Semester 8

Machine Intelligence	16
Industrial Automation	16
Safety, Health and Environment	17
Entrepreneurship	17
Mechatronics System Design	15
Project / Thesis -II	

MEHRAN UNIVERSITY
OF
ENGINEERING AND TECHNOLOGY
JAMSHORO

SYLLABUS

FOR

BACHELOR'S DEGREE

IN

MECHATRONIC ENGINEERING

F16 & ONWARDS BATCHES

DEPARTMENT OF MECHATRONIC ENGINEERING

MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO
DEPARTMENT OF MECHATRONIC ENGINEERING

(B.E MECHATRONIC ENGINEERING PROGRAM)

First Semester

S.#.	Course Codes	Name of Subject	Credit Hours		Marks	
			Th.	Pr.	Th.	Pr.
1	MTH108	Applied Calculus	3	0	100	0
2	EN101	Functional English	3	0	100	0
3	EL117	Applied Physics	2	1	50	50
4	CS191	Computer Programming	2	1	50	50
5	ME106	Engineering Statics	3	1	100	50
6	ME116	Engineering Materials	2	0	50	0
Total			**18**		**450**	**150**

Second Semester

S.#.	Course Codes	Name of Subject	Credit Hours		Marks	
			Th.	Pr.	Th.	Pr.
1	ME126	Engineering Drawing and Computer Graphics	2	2	50	100
2	IS111 / SS104	Islamic Studies / Ethics	2	0	50	0
3	PS106	Pakistan Studies	2	0	50	0
4	MTH112	Linear Algebra and Analytical Geometry	3	0	100	0
5	EL125	Linear Circuit Analysis	2	1	50	50
6	MTE136	Fluid Mechanics	2	1	50	50
7	ME146	Workshop Practice	0	1	0	50
Total			**18**		**350**	**250**

Third Semester

S.#.	Course Codes	Name of Subject	Credit Hours		Marks	
			Th.	Pr.	Th.	Pr.
1	ME206	Mechanics of Materials	2	1	50	50
2	MTE201	Actuating Systems	3	1	100	50
3	ME216	Engineering Dynamics	3	0	100	0
4	CS291	Data Structures and Object Oriented Programming	2	1	50	50
5	ES216	Digital Logic Design	2	1	50	50
6	MTH227	Ordinary and Partial Differential Equations	3	0	100	0
Total			**19**		**450**	**200**

Fourth Semester

S.#.	Course Codes	Name of Subject	Credit Hours		Marks	
			Th.	Pr.	Th.	Pr.
1	MTH217	Laplace Transforms and Discrete Mathematics	3	0	100	0
2	ME226	Fundamentals of Thermal Sciences	3	1	100	50
3	ES246	Electronic Devices and Circuits	3	1	100	50
4	ME236	Mechanics of Machines	3	1	100	50
5	MTE211	Instrumentation and Measurements	3	1	100	50
Total			**19**		**500**	**200**

Fifth Semester

S.#.	Course Codes	Name of Subject	Credit Hours		Marks	
			Th.	Pr.	Th.	Pr.
1	MTH336	Numerical Analysis and Computer Applications	3	1	100	50
2	ES316	Microcontroller and Embedded Systems	3	1	100	50
3	TL301	Signals and Systems	2	1	50	50
4	ME306	Mechanical Vibrations	3	1	100	50
Total			**15**		**350**	**200**

Sixth Semester

S.#.	Course Codes	Name of Subject	Credit Hours		Marks	
			Th.	Pr.	Th.	Pr.
1	MTH311	Statistics and Probability	3	0	100	0
2	MTE301	Control Systems	3	1	100	50
3	ME316	Machine Design and CAD / CAM	3	1	100	50
4	EN113	Communication Skills	2	0	50	0
5	EL329	Power Electronics	3	1	100	50
Total			**18**		**450**	**150**

Seventh Semester

S.#.	Course Codes	Name of Subject	Credit Hours		Marks	
			Th.	Pr.	Th.	Pr.
1	ME406	Engineering Economics and Project Management	3	1	100	50
2	MTE401	Robotics	3	0	100	0
3	CS492	Digital Signal & Image Processing	3	1	100	50
4	ME416	Manufacturing Processes	3	1	100	50
5	MTE499	Project / Thesis –I*	0	3	0	100
Total			**18**		**400**	**250**

Eight Semester

S.#.	Course Codes	Name of Subject	Credit Hours		Marks	
			Th.	Pr.	Th.	Pr.
1	CS491	Machine Intelligence	3	1	100	50
2	MTE421	Industrial Automation	2	1	50	50
3	EE425	Safety, Health and Environment	3	0	100	0
4	STD951	Entrepreneurship	2	0	50	0
5	MTE411	Mechatronics System Design	2	1	50	50
6	MTE499	Project / Thesis -II	0	3	0	100
Total			**18**		**350**	**250**

Title of Subject	:	APPLIED CALCULUS

Introduction to functions: Mathematical and physical meaning**,** types of function and their graphs.
Introduction to limits: Theorems of limits and their applications to functions. Right hand and left hand limits. Continuous and discontinuous functions and their applications.
Derivatives: Introduction to derivatives. Geometrical and physical meaning of derivatives. Partial derivatives and their geometric significance. Application problems (rate of change, marginal analysis).
Higher Derivatives: Leibnitz theorem, Rolle's theorem, Mean value theorem. Taylors and Maclaurins series.
Evaluation of limits using L' Hospital's rule: Indeterminate forms (0/0), (∞/∞), $(0x\infty)$, $(\infty-\infty)$, 1^{∞}, ∞^{0}, 0^{0}.
Application of Derivatives: Asymptotes, curvature and radius of curvature, differentials with application.
Application of partial Derivatives: Euler's theorem, total differentials; maxima and minima of function of two variables.
Integral Calculus: Methods of integration by substitution and by parts. Integration of rational and irrational algebraic functions. Definite integrals, improper integrals. Gamma and Beta functions; reduction formulae.
Application of Integral Calculus: Cost function from marginal cost, rocket flights; area under curve.
Vector Calculus: Vector differentiation and vector integration with their physical interpretation and applications. ∇operator, gradient, divergence and curl with their application.

