DEPARTMENT OF TELECOMMUNICATIONS ENGINEERING

REVISED SYLLABI OF COURSES
FOR
BE (TELECOMMUNICATION ENGINEERING)
DEGREE PROGRAMME
APPLICABLE FORM BATCH 2025 & ONWARDS

NED UNIVERSITY OF ENGINEERING & TECHNOLOGY
KARACHI-75270, PAKISTAN

B.E (TELECOMMUNICATION ENGINEERING)
COURSES OF STUDIES
Applicable from Batch 2025

FIRST YEAR

Fall Semester

Course Code	Course Title	Credit Hours		
		Th	Pr	Total
ES-105/ ES-127	Pakistan Studies / Pakistan Studies (for Foreigners)	2	0	2
EA-128	Functional English	3	0	3
EF-101	IT Fundamentals and Applications	2	1	3
MT-116	Calculus & Analytical Geometry	3	0	3
EE-125	Basic Electrical Engineering	3	1	4
ES-206/ ES 209	Islamic Studies / Ethical Behavour (for non-muslims)	2	0	2
	Total	**15**	**2**	**17**

Spring Semester

Course Code	Course Title	Credit Hours		
		Th	Pr	Total
EL-106	Basic Electronics	3	0	3
CY-110	Applied Chemistry for Engineers	2	0	2
EE-121	Circuit Analysis	3	0	3
EL-104	Electronic Engineering Drawing and Workshop	3	1	4
MT-227	Differential Equations	0	2	2
	Total	**14**	**4**	**18**

SECOND YEAR

Fall Semester

Course Code	Course Title	Credit Hours		
		Th	Pr	Total
EE-127	Circuit Analysis	2	0	2
TC-205	Digital Logic Design	3	0	3
TC-206	Signals and Systems	3	1	4
EL-201	Electronic Devices & Circuits	3	1	4
CS-216	Data Structure and Algorithms	3	0	3
EE-127	Circuit Analysis	2	0	2
	Total	**15**	**3**	**18**

Spring Semester

Course Code	Course Title	Credit Hours		
		Th	Pr	Total
EA-244	Academic Reading and Writing	3	0	3
EE-382	Electromagnetic Fields	2	0	2
EF-201	Civics and Community Engagement	2	0	2
TC-212	Digital Signal Processing	2	1	3
EE-223	Instrumentation and Measurement	2	1	3
MT-331	Probability & Statistics	3	0	3
MG-257	Organizational Behaviour	2	0	2
	Total	**16**	**2**	**18**

THIRD YEAR										
Fall Semester						**Spring Semester**				
Course Code	**Course Title**	**Credit Hours**				**Course Code**	**Course Title**	**Credit Hours**		
		Th	**Pr**	**Total**				**Th**	**Pr**	**Total**
TC-307	Communication Systems	3	1	4		TC-314	Telecommunication Network	3	1	4
TC-318	Microwave Engineering	3	0	3		EF-309	Occupational Safety & Health	1	0	1
EE-375	Feedback Control Systems	3	1	4		TC-311	Wireless & Mobile Communication	3	1	4
TC-317	Artificial Intelligence and Machine Learning	2	1	3		TC-319	Optical Fiber Communication	2	1	3
TC-320	Optical Communication	3	1	4		EF-305	Engineering Economics & Management	3	0	3
						EA/ES-###	Foreign Language-1	NC		
	Total	**14**	**4**	**18**			**Total**	**12**	**3**	**15**

FINAL YEAR										
Fall Semester						**Spring Semester**				
Course Code	**Course Title**	**Credit Hours**				**Course Code**	**Course Title**	**Credit Hours**		
		Th	**Pr**	**Total**				**Th**	**Pr**	**Total**
MT-442	Numerical Methods	3	0	3		MG-485	Entrepreneurship	2	0	2
CS-430	Microprocessor programming and interfacing	3	1	4		TC-431	Wireless Technologies and RF Planning	2	0	2
TC-XXX	Elective 1	2	0	2		TC-434	Telecommunications Switching Systems	2	1	3
TC-421	Telecommunication Networks	3	1	4		TC-435	Communication Security	2	1	3
TC-490	Telecommunications Engineering Project*	0	3	3		TC-###	Elective 2	2	0	2
EA/ES-###	Foreign Language-II	NC				TC-490	Telecommunications Engineering Project*	0	3	3
	Total	**11**	**5**	**16**			**Total**	**10**	**5**	**15**

Elective 1 course		**Th**	**Pr**	**Total**	**Elective 2 courses**		**Th**	**Pr**	**Total**
TC-429	Telecom Policies & Standards	2	0	2	TC-422	Satellite Communication	2	0	2
TC-430	Multimedia Communication Systems	2	0	2	TC-423	Navigational Aids and Radar Systems	2	0	2
TC-433	Internet of Things	2	0	2	TC-427	Digital Image Processing	2	0	2

* Duration one academic year: Requires literature survey and preliminary work during this semester

FIRST YEAR (FALL SEMESTER)

ES-105 Pakistan Studies

Historical and Ideological Perspective of Pakistan Movement: Two Nation Theory, Factors leading to the creation of Pakistan, Jinnah and demand for Pakistan.

Land of Pakistan: Geophysical conditions of Pakistan, Geopolitical and strategic importance of Pakistan, Natural resources of Pakistan: mineral, water and power resources.

Constitutional process: Early efforts to make a constitution (1947-1956), Salient features of the Constitution of 1956, 1962, Political and Constitutional crisis of 1971, Salient features of the Constitution of 1973, Constitutional amendments from 1973 to date.

Contemporary issues of Pakistan: A brief Survey of Pakistan's economy, The Current Economic Situation of Pakistan: Problems & Issues and future perspective, Social Issues: Pakistan's society and culture: broad features, Literacy and education in Pakistan: problems and issues, Scientific and technical development in Pakistan, Citizenship: national and international. Environmental Issues: Environmental pollution: causes, hazards and solutions, National policy, International treaties, conventions and protocols.

Pakistan's Foreign Policy: Pakistan's Foreign Policy from 1947 to present, Relations with immediate neighbors, Relations with major powers, Relations with the Muslim world.

Human Rights Conceptual foundations, Western and Islamic perspective of Human Rights, Human Rights in the Constitution of 1973, Human rights issues in Pakistan.

ES 127 Pakistan Studies For Foreigners

Land of Pakistan:
Land & People-Strategic importance- Important beautiful sights, Natural resources.

A Brief Historical Background:
A brief Historical survey of Muslim community in the sub-continent, British rule & its impacts, Indian reaction, Two nation theory, Origin & development, Factors leading towards the demand of a separate Muslim state, Creation of Pakistan.

Government & Politics in Pakistan:
Constitution of Pakistan, A brief outline, Governmental structure, Federal & Provincial, Local Government Institutions, Political History, A brief account.

Pakistan & the Muslim World: Relations with the Muslim countries.

Language and Culture: Origins of Urdu Language, Influence of Arabic & Persian on Urdu Language & Literature, A short history of Urdu literature.

EA-128 Functional English

Listening skills and subskills: Effective listening techniques: listening for gist, details, and specific information in a range of situations (AV lectures, interviews, documentaries etc).

Speaking skills: Speaking with fluency and accuracy in a variety of situations including conversations, group discussion, academic and social interaction, public speaking, presentation skills, and interviews; Pronunciation improvement exercises (through websites, apps, and in class worksheets).

Reading and subskills: Reading strategies: Skimming, scanning, and detailed reading, identifying main ideas, supporting details, and inferences (multiple genres including newspapers, books, stories, documentaries etc). Reading Practice: Reading comprehension tasks. Reading output tasks (notes, summary, discussion, counter argument etc).

Study skills: Effective note-taking strategies for lectures, meetings, and reading texts. Taking in varied forms paragraph, lists, infographics etc.); Interpreting instructions oral and written. Effective examination taking technique (comprehending instructions, planning, and writing answers ensuring relevance and precise.

Writing skills: Writing process, Pre-writing strategies (Mind mapping, cubing, outlining, clustering etc.); Writing to describe, argue, compare and contrast, persuade through writing prompts; Writing academic and professional genres: emails, letters, short report, resume, cover letter, building profiles on various job portal; Writing accuracy: Identifying and overcoming grammatical problems.

Vocabulary and grammar development: Vocabulary Development strategies. Exposure and practice to develop every day and academic vocabulary and basic grammatical structures applied in the formal contexts.

