, Scatter Diagrams, Correlation & its Coefficient, Regression Lines, Rank Correlation & its Coefficient, Probable Error (P.E).

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## Spring Semester

### **CS-301                    MICROPROCESSOR BASED SYSTEM DESIGN                    (3+1)**

Programmer Visible Architecture; Internal Bus Architecture; Pin Functions; Memory Addressing Schemes; Bus Buffering; Bus Cycles; Timing and Sequencing; The Wait State; Clock Generation Circuit; Reset Circuit; Memory Interfacing; Basic I/O Interface; Hardware Single Stepping; Memory Speed Requirements; Programmable Peripheral Interface; Programmable Interval Timer; Hardware Interrupts; Programmable Interrupt Controller; DMA Operations, Microprocessor System Design. Instruction Set Architecture & Addressing Modes; Data Transfer, Arithmetic & Logic; Branch & String Instructions; Program Assembly and Testing; Assembler Directives; Macros; Procedures; Instruction Encoding; Two Pass Assemblers; Software Interrupts

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### **CS-329                    OPERATING SYSTEMS                    (3+1)**

Operating system - objectives and functions; Kernel types and functionality; Processes - state, description, and control; Threads; Operating system design issues; Concurrency - principles; mutual exclusion (hardware support, operating system support); deadlock; Scheduling algorithms; Memory management; secondary storage management; file management - organization and access; I/O management; disk scheduling; Operating system support for multicore architectures

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### **MT-442                    NUMERICAL METHODS                    (3+0)**

Error Analysis: Types of errors (relative, Absolute, inherent, round off, truncation), significant digits and numerical instability, flow chart. Use any Computational tools to Analysis the Numerical Solutions. Solution of Non-linear Equations: Numerical methods for finding the roots of transcendental and polynomial equations (Secant, Newton - Raphson Chebyshev and Graeffe's root squaring methods), rate of convergence and stability of an iterative method. Solution of Linear Equations: Numerical methods for finding the solutions of system of linear equations (Gauss- Elimination, Gauss-Jordan Elimination, triangularization, Cholesky, Jacobi and Gauss - Seidel). Numerical Integration & Differentiation: Computation of integrals using simple Trapezoidal rule, Simpson's rule, Simpson's rule, Composite Simpson's and Trapezoidal rules, computation of solutions of differential equations using( Euler method, Euler modified method, Runge Kutta method of order 4), Numerical Solutions of Partial differential Equations, Optimization problem (Simplex Method), Steepest Ascent and Steepest Descent Methods. Interpolation & Curve Fitting: Lagrange's, Newton, Hermit, Spline, least squares approximation, (Linear and non-linear curves). Linear Operators: Functions of operators, difference operators and the derivative operators, identities. Difference Equations: Linear homogeneous and non- homogeneous difference equations.

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**EF 305                      ENGINEERING ECONOMICS & MANAGEMENT****(3+0)**

Introduction: Basic Concepts and principles of Economics, Micro- and Macro-economic theory, the problem of scarcity. Basic concepts of Engineering Economy, Financial effectiveness and non-monetary factors, Economic Environment: Consumers and producer goods, Goods and services, Demand & Supply concept. Market Equilibrium, Elasticity of demand, Elasticity of Supply, Measures of Economics worth, Pricesupply-demand-relationship, Revenue, Cost and profit function. Elementary Financial Analysis: Basic accounting equation. Development and interpretation of financial statements-Income Statement, Balance Sheet and Cash Flow, Working capital management, Financial Ratio Analysis. Time Value of Money and Financial Returns: Concepts of simple, compound and effective interest rates, less often than compounding period and more once a year; Present Value, Future Value and Annuities concepts, Uniform gradient and geometric sequence of cash flow; Depreciation and Taxes: Depreciation concept, Economic life, Methods of depreciation, Gain (loss) on the disposal of an asset, Depreciation as a tax shield. Basic cost concepts and Break Even Analysis: Types of costs and cost curves; Determination of Cost/Revenues; Numerical and graphical presentations; Practical applications, BEA as a management tools for achieving financial/operational efficiency Linear Programming: Mathematical statement of linear programming problems, Graphical solutions, Simplex method, Duality Problems. Business Organizations and financial Institutions: Type of ownership, single ownership, partnerships, corporation, type of stocks and joint stock companies, Banking and specialized credit institutions. Project Management: Integration of Organization Strategy with Projects, Defining the project, developing a network plan, managing risk, reducing project time, project selection and comparing alternatives techniques scheduling resources: Introduction to Projection Management and Production Concepts: Basic production function, stages of production, returns to scales, Production lead time, Production rate, capacity, operations, planning and control, order processing, Scheduling, Material requisitions planning, line of balance

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Elements of Modern Digital Communications: Channels, Fundamentals Limitations, Electromagnetic spectrum Signal Analysis: Classification, representation of signals, Baseband systems, filtering, random signal analysis, Analog communication systems: Pulse code modulation, time division multiplexing, Satellite communication, Digital communication: Baseband digital transmission, Digital modulation techniques; Digital encoding; Broadband communication; Error-control and Coding: Error correction and detection techniques, Hamming code, Linear Block Encoding, Information Theory: Entropy, Discrete channels;

[\(back\)](#)**CS-324                      MACHINE LEARNING**

The Learning Problem: Components of Learning, Types of Learning; Learning Feasibility, Linear Models: Linear Classification and Regression, Logistic Regression, Non-Linear Transformation; Error and Noise: Error Measures

and Noisy Targets; Training vs. Testing, Theory of Generalization, The VC(Vapnik–Chervonenkis) Dimension: Definition, VC Dimension of Perceptrons, Interpreting VC Dimension, Generalization Bounds; Bias-Variance Tradeoff, Neural Networks: Stochastic Gradient Descent, Backpropagation Algorithm; Overfitting, Regularization, Validation: Model Selection and Cross Validation; Support Vector Machines, Kernel Methods; Introduction to Deep Learning.