Title of Subject	:	FUNCTIONAL ENGLISH

Reading: Interactive Reading, apply the skills of surveying skimming, scanning and detailed reading and identify topic sentence
Writing: Audience Related Writing, composition of sentences, Paragraph, short descriptive writing, précis and letter and application, identify contextual clues with the help of cohesive devices.
Listening: Collect gist and important points from a listening text or any other oral source viz. Lecture, speech or conversation
Speaking: Taking part in different real life situations, answer question, argue and explain one's point of view, ask for information turn taking techniques and presentation skills.
Grammar: Mechanics of English Language, Punctuation, vocabulary, conversion of words, tenses and sentence structure.

Title of Subject	:	APPLIED PHYSICS

BASIC CONCEPTS AND LAWS
Electrical quantities, sources of electricity, effects of electric current, basic circuit elements, Series and parallel circuits, voltage and current divider rules resistive bridges and ladders, Ohm's law. Kirchhoff's laws,
ELECTROSTATICS AND CAPACITANCE
Coulomb's law. Electric charge. Electric field. Electric field strength and Electric Flux. Electric potential. Dielectric. Capacitance. Charging and Discharging of Capacitor. Capacitors in series and in parallel. Energy stored in capacitor.
ELECTROMAGNETISM
Magnetic fields. Characteristic of lines of magnetic flux. Magnetic fields due to currents. Electromagnet. Force on current carrying conductor in magnetic field. Electromagnetic induction. Magneto-motive force. Permeability. Reluctance. Self-inductance. Inductance of a coil, Air core and Iron cored inductor. L/R Time constant. Energy stored in inductance. Mutual inductance. Principle of transformer. Principles of dc generator and motor.
AC FUNDAMENTALS
Instantaneous, RMS or effective, average and maximum values of current & voltage for sinusoidal signal wave forms. Form factor and Peak factor of alternating waveforms.

Title of Subject	:	COMPUTER PROGRAMMING

Introduction to computers: Computer defined • Application areas of computer • Generations of computers • Advantages and disadvantages of computer over humans • Data and Information • Information/Data Processing Cycle.

Number Systems: Overview of Binary, Octal, Decimal and Hexadecimal number systems • Number system conversions.

Input and Output devices: Role of input and output devices • Commonly used input and output devices.

Computer Memory: Random Access memory (RAM) • Read Only Memory (ROM) • Units of memory measurement.

Central Processing Unit (CPU): Introduction to CPU • Basic CPU organization • Parts of CPU: ALU, CU, MU, FPU and Registers

Basics of programming: Compilation process • Basic C program structure • The main procedure, return type and return statement • Outputting data with cout statement • Preprocessor directives, header file and namespace• Comments • Whitespaces • Manipulators (endl) • Escape sequences

Variables and Operators: Variables • Variable declaration and initialization • Data Types and Identifiers • Literals • Constants • Rules for identifiers • Operators in C++ (Arithmetic, Relational, Logical, Short circuit, Arithmetic assignment , Increment and Decrement)

Conditional and Iterative control structures: Role of conditional control structures • If, If-else, Else-If and Switch statement of C++ • Role of iterative control structures • For, While and Do-While loops in C++ • Break and Continue statements • Nested loops

Arrays and Function: Declaring and initializing arrays • Array indices and accessing array elements • Multidimensional arrays. Function declaration • Function definition • Function calling • Return type of functions • Arguments and parameters

String; Character string • String Objects • Functions of character string • Functions of string objects

Title of Subject	:	ENGINEERING STATICS

Force System: Introduction to the subject, fundamental concepts of statics, representation & types of vectors, principle of transmissibility, graphical & analytical methods of vector operation, rectangular and non-rectangular components, Cartesian vector, and position vector.
Equilibrium of Particle: Free body diagram of particle in equilibrium, equilibrium of particle for 2D and 3D systems.
Force System Resultants: Moment of a force (scalar and vector formulation), moment of force about a specified axis, moment of a couple, resultant of a force and couple systems.
Equilibrium of Rigid Bodies: Free body diagram of rigid bodies in equilibrium, equilibrium of rigid bodies for 2D and 3D systems.
Frames & Cables: Free body diagram for frames & machines, cables subjected to various loads.
Friction: Characteristics of dry friction, laws of friction, angle of friction, angle of repose, static and dynamic friction, friction on horizontal and inclined planes.

Title of Subject	:	ENGINEERING MATERIALS

Introduction: Engineering Properties of Materials, Concept of Structures, Metals and Alloys, Ceramics, Polymers, Composites, Semiconductors, Materials Characterization, Scanning Probe Microscopy, Non-Destructive Testing, and Material Selection.
Non-ferrous and their alloy: Aluminum alloys, zinc alloys, copper alloys and their applications.
Heat treatment: Heat treatment, critical temperature, transformation on heating/cooling, annealing, normalizing, tempering, quenching, austempering, hardening.
Non-metallic Materials: Polymer, molecular structure, bonding, plastic & rubber, classification of polymer, ceramic bonding, properties, ceramic material, crystalline and amorphous glass etc, refractory materials and their types, composite materials and their classifications, glass-fibre reinforced plastics, ceramic-metal composites (Cermets).

Title of Subject	:	ENGINEERING DRAWING AND COMPUTER GRAPHICS

Introduction: Introduction to graphic language. Essential drawing instruments and their correct use. Line types and lettering. Basic drafting techniques and standards. Curves used in engineering.
Orthographic Projections: Projection and types of projection, first angle & third angle projection, orthographic multi-view projection of some simple and composite solids.
Sections: Sectioning and types of sectioning, projection of auxiliary views.
Isometric Projections: Fundamentals of axonometric projection, isometric projections and isometric drawings.
Detail, assembly and Working Drawings: Preparing detail, assembly and working drawings of machine parts.
Electronics drawings: Electronics symbology (graphic symbols used in electronics drawing) and drawings such as block and schematic diagrams.
Freehand / Sketching: Sketching and basic rules of sketching.
Fundamentals of geometric dimensioning and tolerancing.
Computer Aided Drafting: Developing understanding regarding the use of computer aided drafting (CAD) software.