EF-101 IT Fundamentals and Applications

Fundamentals of IT: Introduction to Information and Communication Technologies (ICT), Components and scope of ICT, ICT productivity tools, Emerging technologies and future trends, Ethical Considerations in Use of ICT Platforms and Tools, Applications of ICT in education, healthcare and finance. Digital citizenship.

Data Representation and Number Systems: Binary, octal, decimal, hexadecimal systems, data representation: characters, numbers, multimedia.

Databases: Fundamentals of databases, organization and storage, introduction to Information Systems (IS) and Management Information Systems (MIS), real world IS and MIS applications.

Data Communication and Computer Networking: Network topologies, types of network

Programming Languages: Evolution and structures: syntax, semantics, special purpose vs. general-purpose languages, comparative study of data types, control structures and algorithms, basics of coding, practical problem solving.

MT-116 Calculus & Analytical Geometry

Set and Functions: Define rational, irrational and real numbers; rounding off a numerical value to specified value to specified number of decimal places or significant figures; solving quadratic, and rational inequalities in involving modulus with graphical representation; Definition of set, set operations, Venn diagrams, De Morgan's laws, Cartesian product, Relation, Function and their types (Absolute value, greatest integer and combining functions). Graph of some well-known functions. Limit of functions and continuous and discontinuous functions with graphical representation.

Differential Calculus: Differentiation and Successive differentiation and its application: Leibnitz theorem. Taylor and Maclaurin theorems with remainders in Cauchy and Lagrange form, power series. Taylor and Maclaurin series, L' Hopitals rule, extreme values of a function of one variable using first and second derivative test, asymptotes of a function, curvature and radius of curvature of a curve, partial differentiation, extreme values of a function of two variables with and without constraints. Solution of non-linear equation, using Newton Raphson method.

Integral Calculus: Indefinite integrals and their computational techniques, reduction formulae, definite integrals and their convergence. Beta and Gamma functions and their identities, applications of integration relevant to the field.

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

Analytical Geometry: Review of vectors, scalars and vector products, Three-dimensional coordinate system and equation of straight line and plane and sphere, curve tracing of a function of two and three variables, surface

revolutions, coordinate transformation.

Complex Number: Argand diagram, De Moivre formula, root of polynomial equations, curve and regions in the complex plane, standard functions and their inverses (exponential, circular and Hyperbolic functions).

EE-125 Basic Electrical Engineering

Fundamentals of Electric Circuits: Charge, Current, Voltage and Power, Voltage and Current Sources, Ohm's Law. Equivalent resistance of a circuit.

Voltage and Current laws: Node, Loop and Branches, Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), single-loop circuits, single Node Pair Circuit, Series and Parallel Connected Independent Sources.

Circuit Analysis Techniques: Nodal Analysis, Mesh Analysis, Linearity and Superposition, Source Transformations, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer theorem.

Capacitors and Inductors: Capacitor, Inductor, Inductance and Capacitance Combination, voltage current relationship for inductor and capacitor. Energy storage.

Introduction to AC Circuits: Sinusoids and Phasors, Phasor Relationships for Circuit Elements, Impedance and Admittance, Kirchhoff's Laws in the Frequency Domain, Impedance Combinations, Instantaneous and Average Power, Maximum Average Power Transfer, Effective or RMS Value, Apparent Power and Power Factor, Complex Power, Conservation of AC Power.

Sinusoidal Steady-State Analysis: Nodal Analysis, Mesh Analysis, Superposition Theorem, Source Transformation, Thevenin and Norton Equivalent Circuits.

ES-206 Islamic Studies

Fundamentals of Islam: Tauheed, Arguments for the Oneness of God; **Al-Ambiya-22, Al-Baqarah-163-164**, Impact of Tauheed on human life, Place of Man in the Universe: **Al Israa/Bani Israil-70**; Purpose of creation: **Al zariyat-56**, Prophethood, Need for Prophet, Characteristics of Prophet, Finality of Prophethood: **Al-Imran-79, Al-Hashr-7, Al-Maidah-3**, and Faith in Hereafter (Aakhirat), Effects on worldly life: **Al-Hajj-5, Al-Baqarah-48, Hadith.**

Ibadah: Concept of Ibadah, Major Ibadah, Salat, Zakat, Hajj and Jihad**. Al-Mu'minun-1-11, Al Anfaal- 60, & Two Ahadiths.**

Basic Sources of Shariah: The Holy Quran, Its revelation and compilation, the authenticity of the Text, Hadith, Its need, Authenticity and Importance, Consensus (Ijmaa), Analogy (Qiyas).

Moral and Social Philosophy of Islam: The concept of Good and Evil; **A'l e Imran - 110, Al Nahl-125,** Akhlaq-e-Hasna with special reference to **Surah Al-Hujrat, verses 10, 11, 12, 13,** Professional Ethics (Kasb-e-Halal), **Al Taha-81, Al Baqar 188, one hadith.**

Seerat of the Holy Prophet (PBUH):
a) Moral and ethical teachings of the Holy Prophet (PBUH) with special reference to Hajjat-ul-Wida, (Fundamentals of Islam, Social aspects, Economics aspects, political aspects
b) Personal Characteristics: perseverance & trust in Allah, honesty & integrity, simplicity & humility, mercy & compassion, clemency & forgiveness, bravery & valor, generosity, patience.
c) Engagement and communication with collaborators and foes: Cases Study from Seerah: Charter of Madina, Ghazwa e Khandaq, Treaty of Hudaibya , Ghazwa e Khayber, Najran's Delegation, Victory of Makkah.
d) Social values and rights: Peace & harmony, tolerance, solidarity, collaborations, inclusivity & cohesion.

Case Studies from Seerah: Al –Fudoul Confederacy, Placement of Black stone, charter of Medina, Treaty of Hudaibya).

Leadership skills: Vision, communication, negotiation, conflict management, decision making, relationship building, Integrity, positivity, compassion, empathy, loyalty, accountability, confidence, delegation, empowerment, problem- solving, foresightedness, openness, gratitude and justice.

Teaching of Holy Quran: Translation and tafseer of Surah-e- Fatiha, and The Selected Section of **Sura Al-Furqan verses (63-77), Surah-e-Luqman verses (12-19).**

Nazraah and Tajveed of: Suratul Fatiha, Ayatal Kursi, and last 10 surahs of the Holy Quran. (Ghunnah, Qalqalah, Al-Madd, Noon Sakinah & Tanween Rules).

ES-209 Ethical Behaviour

Nature, Scope and Methods of Ethics: Ethics and Religion, Ethical teachings of World Religions.

Basic Moral Concepts: Right and Wrong, Good and Evil.

Ethical Systems in Philosophy: Hedonism, Utilitarianism, Rationalism & Kant, Self-Realization Theories, Intuitionism.

Islamic Moral Theory: Ethics of Qur'an and its Philosophical basis, Ethical precepts from Qur'an and Hadith and Promotion of Moral Values in Society.

FIRST YEAR (SPRING SEMESTER)

PH-129 Applied Physics

Vectors & Mechanics: Review of vectors, Newton Laws and their Applications, Frictional Forces and determination of Co-efficient of Friction, Work-Energy Theorem, applications of law of Conservation of Energy, Angular Momentum, Centre of Mass.

Waves and Oscillations: Simple Harmonic Oscillator, Damped Harmonic Oscillation, Forced Oscillation and Resonance, Types of Waves and Superposition Principle.

Optics and Lasers: Huygens Principle, Two-slit interference, Single-Slit Diffraction, Types of Lasers, Applications of Laser.

Modern Physics: Planck's explanations of Black Body Radiation Photoelectric Effect, De-Broglie Hypothesis, Electron Microscope, Atomic structure, X-rays, Radioactive Decay and Radioactive Dating, Radiation Detection Instruments.

Electrostatics and Magnetism: Electric field due to different Charge Distribution, Electrostatic Potential Applications of Gauss's Law, Lorentz Force Ampere's Law, Magnetism, Magnetization, Magnetic Materials.

Electrical Elements and Circuits: Review of electric current, voltage, power, and energy, Ohm's law, inductance, capacitance, Basic Electrical circuits, Electromechanical systems.