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### **CS-325 SOFTWARE DEVELOPMENT & TESTING**

Advanced software process models: formal methods, unified process model; Agile software development: extreme programming, agile process models, scaling agile methods; Embedded software development: embedded systems design, architectural patterns, timing analysis; Software review techniques: defect amplification and removal, review metrics, formal and informal reviews; Software Quality Assurance: SQA elements, tasks, goals and metrics; Statistical SQA; Software Reliability; Testing for conventional applications: white-box testing, black-box testing, model-based testing; Testing for object-oriented applications: Object oriented testing strategies and methods, testing methods applicable at class-level.

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**CS-434      BIOINFORMATICS**

Motivation, A Brief History of Bioinformatics, The Biological Foundations of Bioinformatics: The Storage of Genetic Information, Understanding of DNA, RNA & Proteins; Biological Databases: Primary Databases, Nucleotide Sequence Databases, Protein Sequence Databases, Secondary Databases Genotype-Phenotype Databases; Sequence Comparison: Pairwise & Multiple Sequence Comparisons, Algorithms for Database Searching; Probabilistic Models: Bayesian Model, E-Value and Null Model; The Functional Analysis of Genomes.

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**CS-435      SOFTWARE PROJECT MANAGEMENT**

Introductory concepts; Project planning: pricing, planning process and project scheduling; Risk management process; Managing people; Teamwork; Agile planning; Monitoring and control; Estimation techniques: decomposition techniques, empirical estimation models; Software process improvement: the Capability Maturity Model Integration; Software configuration management: change and version management.

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issues.

Foundations of Organizational Structure: Organizational structure and design; work design; work stress, Organizational culture: definition; culture's functions, employees and organizational culture, Organization change and development: forces for change; managing planned change, resistance to change; approaches to managing organizational change.

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**CS-4XX**

**ELECTIVE-3**

**(2+1)**

**CS-426**

**COMPUTER SYSTEMS SECURITY**

Cryptographic foundations; Access Control Lists (ACLs); Operating System Security - Principles; Computer systems' structure and its impact on security; Principles and practices for secure system design; Security models: Properties, information flow, non-interference, separation of duties; Software vulnerabilities: Memory corruption (stack-smashing, heap overflows, integer overflows), Input validation errors, Race conditions; Web server and Browser vulnerabilities; Malware and Untrusted software: Viruses and worms, Rootkits, Botnets, Obfuscation and evasion; Defenses for software threats: Static analysis for vulnerability detection, Code transformation for runtime policy checking, Runtime policy enforcement and sandboxing, Isolation and information-flow control; Virtual machines; Network-layer threats: network probing, scanning, Defenses - intrusion detection, Side-channel attacks - covert channels, timing attacks, power analysis, emanations, remanence and reuse; Human and social engineering - Digital rights management

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**CS-436**

**COMPUTER VISION**

Fundamentals of Computer Vision: Nature of Images, Homogeneous Transformations, Image Acquisition, Geometrical and Optical Image Formation, Human Encoding of Color, Color Spaces, Perspective Projection, Camera Technologies and Vision Systems Design; Basics of Image Processing: Filtering, Edge Detection, Features Detection, Contours, Segmentation, Morphological Operators; Motion: Detection, Optical Flow, Object Tracking, Motion Capture; Recognition: Large-Scale Instance Recognition and Retrieval, Category Recognition and Advanced Feature Encoding, Applications: OCRs, Facial Recognition, Quality Control, Visual Feedback, Mapping and Robot Guidance, Activity Monitoring, Motion Estimation, Autonomous Systems, Biomedical Imaging.

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**CS-437**

**PARALLEL PROGRAMMING**

Introduction of Parallel Programming; consideration of Parallel Programming; Classical applications; Models for Parallel Systems; Parallelization of Programs; Levels of Parallelism; Parallel Programming Patterns; Data Distributions; Parameterized Data Distribution; Information Exchange; Shared Variables; Communication Operations, concurrency and mutual exclusion; Parallel Algorithm design; parallel sorting and search; parallel matrix multiplication; parallel I/O; Performance Analysis of Parallel Programs; Benchmark; Performance

Metrics for Parallel Programs; Asymptotic Times for Global Communication; Message-Passing Programming; Interconnecting Topologies; Introduction to MPI; Collective Communication Operations; Process Groups and Communicators; Thread Programming; Creating and Merging Threads, Thread synchronization; thread scheduling; priority inversion; Introduction to Pthreads, Java Threads, OpenMP and CUDA; Introduction to Parallel Software Engineering and basic Patterns for Parallel Software Design.

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**CS-406**

**COMPUTER ENGINEERING PROJECT**

**(0+6)**

The final year students will be required to consult the Chairman of Computer Systems Engineering Department regarding the offering of various projects in the department. The student or group of students will be assigned the project by teacher concerned and will carry out the assignment as required and directed by the teacher. At the end of the academic session, they will submit the written report on work of their project to the chairman, preferably in the typed form. The students will be required to appear before a panel of examiners for oral examination.

By doing project the student will demonstrate the application of the knowledge gained during his/her stay in the university. He/she may also work on a project which may help him/her to learn more in some specific area related to Computer Engineering.

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