Title of Subject	:	ISLAMIC STUDIES

Quran and Uloomul Quran: Surah Al-Hujurat., Surah Al-Furqan (These both surahs cover all topics related to ethical values of Islamic society including Taqwa, Taqwa, Simplicity, Lawful earning, Social Justice, Rights of Parents, elders, neighbors, Fear of Allah and Truthfulness), Excellence of Holy Quran (Aijazul Quran), History of collection and compilation of Holy Quran.**Basic Beliefs of Islam:** Tauheed, its importance, effects on the life of believer, shirk and its types, Existence of Angles, Holy Scriptures, Prophethood, its need and necessities, characteristics and Finality of Prophethood, Concept on life hereafter.**Life history of Holy Prophet Muhammad (ﷺ):** Life history at Makkah (Before Prophethood), Life history at Makkah (after Prophethood), Life history at Madina {including Brotherhood, Charter of Madina, Victory of Makkah and Last Sermon of Holy Prophet Muhammad **(**ﷺ), Importance of Hadith and Sunnah, Ten selected Ahadiths (Covering topics related to Proper usage of time, Hospitality, quality of shyness, love and affection to humanity, facilitate to others and tolerance etc). **Fundamentals of Islam:** Testifying KalimaShahadah, Prayer, its importance, pre-conditions, obligations and effects, Zakat, its aims & objectives, Requirements, Legal recipients, Nisab and benefits, Fasting, its philosophy, requirements and benefits, Pilgrimage, requirements, types, obligations, procedure and benefits, Jihad and its types.**Islam and Science:** Quran and Science, Importance of science and technology in Islam, Historical contribution of Islam and Muslims in the development of science, Verses of Holy Quran those cover different fields of science e.g. social, management and natural science.

Title of Subject	:	ETHICS

Ethics: Definition of Ethics, Position of ethics in different religions.
Islam: Introduction, Role of Beliefs and Arakans in character building, Rights of Non-Muslim, Ill effects of corruption and respect of law.
Hinduism: Introduction, Role of doctrines in character building, Religious books, Concept of Re-Birth and its influence in social life, Celebration days and their social effects, Comparative study of cast systems in the contemporary atmosphere.
Buddhism: Introduction, Doctrines, Eight Nobel Paths of Buddha and its benefits, Critical study on concept of Renunciation of material & worldly life.
Christianity: Introduction, Doctrines, Religious books, Celebration days.
Judaism: Introduction, Doctrines, Religious books, Ten Commandments of Moses and its importance in social life.
Moral values of different religions: Patience, Modesty, Moderation, Tawakal, Taqwa, Lawful earning, Sincerity, Positivity, Forgiveness and Softening.
Bad morals: lying, pride, selfishness, Fame, Greed, Extravagantness, Bribe, Social injustice, Religious biasness and Discrimination on the basis of race, color and faith

Title of Subject	:	PAKISTAN STUDIES

The Historical Background of Pakistan

Evolution and growth of Muslim society in Subcontinent
Muslim Revivalist and Reformist Movements
The Factors that shaped the Muslim Nationalism in the Subcontinent
The Factors that led birth to Pakistan
Ideology of Pakistan with special reference to Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah
Role of Sindh in Making of Pakistan

History of Internal and External Affairs of Pakistan:

The Constitutional and Political Developments in Pakistan (1947-1973)
The Constitution of 1973; Salient Features and Amendments
Political Development in Pakistan (1973 to date)
Determinants of Foreign Policy of Pakistan
Pakistan's Relations with Big Powers

Contemporary Pakistan (Issues and Challenges):

Geo-Strategic Significance of Pakistan
Economic Potential and its Utilization
Challenges to National Security of Pakistan
Internal Political, Economic and Legal Problems
Futuristic Outlook of Pakistan

Title of Subject	:	LINEAR ALGEBRA AND ANALYTICAL GEOMETRY

Introductions to matrices and elementary row operations. Briefintroduction of matrices.Types of matrices.Introduction to elementary row operations. Echelon and reduced echelon forms. Rank of a matrix. Inverse of a matrix using elementary row operations.

System of linear equations. System of non-homogeneous and homogeneous linear equations.Gaussian elimination method, Gauss Jordan method.Consistence criterion for solution of homogeneous and non-homogeneous system of linear equations.Application of system of linear equations.

Determinants. Introduction to determinants. Properties of determinants of order n. Rank of a matrix by using determinants.

Analytic geometry of 3-dimensions. Introduction; Coordinates in R3.

Line: Coordination of a point dividing a line segment in a given ratio. Straight line, in R^3. Vector form of a straight line, parametric equations of a straight line, equation of a straight line in symmetric form, direction ratios and direction cosines, angle between two straight lines; distance of a point from a line.

Plane: Equation of a plane, angle between two planes, intersection of two planes, a plane and a straight line; skew lines. Cylindrical and spherical coordinates.

Sphere: General equation of sphere. Latitude and longitude directions; direction of Qibla.

Multiple Integrals. Evaluation of double and triple integrals in Cartesian and polar coordinates.

Title of Subject	:	LINEAR CIRCUIT ANALYSIS

CIRCUIT THEOREMS

Nodal analysis, loop analysis. Linearity property, Superposition theorem, Thevenin's theorem, Norton's theorem, Concept of power, Maximum power transfer theorems, Reciprocity theorem.

SINUSOIDS AND PHASORS

Introduction to phasors, The complex number system, Rectangular and polar forms.

R-L-C CIRCUITS

Impedance and phase angle of series RC and RL circuits, Impedance and phase angle of parallel RC and RL circuits, Series and parallel RC circuits, Power in RC and RL circuits, Series and parallel resonance.