Semiconductor Physics and Electronics: Energy levels in a Semiconductor, Hole concept, P-N junction, Diodes, Transistors, Basic Electronic circuits (e.g. rectifier)

Thermodynamics: Review of Laws of Thermodynamics, conduction, convection, and radiation. Thermal conductivity, specific heat, and overall heat transfer coefficients. Heating, Ventilation and Air Conditioning (HVAC).

ES-108 Ideology and Constitution of Pakistan

Two-Nation Theory: Nation and Nationalism in British India. Inclusive nationalism, Exclusive nationalism, Freedom movement in British India, Two-Nation Theory.

Ideology: definition and its significance: Difference between Philosophy, Ideology, and Theory. Evolution of Islamic ideology in British India. Pakistan movement: role of ideology. Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949).

Introduction to the Constitution of Pakistan: Definition and importance of a constitution. First Constituent Assembly of Pakistan. Main issues that delayed the Constitution-making in Pakistan. Dissolution of the Constituent Assembly. Second Constituent Assembly of Pakistan. Third Constituent Assembly of Pakistan.

Constitution and State Structure: Federal form of State. Parliamentary form of government. Structure of Government (executive, legislature, and judiciary). Distribution of powers between federal and provincial governments.

Fundamental Rights, Principles of Policy, and Responsibilities: Duty of the citizens of Pakistan (Article 5). Overview of fundamental rights to citizens of Pakistan guaranteed by the Constitution 1973 (Articles 8-28). Overview of Principles of Policy (Articles 29-40).

Constitutional Amendments: Procedures for amending the Constitution. Notable constitutional amendments and their implications: 8^{th}, 13^{th}, $17^{th,}$, and 18^{th} **.**

MT-221 Linear Algebra & Ordinary Differential Equations

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 in relevant engineering problem.

1st Order Differential Equations: Basic concept: Formation of differential equations and solution of differential equations by direct integration and by separating the variables: Homogeneous equations and equations reducible to homogeneous from; Linear differential equations of the order and equations reducible to the linear form; Bernoulli's equations and orthogonal trajectories: Application in relevant Engineering.

2nd and Higher Orders Equations: Special types of IInd order differential equations with constant coefficients and their solutions: The operator D; Inverse operator I/D; Solution of differential by operator D methods; Special cases, Cauchy's differential equations; Simultaneous differential equations; simple application of differential equations in relevant Engineering.

Partial Differential Equation: Basic concepts and formation of partial differential equations: Linear homogeneous partial differential equations and relations to ordinary differential equations: Solution of first order linear and special types of second and higher order differential equations; D' Alembert's solution of the wave equation and two dimensional wave equations: Lagrange's solution; Various standard forms.

Fourier Series: Periodic functions and expansion of periodic functions in Fourier series and Fourier coefficients: Expansion of function with arbitrary periods. Odd and even functions and their Fourier series; Half range expansions of Fourier series.

EL-106 Basic Electronics

PN Junction Diode: Introduction. PN junction diode, Unbiased diode, Barrier potential, Diffusion & drift current, Forward & reverse bias, Minority carrier current. Diode characteristics, Load line, Diode current equation.
Diode applications: Rectifier switch, Wave-shaping, Voltage multiplier. 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. MOSFET amplifier configurations Common Source, common drain and common gate with passive loads. Determining voltage gain, input and output resistance for each configuration

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.

EL-104 Electronic Engineering Drawing and Workshop

PCB Design & Workshop: PCB design and layout drawings using PCB software, From Schematic & Layout to Machine File generation. PCB technologies, single layers and multi-layer boards, PCB testing, Switches, PCB standards, Routing. Fabricating PCB, Assembling & soldering components on PCB, PCB Processes; CNC Drilling, Electroplating, Photo-plotting, Laminating, Developing and Exposing.

Electronic Workshop: Introduction to Operations of Voltmeters, Ohmmeters, Power supplies, Function generators & Oscilloscopes. Measuring parametric values of discrete passive components. Fabricating simple electronic circuits on breadboard. Simulate an electronic circuits using pspice/ multisim/ Simulink.

TC-108 Computer Programming

Introduction to Programming Languages: Overview of programing, writing, compiling and debugging, data types, variables, Input/output functions.

Building Blocks: data types, variables, Input/output functions.

Operators: Arithmetic, Relational, logical and Assignment Operators.

Decisions: if-else statements, conditional Statements, Switch, break, continue.

Loops: for Loop, while loop, do while loop.

Modular programming: declaring, definition, calling functions.

Arrays and strings: single and multidimensional arrays, sorting, strings and string functions.

Pointers: Pointer overview, Returning data from functions, Pointers and arrays, Pointers and strings, Pointers to pointers.

Structures: defining, structures with arrays, Dynamic memory allocation.

Object Oriented Programming: Object oriented programming, Some useful C++ features, Classes and objects, Constructors and memory allocations, Encapsulation, Inheritance, Polymorphism, Abstraction, Inheritance, Function overloading, Operator overloading, Practical design through object-oriented programming. Ethical use of generative AI in programming.

SECOND YEAR (FALL SEMESTER)

EE-127 Circuit Analysis

Introduction to Circuit Analysis: Definition of circuit, analysis, modeling significance of circuit analysis for engineers.

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 overdamped 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.

AC Power Analysis: Instantaneous and Average Power, Maximum Average Power Transfer, Effective or RMS Value, Apparent Power and Power Factor, Complex Power, Conservation of AC Power, Power Factor Correction.

Three-Phase Circuits: Balanced Three-Phase Voltages, Balanced Wye-Wye Connection, Balanced Wye-Delta Connection, Balanced Delta-Delta Connection, Balanced Delta-Wye Connection, Power in Balanced System, Unbalanced Three-Phase Systems.

Magnetically Coupled Circuits: Mutual Inductance, Energy in a Coupled Circuit, Linear Transformers, Ideal Transformers, Ideal Autotransformers, Three-Phase Transformers.

Two-Port Network: Impedance Parameters, Admittance Parameters, Hybrid Parameters, Transmission Parameters, Relationship between Parameters, Interconnection of networks.

Measurement of Electrical Quantities: Basics of electromechanical instruments, Active and Reactive power measurement, Max. Demand indicator, Induction type KWH meter, p.f meter. Measurement of resistance, measurement of Inductance and capacitance. Measurement of dielectric strength of insulators, high voltage surges. Electronic and digital voltmeters, digital frequency meter, time interval measurement.

TC-205 Digital Logic Design

Combinational Logic Design: Logic gates, Boolean Equation, Boolean Algebra, Multilevel Combinational Logic, Karnaugh Maps, Combinational Building Blocks (Multiplexers and Decoders), NAND and NOR based combinational circuits, and Multiplexer based combinational circuit.

Sequential Logic Design: Latches, Flip Flops, Registers, Counters, Finite state machines, Pipelining, Timing issues of sequential logic.

Programmable Logic Devices (PLDs): Introduction to PLDs, Structure of complex PLDs, Structure of FPGA.

Hardware Description Language (HDL): Introduction to HDL coding, HDL coding of Combinational logic, HDL coding of Sequential Logic, HDL coding of Finite state machine, and basic of Test benches.

Computer Architecture: RISC and CISC architecture, Addressing modes, Cache, Machine/assembly instruction, Micro architecture.

TC-206 Signals and Systems

Signals and Systems: Continuous time and discrete time signals, periodic signals, even and odd signals, exponential and sinusoidal signals, the unit impulse and unit step functions, Continuous time and discrete time systems, system properties, causality, BIBO stability, time invariance, linearity.

Linear Time Invariant (LTI) systems: Continuous time LTI system, Convolution Integral, Discrete time LTI system, Convolution Sum, properties of LTI systems, causal LTI systems, difference equation, time domain analysis of LTI Systems.

Fourier Series: Continuous time Fourier series, Properties of Continuous time Fourier series, Parseval's Theorem, Discrete Time Fourier Series, Properties of Discrete time Fourier series.

Fourier Transform: Continuous time Fourier Transform, Properties of Continuous time Fourier Transform, Discrete Time Fourier Transform, Properties of Discrete Time Fourier Transform, Parseval's and Duality Theorem.

Laplace Transform: Laplace Transform, inverse Laplace Transform, Properties of Laplace Transform, region of convergence, pole-zero plot, Stability, Frequency Analysis of Continuous time LTI System.

z-Transform: z-Transform, inverse z-Transform, properties of z- Transform, region of convergence, pole-zero plot, System Stability, Frequency Analysis of Discrete-time LTI System.