Title of Subject	:	FLUID MECHANICS

Introduction to Fluid Mechanics: What is fluid, classification of fluid, and fluid properties
Fluid Statics: Basic equation for pressure field, pressure measuring devices, hydrostatic forces on submerged surface, buoyancy, floatation and stability.
Fluid Dynamics: Principles of fluid motion, Definition of path line, streamline, streak line and timeline. Derivation of Bernoulli's and Euler's equation. Flow measurements. Velocity and acceleration field. Derivation of Reynolds transport theorem. Rayleigh's method and Buckingham's Pi theorem. Boundary layer theory.

Title of Subject	:	WORKSHOP PRACTICE

Precautions and safety rules.
Introduction to machine tools, classification and their operations.
Followings Hands-on experiments:
Bench fitting: measuring tools, assembly tools, layout tools, filing, sawing, tap & die practice
Wood working: Its kinds and uses, seasoning of wood and tools for wood working.
Forging: Forging tools, types of forging, heat treatment furnaces.
Foundry: Molding and its types, molding tools, molding sands, melting furnaces, types of casting defects & its remedies.
Machine tools: Lathe, Shaper, Milling, Drilling press, basic and elementary tools used in machine Shop.

Title of Subject	:	MECHANICS OF MATERIALS

Basic concept of stress and strain, Axial loading, Factor of safety, Poisson's ratio, stress concentration, Strain energy, thermal stresses, Torsion of solid and hollow circular shafts, simple bending theory of beams, shear force and bending moment diagrams, transformation of stress and strain, bi-axial stress, Mohr's circle, moment of inertia of an area, deflection of beam and column

Title of Subject	:	ACTUATING SYSTEMS

Concepts of actuating systems,

Hydraulic and pneumatic actuating devices, hydraulic valve types, configuration and characteristic responses, Pneumatic valve types, configuration and characteristic responses, Design and application of hydraulic and pneumatic systems, electro-hydraulic and electro-pneumatic systems, Principles of actuator selection and methods to evaluate their performance.

Solenoids, principles of electro-mechanical energy conversion and rotating machines, Applications of AC motors (including synchronous and asynchronous options), Operating principles of DC machines, Modeling of DC motor, Brush less DC motor,

Title of Subject	:	ENGINEERING DYNAMICS

Kinematics of Particle: Introduction, rectilinear motion, velocity and acceleration, equations of motion and the graphs of motion for constant and variable acceleration, relative motion, curvilinear motion, projectile motion, tangential and normal components of acceleration, cylindrical components.
Kinetics of Particle: Newton's laws of motion. D'Alembert's principle, equations of motion for rectangular, normal, tangential & cylindrical coordinates. Work, power, energy, work of force, work-energy equation, law of conservation of energy, efficiency of machine, impulse and momentum, impulse and impulsive force, linear momentum and its conservation, impact & coefficient of restitution, angular momentum and its conservation.
Kinematics of Rigid body: Rigid body motion about fixed axes, relative motion analysis.
Kinetics of Rigid body: Planar kinetic equation of motion with regard to translation & rotation about fixed axes, general planar motion, kinetic energy of rotation, work of force & couple, principle of work & energy, conservation of energy, principle of impulse & momentum, conservation of momentum.

Title of Subject	:	DATA STRUCTURES AND OBJECT ORIENTED PROGRAMMING

Introduction to data structures: Elementary data organization, data structure selection & algorithm development, data structure operations, space-time analyses.

Basic data structure types: Records, and applications of records, structures and nested structures, arrays of structures

Advanced data structures: Lists and simple linked lists, different implementations of lists, trees and binary trees, stacks, queues, graphs and heaps.

Basic Algorithm types: Traversing, searching, hashing and sorting algorithms, arithmetic expression.

Introduction to Object oriented approach: Introduction to object oriented programming, need and basic characteristics of object-oriented languages. C and C++.

C++ Programming basics: Output using cout directives, Input with cin, data types and type conversion

Functions: Returning values from functions, reference arguments, overloaded function, Inline function, Default arguments, returning by reference.

Object and Classes: Core object concepts (Encapsulation, Abstraction, Polymorphism, Classes) Implementation of classes in C++, C++ Objects as physical object, C++ object as data types constructor. Object as function arguments. The default copy constructor, returning object from function, structures and classes. **Arrays and string arrays fundamentals:** Arrays as class member data, arrays of object, string, the standard C++ String class

Operator overloading: Overloading unary operations, overloading binary operators, data conversion, pitfalls of operators overloading and conversion keywords.

Inheritance: Concept of inheritance, derived class and base classes, derived class constructors, member function, class hierarchies, inheritance and graphics shapes, public and private inheritance.

Pointer: Addresses and pointers. The address of operator and pointer and arrays, C-types string. Memory management: New and Delete, pointers to objects

Title of Subject	:	DIGITAL LOGIC DESIGN

Introductory Digital Concepts: Digital and analog quantities, digital and analog systems, binary digits, logic levels and digital wave forms, representing binary quantities, digital integrated circuits, IC packages, integrated circuits classifications.

Number Systems, Operations and Codes: Introduction to number systems, conversions, binary arithmetic, 1s and 2s complements of binary numbers, signed numbers, arithmetic operations with signed numbers, BCD code, gray code, binary to gray and gray to binary number conversion, parity in codes.

Logic Gates: Introduction to digital logic gates, implementing Boolean expressions with logic gates, describing logic circuits algebraically.

Expression Simplification: Boolean constants and variables, truth tables, introduction to Boolean operations, Simplification using Boolean algebra and theorems, standard forms of Boolean expressions, Boolean expressions and truth tables, introduction to Karnaugh map, reducing an expression using Karnaugh map, Karnaugh map SOP minimization, Karnaugh map POS minimization.

Combinational Logic: Implementation of combinational logic, the universal property of NAND and NOR gates, combinational logic using NAND and NOR gates.

Functions of Combinational Logic: Half adder full adder, parallel adder, parallel adder subtractor, comparators, decoders, BCD-to-seven segment decoder/drivers, seven-segment displays, encoders, code converters, multiplexers, de-multiplexers.

Sequential Logic : Introduction to Sequential Logic, Basic S-R latch, Flip-Flop and its types, Asynchronous & Synchronous counters, Shift Registers, ALU, Finite State machines, Introduction to Programmable logic devices and HDL.

Title of Subject	:	ORDINARY AND PARTIAL DIFFERENT EQUATIONS

First Order Linear and Non-Linear Differential Equations: Introduction, formation and solution of first order, first degree Differential Equations.

Higher Order Linear Differential Equations: Homogeneous linear equations of order n with constants coefficients, solutions of higher order differential equations according to the roots of auxiliary equation. Non-Homogeneous linear equations. Cauchy Euler equation. Method of variations of parameters. Applications of higher order linear differential equations.

Introduction to Partial Differential Equations: Formation of Partial differential equations**.** Solution of PDE by direct integration and variable separable method. Linear and non – linear PDE's of first order. Classification of PDE's. Solution of Laplace's equation, Heat equation and Wave equation.

Title of Subject	:	LAPLACE TRANSFORMS AND DISCRETE MATHEMATICS

Laplace Transforms: Laplace and inverse Laplace transform of elementary functions and
Their properties. Applications of Laplace transformation in various fields of engineering.
Fourier Transform: Fourier transforms and inverse Fourier transforms. Solution of differential equations using Fourier Transform.
Discrete Mathematics: Introduction; Sets; Relations; Functions; Logics; Mathematical Induction; Permutation and Combination; Recurrence Relations and their solution;
Graph Theory. Representation of Graphs; Paths and Circuits; Shortest Path Algorithm; Isomorphism of Graphs; Planar Graphs; Trees and their properties; Spanning Trees; Minimal spanning.

Title of Subject	:	FUNDAMENTALS OF THERMAL SCIENCES

Basic Concept of Thermodynamics,
Properties of Pure Substance,
The First Law of Thermodynamics,
The Second Law of Thermodynamics,
Power and Refrigeration Cycle,
Introduction to Heat Transfer,
Conduction Heat Transfer,
Convection Heat Transfer,
Radiation Heat Transfer,
Heat Exchangers and Cooling of Electronic Equipment.

Title of Subject	:	ELECTRONIC DEVICES AND CIRCUITS

Basic concepts of semiconductors, Impurities in Semiconductors, Electron & hole concentrations in Doped Semiconductors.
PN junction physics, Diodes, Terminal characteristics of junction diodes, Diode characteristics under reverse, zero & forward bias, PN Junction Capacitance, Analysis of diode circuits, Special purpose diodes, Rectifier circuits, Limiting & Clamping circuits, Circuit applications of diodes
Physical Structure and operating principles of BJTs, Operating regions of bipolar transistor, Basic BJT circuit configurations, DC analysis, Small signal and Large signal models of BJT, BJT as a switch.
Physical Structure and operating principles of FETs, MOSFETs, Enhancement and Depletion type MOSFETs, basic MOSFET circuit configurations, DC analysis, Small signal and Large signal models of MOSFETs.

Title of Subject	:	MECHANICS OF MACHINES

Introduction: Kinematic link, joints, pairs, kinematic chain, mechanism and its inversion, degree of freedom of a mechanism, four bar mechanism, single slider crank chain & its inversions.
Linkages: Position analysis, velocity analysis using instantaneous center method, acceleration analysis.
Cams & Followers: Types, displacement diagram and Cam profile. Kinematics of Geneva wheel.
Gears & Gear Trains: Spur gear terminology, velocity ratios of simple and compound gear trains.

Title of Subject	:	INSTRUMENTATION AND MEASUREMENTS

Measurements terminologies including resolution, sensitivity, accuracy, and uncertainty, engineering units and standards.
Principles of different measurement techniques. Sensors for measurement of temperature; Thermocouples, RTDs, Thermisters. Sensors for displacement and position; digital encoders, shaft encoders, absolute and relative encoders, linear encoders. Sensors for force, pressure, strain, vibration, velocity, flow rates etc.
Signal conditioning and filter design. Types of bridge circuits for measurement of resistance, inductance, and capacitance. Analog to digital conversion. Systems for signal processing and signal transmission. Data recording and data acquisition systems. Microprocessor based instrumentation circuits.
Techniques to select different sensors, sensor calibration.

Title of Subject	:	NUMERICAL ANALYSIS AND COMPUTER APPLICATION

Solution of non-linear equation: Bisection method, Regula-Falsi method, Newton-Raphson method, Fixed-Point iterative method.
Solution of linear algebraic equation: Iterative methds: Jaccobi's method, Guass-Seidal method.
Eigen values and Eigen vectors: Power method.
Interpolation and extrapolation: Differences: Forward, backward, central, operators and their relations. Newton's forward interpolation formula.Newton's backward interpolation formula, Newton's divided difference formula,.Lagrange's interpolation formula.Stirling's formula.
Numerical differentiation: Newton's forward and backward differentiation formulae.
Numerical quadrature: Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule, Weddle's rule, Gaussian quadrature.
Numerical solution of ordinary differential equations: Taylor series method, Euler's and its modified methods, Runge-Kutta methods, Predictor Corrector Methods; Miline's method, Adam-Bashforth method.

Title of Subject	:	MICROCONTROLLER AND EMBEDDED SYSTEMS

Introduction to Microprocessors and Microcontrollers, architecture of a modern microcontroller, Software/firmware development tools, Programming languages; Assembly and C, Simulation tools like Proteus, Digital systems design using internal resources, external peripherals and devices, Implementation of data communication; RS-232, I2C, SPI etc.
Introduction to embedded systems, Hardware architecture for embedded systems: Microcontrollers, Programmable logic devices like, Programmable array logic (PAL) and its variants, and Field Programmable Gate Arrays (FPGA) and its variants, Programming of embedded systems with Microcontroller and FPGA, Introduction to Verilog.