EL-201 Electronic Devices and Circuits

Differential Amplifier: MOS differential pair operation with differential and common mode input voltage, large signal analysis, small signal analysis, differential and common mode gain calculations, non-ideal characteristics of differential pairs. Common Mode Rejection Ratio

Current Sources: Simple MOS current sources and mirrors, MOS based current steering circuits. Cascode current source design, Active Loading and Multistage amplifiers, Active loaded MOS differential pair, differential and common mode gains of actively loaded MOS differential pair, Useful cascades of single stage MOS amplifiers like CS-CS, CS-CG (Cascode amplifier) etc.

Introduction to BJT: Construction, configuration and biasing.

Output Stages: Introduction to classes of power amplifier (A, B, C, AB etc.)

Frequency Response: Introduction, High frequency small-signal model of MOSFET, Miller's Theorem, Analysis of Common-Source, Common-Gate, Common-Drain.

Feedback and stability: Negative feedback circuits, Birkhausen Criterion, phase margin and gain margin Oscillators Ring Oscillator, LC oscillator.

CS-216 Data Structure and Algorithms

Basic Concepts: Introduction and classification of Data Structures; Basic operations.

Classification of Algorithms: Classification by implementation; Classification by design paradigm.

Basics of Complexity Analysis: Rate of Growth of Complexity of Algorithms; Asymptotic notations; Time Space Trade Offs.

String Processing: Operations on strings; Word Processing; Pattern Matching Algorithms.

Arrays: One dimensional Arrays: Searching and Sorting Algorithms; Multidimensional Arrays: Matrix Multiplication, Sparse Matrices.
Stacks,

Queues and Recursion: Basic concepts and functions; Polish Notation; Quicksort; Deques; Priority Queues; Factorial Calculation; Fibonacci Series; Ackermann Function, Towers of Hanoi.

Linked Lists: Definition and Representation; Traversal and Searching; Insertion; Deletion; Circular Lists; Doubly Linked Lists.

Trees Terminology: Representation in memory; Binary Trees: Traversal Algorithms; Binary Search Trees, Heaps; Heapsort algorithm. Graphs Terminology; Representation in memory;

Traversal Algorithms: Shortest Path Algorithms. Sorting and Searching, Sorting Algorithms; Hashing

SECOND YEAR (SPRING SEMESTER)

EA-244 Academic Reading and Writing

Introduction to Academic Literacy: Academic reading, writing, and expectations. (Academic v/s non-academic texts); Finding, evaluating, and presenting credible academic sources.; Critical Reading: Identifying main ideas, annotating texts, and analyzing arguments; Academic Texts: Structure of research proposals, Arguments & Evidence Writing Logical

reasoning, integrating evidence, and avoiding fallacies, journal articles, literature review, lab report, policy brief, case study etc.; Academic Writing- Tone, voice, formal vs. informal writing, and structured paragraphs; Academic Vocabulary Development: Discipline-Specific Academic Vocabulary

Academic Writing Process: Outlining, organizing, and refining essay plans; Writing Introductions: Engaging openings, summarizing key points, and implications; Synthesizing Research: Connecting multiple sources and writing literature and critical reviews; Drafting & Revising: Overcoming writer's block, refining drafts, and incorporating feedback; Editing & Proofreading: Improving clarity, grammar, style, and structure. Add attention to technical formatting (e.g., equations, symbols, figures in STEM fields); Citation & Referencing: Using APA or IEEE styles and integrating sources.

Interpreting Visuals: Charts, graphs and tables Drawing logical conclusions from information contained in graphs, diagrams, pie charts and tables with specific reference to the relevant disciplines and their requirements.

EE-382 Electromagnetic Fields

Vector Analysis:
scalars and vectors, vector algebra, the Cartesian coordinate system, vector components and Unit vectors, the vector field, the dot product the cross product, other coordinate systems, circular cylindrical coordinates, the spherical coordinate system, transformations between coordinate systems.

Coulomb's Law and Electric Field Intensity:
The experimental law of coulomb, Electric field intensity, field of a point charge, field due to a continuous volume charge distribution, field of line charge, field of sheet charge, streamlines & sketches of fields.

Electric Flux Density Gauss's Law and Divergence:
Electric flux density, Gauss's law, application of Gauss's law, some symmetrical charge distributions, differential volume element, divergence, Maxwell's first equation, electrostatics, the vector operator and the divergence theorem.

Energy and Potential:
Energy expanded in moving a point charge in an electric field, the line integral, definition of potential difference and potential, the potential field of a point charge, the potential field of a system of charges, conservative property, potential gradient, the dipole, Energy density in the electrostatic field.

Conductor Dielectrics and Capacitances: Current and current density continuity of current metallic conductors, conductor properties and bounded conditions, semiconductors, the nature of dielectric materials, capacitance, several capacitance examples, of a two wire lines, current analogies.

The Steady Magnetic Field: Biot Savart's Law, Amperes circuit law, curl, Stoke's theorem, Magnetic flux and magnetic flux density, the scalar and vector magnetic potentials, derivation of steady magnetic field laws.

Magnetic Forces Materials and Inductance: Force on a moving charge, force on a differential current element, force between differential current element, force and torque on a closed circuit, the nature of magnetic materials, Magnetization and permeability, magnetic boundary conditions, the magnetic circuit, potential energy and forces on magnetic materials, inductance and mutual inductance.

Time Varying fields and Maxwell's Equations: Faraday's Law, displacement current, Maxwell's equation in point form, Equation in integral form, the retarded potentials.

EF-201 Civics and Community Engagement

Introduction to Civics and Citizenship: Definition of civics, citizenship and civic engagement, Historical evolution of civics participation, Types of citizenship: active, participatory, digital etc. The relationships between democracy and citizenship.

Civics and Citizenship: Concepts of civics, citizenship and civic engagement, Foundation of modern society and citizenship. Types of citizenship: active, participatory, digital etc.

State, Government and Civil Society: Structure and functions of government in Pakistan, The relationships between democracy and civil society, Right to vote and importance of political participation and representation.

Rights and Responsibilities: Overview of fundamental rights and liberties of citizens under constitution of Pakistan 1973, Civic responsibilities and duties, Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.).

Community Engagement: Concept, nature and characteristics of community, Community development and social cohesion, Approaches to effective community Engagement, case studies of successful community driven initiatives.

Advocacy and Activism: Public discourse and public opinion, role of advocacy in addressing social issues, Social action movements.

Digital Citizenship and Technology: The use of digital platforms for civic engagement, Cyber ethics and responsible use of social media, Digital divides and disparities (access, usage, socioeconomic, geographic etc.) and their impact on citizenship.

Diversity, Inclusion and Social Justice: Understanding diversity in society (ethnic, cultural, economic, political etc.), Youth, women and minorities' engagement in social development, addressing social inequalities and injustice in Pakistan, Promoting inclusive citizenship and equal rights for societal harmony and peaceful co-existence.

TC-212 Digital Signal Processing

Overview of Discrete-time Signals and Systems: Sampling, Aliasing, Quantization, Convolution, Correlation, Properties of Discrete time Signals and Systems;

Discrete Fourier Transform: Frequency Domain Sampling, DFT Properties, Inverse DFT, Windowing and DFT Leakage, Direct Computation of DFT;

Fast Fourier Transform: Divide and Conquer, Radix algorithms; Inverse FFT, Applications of FFT

Discrete time systems implementation: Overview of z-transform, Structures of Discrete time systems, Fixed and Floating number types, Quantization effects.

Design of Digital Filters: General Considerations, FIR and IIR Filters, Techniques of FIR and IIR filter Design.

Multirate Signal Processing: Down sampling and Up sampling, Decimation and Interpolation.

EE-223 Instrumentation and Measurement

General Theory: Classification of Instruments, block diagram of various instrumentation schemes, performance characteristics of instrumentation.

Measurement of electrical Quantities: Basics of electromechanical instruments, moving coil and electrodynamometer instruments as ammeter, voltmeter and ohmmeter, extension of ranges.

Instrumentation transformers: Their burden and accuracy, clamp meter, active and reactive power measurement, Max. demand indicator, classification of energy meter, induction type KWH meter, p.f meter.

Electronic Instruments: Data Acquisition, A/D conversion, electronic and digital voltmeters, digital frequency meter, time interval measurement, power and energy meter.

Transducers: Temperature transducers, pressure transducers, variable resistance and inductance transducers, linear variable differential transformers (LVDT), capacitive photoconductive and piezo-electric transducers, thermos electric transducers.