Title of Subject	:	SIGNALS AND SYSTEMS

Continuous-time (CT) and discrete-time (DT) signals; signal energy and power, time shift, reversal, and scaling; periodic signals; even and odd signals, CT and DT Complex Exponential and Sinusoidal Signals, Periodicity Properties, unit impulse and unit step signals, Memory, Invertibility, Causality, Stability, Time Invariance, Linearity, DT and CT representation in terms of impulses, DT Unit Impulse Response, Convolution-Sum representation of LTI Systems, CT Unit Impulse Response, Convolution-Integral Representation of LTI Systems, Fourier Series Representation of Continuous and Discrete Time Periodic Signals, Properties of Continuous and Discrete Time Fourier Series, Continuous and Discrete time Fourier Transform, Sampling, Laplace and Z transforms, Region of convergence , BIBO stability, LTV systems.

Title of Subject	:	MECHANICAL VIBRATIONS

1. Vibration: Basic concepts and classification, elements of vibrating systems, harmonic motion, nature and significance of vibration in machines;
2. Free vibration of first and second order single-degree-of-freedom systems, energy methods;
3. Forced vibrations of single-degree-of-freedom systems: Transient and steady state component; rotating unbalance, rotor static and dynamic unbalance.
4. Transient Vibration
5. Frequency response: magnitude and phase;
6. Vibration isolation.
7. Transmissibility ratio
8. Design for vibration isolation systems for reciprocating and rotary machines;
9. Vibration measurement: Transducers, vibration pickups, accelerometers, vibration exciters, signal analysis, power spectral density, machine condition monitoring and analysis ;
10. Stability analysis of engineering systems.
11. Two degree of freedom system: Normal mode analysis, initial conditions, coordinates coupling, forced harmonic vibration, vibration absorbers.
12. Multi degree of freedom system: Newton's dynamics, Lagrange's equation, and modern analysis for multiple degrees of freedom systems.

Title of Subject	:	STATISTICS AND PROBABILITY

Introduction: Nature and importance of statistics, descriptive and inferential statistics, population andsamples.

Descriptive Measures: Measures of central tendency and measures of dispersions.

Probability: Introduction to probability, counting techniques, dependent and independent events, conditional probability, additive rule of probability. Contingency tables, joint and marginal probabilities, the multiplication rule, Bayes's theorem.

Probability Distribution: Concept of random variables, discrete and continuous probability distributions., Mean and variance of a random variables. Binomial and Poisson distributions, mean and variance of Binomial and Poisson distribution.Normal distribution, Standard normal distribution and inverse use of table of areas under the normal curve.

Sampling Distribution: Sampling distribution of means with replacement and without replacement, Central limit theorem.

Estimation of Parameters: Confidence interval of one population mean, estimation a population mean, estimating the difference between two population mean. The Chi-square distribution.

Tests of Hypothesis: Testing a statistical hypothesis, Type I & II error, one tailed and two tailed tests. Test concerning means and variances, testing the difference between two means, Good-ness of fit test.

Simple Regression and Correlation: Regression analysis by least squares method, testing the significance of the slope, simple correlation analysis, coefficient of correlation, testing the significance of coefficient of correlation.

Title of Subject	:	CONTROL SYSTEMS

Basic Concepts, Modeling of Electrical, Mechanical and Electro-Mechanical Systems,

Transfer functions, Block Diagrams and Signal Flow Graphs. Response of First and Second Order Systems, Asymptotic/BIBO Stability and Routh-Hurwitz Stability Criterion. Performance Specifications of Linear Time-Invariant Control Systems, PID controller design, Root Locus Analysis, Root Locus Design, Frequency Response Analysis, Frequency Response Design, Bode plots, and Nyquist criterion. State space analysis and design.

Title of Subject	:	MACHINE DESIGN AND CAD/CAM

Introduction: The design process needs analysis, concept of contrivances or conceptualization, basic system concepts, optimization, cost evaluation, characteristics of a designer, standardization.

Springs – Helical and Leaf: Primary functions of springs, spring materials, design of helical springs, surge and vibration, buckling of compression springs, spring design formulae and general data, standard wire size, helical springs subjected to fatigue loading, construction of leaf spring, equalized stresses in spring leaves (Nipping), standard sizes of automobile suspension springs.

Fastening Devices: 1- Riveted Joints: Introduction, material for rivets, types of joints, design of riveted joint, structural joints, and boiler joints. **2- Welded Joints:** Introduction, types of joints, strength of fillet welded joints, eccentric loading. **3-Cotter and knuckle joints:** Types of cotter joints, design of: socket and spigot cotter joint, sleeve and cotter joint, Gib and cotter joint, design procedure of knuckle joint.

Gears: 1- Spur Gears: Introduction, design considerations of a gear drive, beam strength of gear teeth (Lewis equation), tooth loads (dynamic, static and wear), causes of gear tooth failure, design procedure for spur gears. **2- Helical Gears:** Introduction, equivalent spur gear and virtual number of teeth, design equation for helical gears, force analysis. **3- Bevel Gears:** Introduction, forces acting on a bevel gear, design of a shaft for bevel gears.

CAD/CAM: Design and analysis of some selected mechanical systems using suitable CAD packages.

Title of Subject	:	COMMUNICATION SKILLS

Introduction to Communication to skills

a. Communication Principles.
b. The process of communication.
c. Importance of good communication skills in business environment

Communication in business organizations

a. Internal-operational
b. External-operational
c. Personal
d. Challenge of communication in the global market.

Study Skills

a. Brain storming
b. Time-management
c. Effective reading strategies
d. Note-taking
e. Organization
f. Summarizing

Components of communication :

a. Context
b. Sender-Encoder
c. Message
d. Medium
e. Receiver-decoder
f. Feedback

Non Verbal Communication:

a. Appearance and dress codes
b. Body language
c. C., Silence, time and space
d. Importance of listening in communication

Functional English:

A. Defining factors in everyday communication:
   a. In business organization
   b. In social exchanges
B. Role-play/Speaking activities

Public Speaking:

a. Difference between speaking and writing.
b. Reading texts of good public speeches and analysis of their components.
c. Listening to famous public speeches.
d. Exercises in public speaking

Formal presentations:

A. Difference between informal and formal presentations
B. Modes of formal presentations
   a. Extemporaneous
   b. Prepared
   c. Reading out from a written text
   d. Combination of the above mentioned
C. Purpose of oral presentations
   a. Entertain
   b. Persuade
   c. Inform
   d. Sell
D. Mechanics of presentations
   a. Organization
   b. Preparation (including AVAs)

c. Rehearse
d. Present

E. Teacher shall model presentations both, with and without AVAs

Formal Presentations.

Student presentations.

Correctness of Written Communication:

A. Punctuation
B. Grammar: Some basic principles.
C. Error correcting Exercises.

Written Communication:

A. Systematic approach to effective written communication.
   a. Language
   b. Style
   c. Tone
   d. Organization
B. Practice of written communication for a variety of situations.

Title of Subject	:	**POWER ELECTRONICS**

POWER DIODE and TRANSISTOR

Power diode and its types, free-wheeling diodes, Power Transistor: BJT, MOSFET, IGBT and COOLMOS; Control characteristics of power devices

THYRISTOR

Principle of operation, characteristics, two transistor model of SCR, Thyristor Turn-on and Turn off , Commutation techniques, Thyristor firing circuits , Series and Parallel operation of thyristors. Protection and cooling

POWER ELECTRONIC CONVERTERS

Un-controlled and controlled rectifiers, DC-DC converters, Inverters, AC voltage controllers DC link converters, Cyclo converters.

POWER ELECTRONIC DRIVES

Speed control of Induction motors, Direct current motors - Stepper motor drives- BLDC motor - Application of PLC in solid state drives.

POWER ELECTRONIC APPLICATIONS

Industrial heating, welding, Switched mode power supplies. UPS, Power Electronics in vehicles and renewable energies.

Title of Subject	:	**ENGINEERING ECONOMICS AND PROJECT MANAGEMENT**

Introduction to economic analysis: meaning and concept of economic analysis. Rational decision making. Relationship between engineering and management. Engineering design and economic analysis.

Economic Costs: Fixed and variable costs. Direct and indirect costs. Life cycle cost. Opportunity cost. Cost estimation techniques. Time value of money.

Methods for evaluating economic feasibility/ profitability: Present Worth Method. Future Worth Method. Annual Worth Method. Internal Rate of Return method. External Rate of Return Method. Payback Period method.

Breakeven Analysis Depreciation: Depreciation concepts and terminology. Classical depreciation methods. Modern depreciation methods.

Replacement Analysis: Reasons for replacement analysis. Factors considered in replacement analysis. Determining economic life of new and existing asset.

Project Management Basics: Project life cycle. Project organization. Human resources issues in project management.

Project Planning and Scheduling: work Breakdown Structures. Network techniques: CPM and PERT. Scheduling with or without constraints on resources.

Project execution: Crashing. Project time/duration optimization. Monitoring and evaluation.

Risk Analysis: Risk identification. Risk assessment. Risk response options.

Computerized Project Management.

Title of Subject	:	ROBOTICS

Introduction: Robot components, Robot classification, Degrees of freedom

Kinematics: Rotation about Cartesian axes, Euler angles, General transformation, Homogeneous transformation, Denavit-Hartenberg notation, Forward and inverse position kinematics of a robot manipulator, Angular velocity vector and matrix, Forward velocity kinematics, Angular acceleration vector and matrix, Velocity Jacobian, Forward and inverse acceleration kinematics, Solution of kinematic problems using computer programs

Dynamics: Force and moment, Rigid body translational kinetics, Rigid body rotational kinetics

Sensing and Actuation: Selection and programming of sensors: Vision, Proximity and Touch Selection and programming of actuators: DC, Servo, Stepper motors

Control: Path planning, open and closed-loop control, Linear and non-linear control, Solution of control problems using computer program.

Title of Subject	:	MECHATRONICS SYSTEM DESIGN

Mechanical Design:

Mathematical Model. General equation of motion for a mechatronic system. Estimating Motor torques based on inertia of the system and the desired maximum velocity and acceleration. Estimating frictional forces due to dry friction and misalignment.

Designing for low friction and high-rigidity systems. Design of mechanical drive system. Ball screw design. Design of Linear Motion guides. Preparing workshop drawings of various mechanical components using CAD.

Preparing part program files for CNC machining of components using G-Simple or any other CAD/CAM package. These drawings and CNC codes will later become part of the final design document.

Electronics and Software Design:

Evolving schematic circuit diagrams for the electronic circuitry. H-bridge circuit design for servo motor control. Components selection. Development of computer hardware using modern microcontrollers or DSPs.

Pulse encoder interface circuit. Implementation of PID control algorithm. Interfacing other sensors with the microcontroller. Path planning algorithm, trajectory generation.

Front-end design. Data communication with other devices.

Title of Subject	:	DIGITAL SIGNAL AND IMAGE PROCESSING

Introduction to Digital Signal Processing: Basic Concepts of Digital Signal Processing, Overview of Typical Digital Signal Processing in Real-World Applications.

Discrete Fourier Analysis and Signal Spectrum: Discrete Fourier Series, Discrete Fourier Transform, Amplitude Spectrum and Power Spectrum, Fast Fourier Transform

The z-Transform: Definition, Properties of the z-Transform, Inverse z-Transform, Solution of Difference Equations Using the z-Transform.

Digital Signal Processing Systems, Basic Filtering Types and Digital Filter Realizations: The Difference Equation and Digital Filtering, Impulse Response, Step Response, and System Response, The z-Plane Pole-Zero Plot and Stability, Digital Filter Frequency Response, Basic Types of Filtering, Direct-Form I Realization, Direct-Form II Realization, Cascade (Series) Realization, Parallel Realization

Finite Impulse Response Filter Design: Finite Impulse Response Filter Design, Finite Impulse Response Filter Format, Fourier Transform Design, Window Method, Frequency Sampling Design Method, Optimal Design Method, Realization Structures of Finite Impulse Response Filters; Transversal Form; Linear Phase Form.