Measurement of Non-electrical quantities: Measurement of temperature, pressure, flow strains, thermal conductivity, motion, speed and vibrations.

MT-331 Probability & Statistics

Statistics: Introduction, Types of data & variables, presentation to data, object, classifications, Tabulation, Frequency distribution, Graphical representation, Simple & Multiple Bar diagrams, Sartorial & Pie-Diagram, Histogram, Frequency Polygon, Frequency Curves & their types.

Measures of central tendency and dispersion: Statistics Averages, Median Mode, Quartiles, Range, Moments, Skew ness & Kurtosis, Quartile Deviation, Mean Deviation, Standard Deviation, Variance & its coefficient, Practical Significance in related problems.

Curve fitting: Introduction, fitting of a first and second degree curve, fitting of exponential and logarithmic curves, related problems. Principle of least squares, Second order Statistics & Time series not in bit detail.

Simple regression & correlation: Introduction, Scatter diagrams, Correlation & its Coefficient, Regression lines, Rank Correlation & its Coefficient, Probable Error (P.E), Related problems.

Sampling and sampling distributions: Introduction, Population, Parameter & Statistic, Objects of sampling, Sampling distribution of Mean, Standard errors, Sampling & Non-Sampling Errors, Random Sampling, Sampling with & without replacement, Sequential Sampling, Central limit theorem with practical significance in related problems.

Statistical inference and testing of hypothesis: Introduction, Estimation, Types of Estimates, Confidence interval, Tests of Hypothesis, Chi-Square distribution/test, one tails & two tails tests. Application in related problems.

Probability: Basic concepts, Permutation & Combination, Definitions of probability, Laws of probability. Conditional probability, Baye'snile. Related problems in practical significance.

Random variables: Introduction, Discrete & Continuous random variables, Random Sequences and transformations. Probability distribution, Probability density function, Distribution function, Mathematical expectations, Moment Generating Function (M.G.F.), Markov random walks chain/ Related problems.

Probability distributions: Introduction, Discrete probability distributions, Binomial Poisson, Hyper geometric & Negative binomial distributions. Continuous probability distribution, Uniform, Exponential & Normal distributions & their practical significance.

MG-257 Organizational Behavior

Introduction to Organizational Behaviour: Foundations of OB: Management Functions, roles, and skills; Effective versus successful managerial activities; Replacing intuition with systematic study, Exploring OB challenges and opportunities facing globalization, OB Model.

Foundations of Individual Behaviour: Biographical traits and ability, Personality, Perceptions and individual decision making, Values, attitudes, and job satisfaction, Motivation – basic concepts and applications, Work stress.

Foundations of Group Behaviour: Group in OB, Defining and classifying groups, Stages of group development, work group behaviour, dynamics of groups, Understanding work teams, Leadership: basic approaches and contemporary issues; Conflict & negotiation.

Foundations of Organizational Structure: Organizational structure and design, Organizational culture, Organizational change and development **.**

THIRD YEAR (FALL SEMESTER)

TC-307 Communication Systems

Introduction: Introduction to Communication, elements of Communication system, Fundamental Limitations, Hartley Shannon law Needs and benefits of Modulation, electromagnetic spectrum, multiplexing and multiple access, Phasors and Line Spectra

Random Signal Analysis: Review of probability and random variables, statistical measures, Probability models, Introduction to random processes.

Analog Communication: Baseband and carrier communication, Linear CW (AM, SSB, DSB, VSB) Modulation and demodulation techniques, modulator and demodulator Circuits, AM and SSB Transmitters and Receivers, SSB Filters, Transmission Bandwidth for AM, Angle/ Exponential CW (FM, PM) Modulation and demodulation techniques, modulator and demodulator Circuits, FM/ PM Transmitter, FM Generation Methods, Transmission Bandwidth for FM/PM , Carson's rule, PLL Systems, Pre-emphasis and De-emphasis circuits, Narrowband and wideband FM, Demodulation of FM/PM and Receivers

Noise*:* Mathematical representation, Signal to Noise Ratio, Noise in AM, FM, and PM systems

Digital Communication systems: Digital transmitters and receivers, Pulse Modulation, Pulse Amplitude Modulation, Pulse Position and Pulse width Modulation, BER, Introduction to information theory, Digital CW modulation, Coherent and non-Coherent systems, Digital modulation error-control coding

TC-318 Microwave Engineering

Transmission Lines: Transmission line theory, the lossless line, terminated line, lossy transmission line. Transmission line of finite Lengths, Reflection, Transmission and Propagation constants of transmission line. Types of transmission lines, Line Characteristics Impedance and physical parameters.

Waveguides: TEM, TE and TM modes, TE and TM solution in rectangular waveguide, TEM modes on coaxial line and Strip-line structure, Quasi-TEM on Micro-strip line, Characteristic impedance and loss calculations.

Smith Chart and Impedance matching: Smith chart, Smith chart Impedance, Admittance manipulation on the chart, Smith chart theory and applications, Reflection coefficient, Impedance of distributed circuits. Microwave matching networks, quarter wave transformer, lumped single stub and double stub matching.

Microwave Network Analysis: Impedance and equivalent voltage and current, impedance matrix, the scattering matrix, Transmission matrix, signal flow graphs.

Microwave Engineering: Microwave resonators, Strip Lines, Microstrip Lines, Coupled Striplines/Coupled microstrip lines, properties of three port and four port networks, Wilkinson's power divider, hybrid coupler, directional couplers and circulators. Introduction to microwave active devices.

EE-374 Feedback Control Systems

Introduction: Introduction to control systems, examples and classifications, Feedback and its characteristics. Nature and representation of control system problem, block diagram fundamentals and terminology for a feedback control system. Response of second order systems with time-domain specifications. Closed Loop Transfer functions of physical systems.

Block Diagram Algebra: Canonical and unity feedback forms of control system block system block diagram, block diagram reduction techniques and theorems, signal flow graph algebra, block diagram reduction using signal flow graphs.

Control System Stability: Stability of control systems, Routh Hurwitz Criteria for Stability, Conditional Stability, and Classification of feedback systems by type, analysis of system types, Steady State error efficiency, coefficients, and constant.

Root Locus: Introduction, rules for construction of root locus, qualitative analysis of root locus, analysis of performance characteristic of systems in time domain, dominant pole zero approximations, System design via root locus compensation, PID controller.

Control System Design: Introduction and review of control system design for closed loop systems via gain and phase margin adjustment in Bode/Nyquist/Polar plots.

Introduction to Digital Control: Computer control systems, Single-loop digital control system, Digital control vs Analog Control systems, Relation between S and z-domain and responses.

TC-317 Artificial Intelligence and Machine Learning

Introduction to Artificial Intelligence: Overview of AI and its applications, AI Branches.

Machine Learning: Basics of Machine Learning, Supervised and unsupervised learning, Regression, Cost function, Gradient Descent and its different types, over fitting, under fitting and Regularization, Clustering, K-means clustering.

Neural networks: Introduction to perceptron, its working and limitations, multilayer neural networks, cost function, cross-entropy function and classification, Back propagation Algorithm, Deep Learning and its architecture.

TC-320 Optical Communication

Introduction: Comparison between optical and electrical mediums, basic optical communication system, Snell's law, refractive index, line width, optical and electrical bandwidth.

Basics of optical fiber: Step index fiber, graded index fiber, refractive index profiles, meridional and skew rays, acceptance angle and acceptance con, numerical aperture for meridional and skew rays. Fabrication of Optical fibers.

Light Propagation through Fibers: Planar optical waveguides, cylindrical optical waveguides, propagating wave and evanescent wave, phase velocity, group velocity, group index, multimode fibers, single mode fibers.

Transmission characteristics of optical fiber: Losses due to attenuation, absorption, scattering, bending, misalignment at a joint. Dispersion and fiber birefringence.

Elements of Optical communication system: Optical sources, Optical detectors, modulators and modulating schemes, line coding, demodulator and demodulation methods, couplers, multiplexers, connectors, splicing, optical amplifiers and regenerators, Optical time division multiplexing, wavelength division multiplexing, link budgeting.

Optical Networks: Passive Optical Networks (PON), Applications of PON, Optical network topologies, SONET and SDH.

Free Space Optical (FSO) Communication: Introduction, Challenges associated with FSO communication, technological developments in FSO communication.

THIRD YEAR (SPRING SEMESTER)

TC-314 WIRELESS & MOBILE COMMUNICATION

Introduction to Wireless Communication Systems: Evolution of Mobile Radio Communications, Examples of Wireless Communication Systems, Paging Systems, Cordless Telephone Systems, Cellular Telephone Systems.

The Cellular Concept-System Design Fundamentals: Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference & System Capacity, Improving Coverage & Capacity in Cellular Systems Trunking & GoS.

Mobile Radio Propagation: Large Scale Path Loss, Basic Propagation Mechanisms, Free Space propagation Model, Outdoor Propagation Models, Indoor Propagation Models, Practical Link Budget Design.

Small Scale Fading & Multipath: Multipath Propagations, Parameters of Mobile Multipath Channels, Types of Small Scale Fading.

Modulation Techniques for Mobile Radio: FM vs AM, Overview of Digital Modulation, Spread Spectrum Modulation Techniques, Modulation Performance in Fading & Multipath Channels.

Multiple Access Techniques for Wireless Communication: Frequency Division Multiple Access, Time Division Multiple Access, Spread Spectrum Multiple Access, Space Division Multiple Access, Packet Radio.

Wireless Networks.

EF-309 Occupational Safety & Health

Health and Safely Foundations: Nature and scope of health and safety, Reasons/benefits and barriers for good practices of health and safety, Legal framework and OHS Management System.

Fostering a Safety Culture: Four principles or safely- RAMP (Recognize, Assess, Minimize, Prepare), Re-thinking safety-learning from incidents, Safety ethics and rules, Roles and responsibilities towards safety, Building positive attitude towards safety, Safety cultures in academic institutions.

Recognizing and Communicating Hazards: Hazards and Risk, Types of hazards: Physical (mechanical and non-mechanical), Chemical (Toxic and biological agents), electrical, fire, construction, heat and temperature, noise and vibration, falling and Lifting etc., Learning the language of safety: Signs.

symbols and labels, Finding Hazard Information, Material safety data sheets, Safety data sheets and the GHS (Globally Harmonized Systems).

Accidents & Their Effect on Industry: Costs of accidents, Time lost, Work injuries. parts of the body injured on the job, Chemical burn injuries, Construction injuries, Fire injuries.

Assessing and Minimizing the Risks from Hazards: Risk Concept and Terminology, Risk assessment procedure, Risk Metrics, Risk Estimation and Acceptability Criteria, Principles of risk prevention, selection and implementation of appropriate Risk controls, Hierarchy of controls.

Preparing for Emergency Response Procedures: Fire, Chemical Spill, first Aid, Safety Drills/Trainings: Firefighting, Evacuation in case of emergency.

Stress and Safety at work Environment: Workplace stress and sources, Human reaction to workplace stress, Measurement of workplace stress, Shift work, stress and safety, improving safety by reducing stress, Stress in safety managers, Stress and workers compensation.

Incident Investigation: Importance of investigation, Recording and reporting, Techniques of investigation, Monitoring, Review, Auditing Health and Safety.

TC-311 Digital Communication and Information Theory

Introduction to Digital Communication: Why Digital? Elements Digital Communication System, Basic transmission, Bits, Baud, Timing, Distortion and Channel Capacity, Digital input-output Devices, Digital Transmission on Analog Channel.

Formatting & Base Band Modulation: Analog to Digital Conversion, Sampling Theory, Quantization & its Types, Pulse Code Modulation (Linear Companded), Delta Modulation, Waveform Representation of Binary Digits, PCM Waveform Types, M-ary Modulation Waveforms.

Base Band Demodulation/ Detection Theory: Basic Detection Theory & Optimum Receiver Design, Detection of Binary Signal in Gaussian Noise, The Matched Filter, Inter Symbol Interference, Equalization.

Digital Modulation Techniques: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK,DPSK,QPSK), Detection of Modulated Signal, M-Ary Digital Modulation Schemes, Sampled Matched Filter.

Multiplexing, Framing & Synchronization: Information Theory, Information measure, Entropy, Information rate, Shannon's Theorem, Coding for discrete memory less source. Information Transmission on Discrete Channel, Discrete Channel Capacity, Linear Block Codes, Cyclic codes.

TC-319 Antennas and Wave Propagation

Wave Propagation: Review of electromagnetics and Maxwell's equations, Ground Wave Propagation, Friis free space equation, Surface and space wave propagation, Field strength of space wave, Range of space wave propagation, Effective earth's radius, Effect of earth imperfections and atmosphere on space wave propagation, Duct propagation, Tropospheric propagation, Ionospheric Propagation.

Antenna Basics: Radiation mechanism and fundamental antenna parameters – radiation pattern, radiation power density, radiation intensity, radiated power, radiation resistance, antenna efficiency, input impedance, beam solid angle, directivity and gain. Properties of receiving antennas – reciprocity, effective antenna area, Polarization, and radar cross section, Antenna bandwidth.

Introduction to different types of Antennas: Dipole, monopole antennas, loop antenna, traveling wave antenna (long wire, V and rhombic antennas), broadband antennas, helical, Yagi-uda, log-periodic antennas, aperture antenna (horn), and dish reflectors antennas, microstrip patch antennas and slot antennas. Antennas in wireless technology.

Array Antennas: Uniform linear array of isotropic elements, Array factor, Pattern Multiplication, Polar diagram, Broadside array of equally spaced, equal amplitude radiators, End fire array of equally spaced, equal amplitude radiators, Scanned /phased array, Optimum element spacing, Hansen-Woodyard End-Fire Array, Array design using the theory of polynomial.

EF-305 Engineering Economics & Management

Introduction: Basic concepts and principals of economics, micro- and macro-economics theory, problem of scarcity, basic concept of engineering economics, financial effectiveness and non-monetary factors.

Economic Environment: Consumer and producer goods, goods and services, demand and supply concepts, market equilibrium, elasticity of demand, elasticity of supply, measures of economic worth, price-supply-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 than once a year, present value , future value and annuities, uniform gradient and geometric sequence of cash flow.

Depreciation and Taxes: Depreciation concepts, economic life, methods of depreciation, gain (loss) on the disposal of an asset, depreciation as tax shield.

Basic Cost Concepts and Break-Even analysis: Types of costs and cost curves, determination of Cost/Revenue numerical and graphical presentation, practical application, BEL as management tool for achieving financial/operational efficiency.

Linear Programming: Methamatical statement of Linear Progranmming, problems, Graphical solutions, Simplex method, Duality problem.

Business organizations and Financial Institutions: Type of ownership, Single ownership, partnership, Corporation, types of Stocks and Joint stock companies, Banking and specialized credit institutions.

Management: Project management; Integration of Organization strategy with projects, defining the project, developing a Network plan, Managing risk, reduce project time, Project selection and comparing alternative techniques, scheduling resources.

Introduction to Production Managemnt and Production concepts: Basic production function, stages of production, returns to scale, Production lead time, Production rate capacity, operations, Planning and control, order processing, scheduling, material requisitions palnning, Line of balance.

FINAL YEAR (FALL SEMESTER)

MT-442 Numerical Methods

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.

Difference Equations: Functions of operators, difference operators and the derivative operators, identities, Linear homogenous and non-homogenous difference equations.

Interpolation & Curve Fitting: Lagrange's, Newton, Hermit, Spline, least squares approximation. (Linear and Non-Linear Curves).

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).

Solution of Non-linear Equations: Numerical methods for finding the roots of transcendental and polynomial equations (Secant, Newton – Raphson,

Chebyshev and Giraffe's root squaring methods), rate of convergence and stability of an iterative method.

Numerical Integration & Differentiation: Computation of integrals using simple Trapezoidal rule, 1/3th Simpson's rule, 3/8th Simpson's rule. Composite Simpson's and Trapezoidal rule, computation of solutions of differential equations using (Euler method, Euler modified method Range Kutta method of order 4).

Numerical Solutions of PDE & Optimization: Partial differential Equations, Optimization problem (Simplex Method), Steepest Ascent and steepest Descent Methods.