Infinite Impulse Response Filter Design: Infinite Impulse Response Filter Design, Infinite Impulse Response Filter Format, Bilinear Transformation Design Method, Impulse Invariant Design Method, Polo-Zero Placement Method, Realization Structures of Infinite Impulse Response Filters

Hardware and Software for Digital Signal Processors: Digital Signal Processor Architecture, Digital Signal Processor Hardware Units; Multiplier and Accumulator, Shifters, Address Generators, Digital Signal Processing Programming Examples

Adaptive Filters and Applications: Introduction to Least Mean Square Adaptive Finite. Impulse Response Filters, Basic Wiener Filter Theory, Applications; Noise Cancellation. Multi-rate Digital Signal Processing, Oversampling of Analog-to-Digital Conversion, and Under sampling of Band pass Signals: Multi-rate Digital Signal Processing Basics

Image Processing Basics: Image Processing Notation and Data Formats, Image Histogram and Equalization, Image Level Adjustment and Contrast, Image Filtering Enhancement, Image Pseudo-Color Generation and Detection, Image Spectra, Video Signal Basics.

Title of Subject	:	MANUFACTURING PROCESSES

Modern Casting:

Metal Forming and Powder Metallurgy: Rolling, forging, extrusion and drawing. Powder metallurgy.

Joining Processes: Welding and types of welding, weld ability, welding defects, brazing, soldering and adhesive bonding.

Material Removal Processes: Introduction to machine tools and their classification. Operations performed on Lathe, Shaper, Milling, Drill Press and grinders. Cutting fluids, , Numerical control (NC) basic components of a numerical control, Computer Numerical Control (CNC).

Non-Traditional Machining (NTM) Processes: Chemical machining (CHM), electrochemical machining process (ECM), water jet machining (WJM), and electrical discharge machining (EDM). Laser cutting Rapid prototyping.

Title of Subject	:	MACHINE INTELLIGENCE

Introduction: Foundation, scope, problems, AI definitions, History of AI, Artificial versus Natural Intelligence, Turing Test, Applications.

Intelligent Agents: Basic concepts, Structure of Intelligent Agents, Types, Reactive, deliberative, goal-driven, utility-driven, and learning agents, Environments, Real time agents.

Problem formulation and Solving through Search Methods: Formulating Problems, Searching for solutions, Search strategies, Informal Search Methods, Game Playing, Knowledge Representation (logic), Representing facts in logic, Predicate logic, Resolution unification, Question answering, non-monotonic reasoning, Statistical and probabilistic reasoning.

Knowledge Representation and Reasoning: Foundations of knowledge representation and reasoning, ontologies, Knowledge Representation(structured), Declarative representation, Semantic nets, Frames, Scripts, Procedural representation, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, description logics, reasoning topics.

Expert Systems: Introduction, Knowledge Base, Inference Engine, User Interface, Expert System Architectures, An analysis of some classic expert systems, Limitations of first generation expert systems

Decision-Making: Basics of utility theory, Decision theory, Sequential decision problems, Elementary game theory, Sample applications.

Machine Learning and Knowledge Acquisition: Learning from memorization, Examples, Explanation, and exploration, Learning nearest neighbor, Naive Bayes, and Decision tree classifiers, Q-learning for learning action policies, Perception, Techniques used in solving perceptual problems, Constraint Satisfaction, Applications.

Title of Subject	:	INDUSTRIAL AUTOMATION

Manufacturing Automation: Automation Theory; Faradism, Toyotism. Driving Forces and Manufacturing Strategies, Designing for Automation, Opportunities and Pitfalls of Automation.

Computer Numerical Control (CNC) Machining Requirements, Limitations of Conventional Machining, Advent of Numerical Control, Impact of Computer Technology, Building blocks of CNC, CNC Programming, Machining Codes, Computer Assisted Programming, CAD/CAM.

Programmable Logic Controllers (PLC): Introduction to PLC, PLC Architecture and Operation, Advantages / Limitations of PLC, Ladder Logic and other Programming Formats, Relay Logic, Timers, Counters, Comparator and Misc Math Instructions, Advent of 47 Numerical Control, Bit Shift Registers, Advanced Applications, Field bus, industrial data communication protocols, SCADA, HMI.

Title of Subject	:	SAFETY, HEALTH AND ENVIRONMENT

Introduction of health & Safety, Industrial Safety. Introduction, objectives of safety, Importance of safety in an industry, Industrial accidents, Types of accidents, Fire prevention and control.

Techniques of safety management, Principles of accident prevention, Hazard analysis, Legal, humanitarian and economic reason for action, safety inspection procedures, safety training, First aid and emergency procedures.

Importance of clean environment, Scale of environment pollution, Atmosphere pollution and its effect on human health and technologies for pollution control, Industrial wastes and its treatment. Noise pollution and its effects on human health. Remedial measures, ISO standard for safety, health and environment.

Communicable and non-communicable diseases, air borne and sanitation related diseases and control measures, Industrial Nuclear hygiene and safety equipment, Occupational health and safety in Pakistan, Labor code of Pakistan.

OHASA-18001. Pakistan Nuclear Regulatory Authority (PNRA) Regulations Pak 904 "Regulation on Radiation Protection-2004"

Title of Subject	:	ENTREPRENEURSHIP

Introduction to entrepreneurship: meaning and concept of entrepreneurship. Economic and social perspectives of entrepreneurship. Role and importance of entrepreneurship. Entrepreneurship in services sector. Entrepreneurial mindset. Forms of enterprise. Social and ethical responsibilities.

Entrepreneurial Process: Competing models of entrepreneurship. Developing and screening ideas. Identifying and evaluating opportunities. Business Plan. Business plan v/s Business Model.

Entrepreneurship and SMEs: defining SMEs- Role of SMEs in economic development. Financial and marketing problems of SMEs. Strategies for growth in SMEs.

Entrepreneurial Finance: financial objectives of entrepreneurial ventures. Sources of Funding for new ventures. Debit financing. Equity financing.

Entrepreneurial Marketing: Marketing research. Marketing Plan. Marketing strategies. Product marketing v/s Services marketing. Product and service quality.

Case studies.