CS-430 Microprocessor Programming and Interfacing

Computer Architecture, Instruction Cycle, Memory Organization , Address decoding, Memory Hierarchy, Interrupts, Bus Arbitration Schemes, programmed I/O, Interrupt-Driven I/O, Direct Memory Access; General Purpose and Special purpose Processors, Internal Registers, Internal Bus Architecture, Pin Functions, Addressing Modes, Instruction Set Architecture: (Data Transfer Instructions, Arithmetic & Logic Instructions, Branch Instructions), Assembly Programming and Testing, Assembler Directives, Macros, Procedures, Instruction Encoding, Bus Cycles, Rest Circuit, Clock Generation Circuit, Wait States, Memory Interfacing, Memory Speed Requirements, I/O Interfacing, Programmable Peripheral Interface, Programmable Interval Timer, Programmable Interrupt Controller, Microprocessor System, Design; Recent Microcontroller Architectures.

TC-421 Telecommunications Networks

Telecommunications Management Network (TMN), Network Management Tools and Systems. Computer Communication within the framework of the OSI and TCP/IP protocol architectures. Network architectures and switching techniques, characteristics of transmission media. Channel access protocols and their efficiency. Link control protocols, and their efficiency. Routing algorithms and protocols. Interconnection of network at the link level and at the network level, the Internet Protocol (IP) and associated control protocols. End-to-end protocols, with TCP and UDP as examples; congestion control and flow control. Cursory view of application-level protocols, including electronic mail, HTTP and DNS. Introduction to network calculus (optional).

FINAL YEAR (SPRING SEMESTER)

MG-481 Entrepreneurship

Introduction to Entrepreneurship: The concept of entrepreneurship, entrepreneurial mindset, social entrepreneurship, and essential entrepreneurial skills.

Initiating entrepreneurial ventures: Innovation and creativity, assessment of entrepreneurial opportunities, pathways to entrepreneurial ventures, sources of capital.

Developing the entrepreneurial plan: Legal challenges, marketing challenges, financial planning, export orientation, developing an effective business plan.

Growth strategies: Strategic entrepreneurial growth through scaling, valuation of entrepreneurial ventures, and harvesting the entrepreneurial venture.

TC-431 Wireless Technologies and RF Planning

Introduction to 3GPP wireless technologies: Broadband Wireless alternatives, , LTE (Long Term Evolution), LTE-A, Mobile TV Platforms, Multimedia Broadcast/ Multicast Services (MBMS), Cellular and WLAN/ WMAN/ WPAN technologies.

Wireless Networks: WLAN/ WMAN/ WPAN technologies.

RF Planning and Optimization: Introduction to RF environment and propagation model, Wireless network planning process, Antenna and feeder system, Site survey, Link budget, Network optimization process, access optimization, signaling trace, Handoff optimization, power control optimization, drop call optimization.

TC-434 Telecommunication Switching System

Telephone Instruments and Public Switched Telephone Network: Introduction to Telephone, Basic functions of a telephone set, Switching System Evolution from Strowger Switch to Electronic Switching Systems, Network Topology and Hierarchy of Exchanges.

Switching Systems: Introduction, Space Division Analog Switch, PCM Switching and Digital Switches, Approaches to PCM Switching: Time

switching, Space Switching, Space and Time switching and their comparison, Electronic Switching Systems, Digital network synchronization.

Integrated Services Digital Network (ISDN): ISDN Services, Reference Model, B, D, H- Channels, BRI, PRI, Layer 2 protocol- LAPD, Layer3 of ISDN.

Introduction to Signaling System no. 7(SS7): Introduction to SS7 and its services, SS7 Architecture, Network Entities, Datalinks, Signaling Units. SS7 Layers, SS7 reference model.

Integration of PSTN and IP Telephone Network: Next Generation Architecture, Media Gateways, Media Gateway Controllers, Signaling Gateway, SS7 over IP (SIGTRAN), SCTP and User Adaptation.

IP Telephony: Voice call control protocols over IP, H.323 Protocol Suite, Session Initiation Protocol (SIP).

TC-435 COMMUNICATION SECURITY

Introduction to Communication Security: Importance of security in telecommunications, Key concepts: confidentiality, integrity, availability (CIA), Types of information and assets requiring protection, Overview of attack surfaces in communication systems.

Security Standards and Governance: Overview of IT and OT security standards (e.g., ISO/IEC 27001, NIST, ISA/IEC 62443), Governance models and security policies, Legal, ethical, and compliance considerations in telecom security.

Threats, Vulnerabilities, and Risk Management: Types of threats: eavesdropping, spoofing, DoS, malware, phishing, insider threats, Vulnerability analysis and threat modeling in telecom networks, Risk assessment methodologies, Risk mitigation strategies and security controls.

Foundations of Cryptography: Shannon's theory of perfect secrecy, Encryption schemes (Symmetric vs. Asymmetric), Key management and exchange (e.g., Diffie-Hellman, RSA), Cryptographic hash functions and message digests.

Authentication, Authorization, and Digital Identity: Password-based and multi-factor authentication, Digital signatures and public key infrastructure (PKI), Certificates and trusted authorities**.**

Communication Security Protocols: IP Security (IPSec): Authentication Header, ESP, Secure Sockets Layer (SSL)/TLS, Email and Web security.

Network Security Technologies and Tools: Firewalls, Intrusion Detection/Prevention Systems (IDS/IPS), Virtual Private Networks (VPNs),

Secure network design (DMZs, segmentation), Security Information and Event Management (SIEM).

TC-490 TELECOMMUNICATIONS ENGINEERING PROJECT

The final year students will be required to consult the Chairman Department of Telecommunications Engineering regarding the offering of various projects in the department and industry. 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 and / or external supervisor.

ELECTIVE COURSES

TC-422 Satellite Communication

Introduction, Background and Applications, Orbital Mechanics, Geostationary and Non-geostationary Orbits, Launching and Spacecraft subsystems, Satellite Link Design, Modulation Schemes, Multiple Access Schemes, Coding, Propagation Aspects, Earth Station Technology, VSATs and Network Architectures, GPS and future trends.

TC-423 Navigational Aids and Radar Systems

An Introduction to Radar: Basic Radar, The simple form of the Radar Equation, Radar block diagram, Radar frequencies, Application of the Radar, Origin of the radar.

Radar Equations: Introduction, detection of signals in noise, receiver noise and signal to noise ratio, Probability density function, Probability of detection and false alarm, Integration of the Radar pulses, Radar cross section of targets, Transmitter power pulse repetition frequency.

MTI and Doppler Radar: Introduction to Doppler and MTI radar, Delay line cancellers, Staggered pulse repetition frequencies, Limitation to MTI performance.

Tracking Radar: Tracking with Radar, Monopulse tracking, conical scan and sequential lobing.

Radar Transmitters & Receivers: Introduction, Linear beam power tubes, Magnetron, The Radar receiver, The receiver noise figure, Super Heterodyne receiver, Radar displays.

Propagation of the Radar Waves: Introduction, Forward Scattering from a flat earth, Scattering from the round earth surface, Atmospheric Refraction, Standard propagation, Nonstandard propagation.

Navigational aids: Terminology used in navigational Systems, Direction finding, GPS, Laser Gyro, Decca, Loran, Beacon system.

TC-427 Digital Image Processing

Introduction: Definitions, and applications.

Image Fundamentals: Models, sampling, quantization and basic operations, Image Enhancement, Point processing, Histogram equalization and specification, spatial domain filtering: Smoothing, Median, & Sharpening. 1-D and 2-D.

Discrete Cosine Transform (DCT): Properties of DCT, Comparison with DFT, Different forms of DCT, Application of DCT in image processing.

Color Fundamentals: Models, transformation, and enhancement, Image restoration: Degradation and observation models, Inverse filtering, Geometric transformation.

Image Compression: Fundamentals, information theory and entropy concept, Huffman and run-length coding, Compression Standards, Compression of frame Sequences and color images, Image segmentation: Detection of discontinuities, point, line, and edge detection.

Image Segmentation: Thresholding, global and optimal. Region-oriented and Motion-based segmentation, Representation and Description, Computer Vision principles, Practical.

Applications: Videoconferencing and Internet applications.

TC-429 Telecom Policies & Standards

Important Regulatory Terminologies, Pakistan Telecom Industry and regulatory bodies, Functioning of Telecom Regulatory Stakeholders in Pakistan, Familiarization with International and Regional Telecom Organizations, International telecom standardization and regulatory bodies, Standards Setting Process. Types of regulators, Deregulation and Liberalization, Regulating for Effective Competition, Pakistan Telecom Policies, Act, Rules and Regulations, Legislation process. Licensing Procedures, Interconnection regulation, Universal service, Spectrum Management, Number portability regulation, Regulation of electronic media, PEMRA ordinance 2002, PEMRA rules.

TC-430 Multimedia Communication Systems

Multimedia systems, multimedia networks and applications, digitizing principles, text, image audio, video information representation, text and image compression techniques (JPEG, MPEG), audio and video compression standards for multimedia communication, transport of high definition video signals and Video on demand. Modem Networking Methods for Multimedia, Multimedia Conferencing, Digital Video Broadcasting.

TC-433 Internet of Things

Introduction to Internet of Things: Need and significance of IoT systems, technology and business drivers, Elements of an IoT ecosystem, Protocol layers of IoT networks, IoT applications.

IoT Link and Network Layer: Physical and MAC Layer Protocols used in IoT networks, IEEE 802.15.4 (ZigBee), IEEE 802.15.1 (Bluetooth, Bluetooth Low Energy), IEEE 802.11 (WiFi), Thread, LoRaWAN, Cellular IoT, and NB-IoT, network layer function and routing.

IoT Application Layer: IoT application layer protocols, overview of MQTT protocol, publisher/subscriber model, overview of Constrained Application Protocol (CoAP), overview of Advanced Message Queuing Protocol (AMQP).

IoT network implementation: IoT use cases and technical considerations during implementation, embedded system selection for IoT end-devices and gateways, interfacing with input devices and output devices, power management, network scaling, cloud data management and analytics, security features for IoT networks.

COURSES OFFERED IN OTHER DEPARTMENTS / PROGRAMMES

S#	Course Code	Course Title	Credit Hours		
			Th.	Pr.	Total
1	TC-205	Digital Logic Design	3	1	4
2	TC-206	Signals and Systems	3	0	3
3	TC-212	Digital Signal Processing	2	1	3
4	TC-306	Communication Systems	3	0	3
5	TC-307	Communication Systems	3	1	4
6	TC-421	Telecommunication Networks	3	1	4
	TC-201	Digital Logic Design	2	1	3
			2	1	3

TC-201 Digital Logic Design

Computer Operations:
Evaluation of the computer, basic organization of digital computer, instruction formats, some different types of computers, special purpose and general purpose computers.

Number Systems:
Conversion between bases, arithmetic with bases other than ten, negative numbers, binary coded decimal numbers, octal, and hexadecimal number systems.

Truth Function:
Binary connectives, evaluation of truth functions, many statement compounds, physical realisations, sufficient sets of connectives, digital computer examples.

Boolean Algebra:
Truth functional calculus as Boolean algebra, duality, fundamental theorems of Boolean algebra, examples of Boolean simplifications, remarks on Switching functions.

Switching Devices:
Switches and relays logic circuits, speed and delays in logic circuits, integrated logic circuits.

Minimisation of Boolean Functions:
Standard forms of Boolean functions, Minterm and maxterm, Designation of Boolean functions, Karnaugh map representation of Boolean functions, simplification of functions on Karnaugh maps, map minimisation of product of sums expressions, incompletely specified functions.

Tabular Minimisation:
Cubical representation of Boolean functions, Determination of prime implicants, Selection of an optimum set of prime implicants, Design of NAND and NOR Networks and properties of combinational network, Introduction to design of NAND and NOR Networks, Switching expressions for NAND and NOR Networks, Transient response of combination Networks.

Introduction to sequential Networks:
Latches, Sequential Networks in fundamental mode, Introduction to the Synthesis of Sequential Networks, Minimisation of the number of states, Clocked Networks.

Introduction to Verilog HDL and VHDL

Lab work:
The practical work will be based on the above course

TC-202 Signals and Systems

LTI Systems:
Elementary Continuous-Time and Discrete-Time Signals and Systems, Linear Time-Invariant Systems, Differential and Difference LTI Systems.

Transforms:
Continuous time Fourier series, Continuous time Fourier Transform, Discrete Time Fourier Series, Discrete Time Fourier Transform, Discrete Fourier Transform, Laplace Transform, Z-Transform.

Time-Frequency Analysis of LTI System:
Introduction to Time Frequency Analysis of Continuous time LTI System, Introduction to Time Frequency Analysis of Discrete-time LTI System.

Lab work:
The practical work will be based on the above course

TC-212 Digital Signal Processing

Overview of Discrete-time Signals and Systems:
Sampling, Aliasing, Quantization, Convolution, Correlation, Properties of Discrete time Signals and Systems;

Discrete Fourier Transform:
Frequency Domain Sampling, DFT Properties, Inverse DFT, Windowing and DFT Leakage, Direct Computation of DFT;

Fast Fourier Transform: Divide and Conquer, Radix algorithms; Inverse FFT, Applications of FFT

Discrete time systems implementation:

Overview of z-transform, Structures of Discrete time systems, Fixed and Floating number types, Quantization effects.

Design of Digital Filters:
General Considerations, FIR and IIR Filters, Techniques of FIR and IIR filter Design.

Multirate Signal Processing:
Down sampling and Up sampling, Decimation and Interpolation.

Lab work:
The practical work will be based on the above course

TC-306 Communication Systems

Introduction:
Introduction to Communication, elements of Communication system, Fundamental Limitations, Hartley Shannon law Needs and benefits of Modulation, electromagnetic spectrum, multiplexing and multiple access, Phasors and Line Spectra

Random Signal Analysis:
Review of probability and random variables, statistical measures, Probability models, Introduction to random processes.

Analog Communication:
Baseband and carrier communication, Linear CW (AM, SSB, DSB, VSB) Modulation and demodulation techniques, modulator and demodulator Circuits, AM and SSB Transmitters and Receivers, SSB Filters, Transmission Bandwidth for AM, Angle/ Exponential CW (FM, PM) Modulation and demodulation techniques, modulator and demodulator Circuits, FM/ PM Transmitter, FM Generation Methods, Transmission Bandwidth for FM/PM , Carson's rule, PLL Systems, Pre-emphasis and De-emphasis circuits, Narrowband and wideband FM, Demodulation of FM/PM and Receivers

Noise*:*
Mathematical representation, Signal to Noise Ratio, Noise in AM, FM, and PM systems

Digital Communication systems:
Digital transmitters and receivers, Pulse Modulation, Pulse Amplitude Modulation, Pulse Position and Pulse width Modulation, BER, Introduction to information theory , Digital CW modulation, Coherent and non Coherent systems, Digital modulation error-control coding.

TC-307 Communication Systems

Introduction:
Introduction to Communication, elements of Communication system, Fundamental Limitations, Hartley Shannon law Needs and benefits of Modulation, electromagnetic spectrum, multiplexing and multiple access, Phasors and Line Spectra

Random Signal Analysis:
Review of probability and random variables, statistical measures, Probability models, Introduction to random processes.

Analog Communication:
Baseband and carrier communication, Linear CW (AM, SSB, DSB, VSB) Modulation and demodulation techniques, modulator and demodulator Circuits, AM and SSB Transmitters and Receivers, SSB Filters, Transmission Bandwidth for AM, Angle/ Exponential CW (FM, PM) Modulation and demodulation techniques, modulator and demodulator Circuits, FM/ PM Transmitter, FM Generation Methods, Transmission Bandwidth for FM/PM , Carson's rule, PLL Systems, Pre-emphasis and De-emphasis circuits, Narrowband and wideband FM, Demodulation of FM/PM and Receivers

Noise*:*
Mathematical representation, Signal to Noise Ratio, Noise in AM, FM, and PM systems

Digital Communication systems:
Digital transmitters and receivers, Pulse Modulation, Pulse Amplitude Modulation, Pulse Position and Pulse width Modulation, BER, Introduction to information theory, Digital CW modulation, Coherent and non Coherent systems, Digital modulation error-control coding.

Lab work:
The practical work will be based on the above course

TC-421 Telecommunications Networks

Telecommunications Management Network (TMN), Network Management Tools and Systems. Computer Communication within the framework of the OSI and TCP/IP protocol architectures. Network architectures and switching techniques, characteristics of transmission media. Channel access protocols and their efficiency. Link control protocols, and their efficiency. Routing algorithms and protocols. Interconnection of network at the link level and at the network level, the Internet Protocol (IP) and associated control protocols. End-to-end protocols, with TCP and UDP as examples; congestion control and flow control. Cursory view of application-level protocols, including electronic mail, HTTP and DNS. Introduction to network calculus (optional).

Lab work:
The practical work will be based on the above course.