Syllabus of

UNDERGRADUATE DEGREE COURSE

B.Tech. V Semester

Mechatronics Engineering

Rajasthan Technical University, Kota

Effective from session: 2022 – 2023

5MH3-01: Design of Machine Elements

Credit: 2 **Max. Marks: 100 (IA: 30, ETE: 70)**
2L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Design Fundamentals:** Design Process - Computer aided design - Optimum design - Mechanical properties of materials - Types of loads - Stresses - Static, varying, thermal, impact and residual - Factors of safety - Theories of failure – Stress concentration factors.	6
3	**Design of Shafts, Keys and Couplings:** Design of Solid and Hollow shafts- Based on strength, rigidity and deflection- Torsional rigidity- Lateral rigidity- Material constants- Design of Keys-Types-Keyways – Design of rigid and flexible couplings.	6
4	**Gears:** Principles of gear tooth action - Gear correction - Gear tooth failure modes - Stresses and loads – Component design of spur, helical, bevel and worm gears. Design of speed reducers.	4
5	**Brakes and Clutches:** Dynamic and thermal aspects of braking – Design of brakes - Design of clutches- Single plate – Multi plate – Conical clutch.	4
6	**Bearings:** Design of Bearings – Sliding contact – Selection of Rolling contact bearings from manufacturers catalogue	3
7	**Design for fatigue loading:** Endurance limit, endurance limit modifying factors, Soderberg Goodman's criterion, design for finite life.	2
	TOTAL	26

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SYLLABUS

3rd Year - V Semester: B.Tech. (Mechatronics Engineering)

5MH4-02: Power Electronics

Credit: 3
3L+0T+0P

Max. Marks: 100 (IA: 30, ETE: 70)
End Term Exam: 3 Hours

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Power Semi Conductor Devices:** Principle of operation – Characteristics of power diodes, SCR, TRIAC, GTO, Power BJT, Power MOSFET and IGBT – Thyristor protection circuits.	7
3	**Phase Controlled Converters:** Uncontrolled and controlled converters – Single phase semi and full converters, 3 phase half converter and 3 phase full converter – effect of source inductance – Thyristor triggering circuits.	8
4	**DC to DC Choppers:** DC Chopper – control strategies – Principle of operation – step up and step down chopper – quadrant operation – Forced commutation – different techniques – voltage, current and load commutated choppers – triggering circuits.	8
5	**Inverters:** Voltage source inverters – series, parallel and bridge inverters – PWM techniques – sinusoidal PWM , modified sinusoidal PWM, multiple PWM – current source inverters.	8
6	**AC Voltage Controllers and Cycloconverters:** Single phase AC voltage controller – on - off control and phase control – multistage sequence control – step up and step down cycloconverters – three phase to single phase and three phase cycloconverters.	8
	TOTAL	40

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SYLLABUS

3rd Year - V Semester: B.Tech. (Mechatronics Engineering)

5MH4-03: Sensors

Credit: 3 **Max. Marks: 100 (IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Definition, principle of sensing & transduction , classification 1 Mechanical and Electromechanical sensor; Resistive (potentiometric type): Forms, material, resolution, accuracy, sensitivity; Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes.; Inductive sensor: common types- Reluctance change type, Mutual inductance change type, transformer action type, Magnetostrictive type, brief discussion with respect to material, construction and input output variable, Ferromagnetic plunger type, short analysis; LVDT: Construction, material, output input relationship, I/O curve, discussion; Proximity sensor.	7
3	Capacitive sensors: variable distance-parallel plate type, variable area-parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity; Stretched diaphragm type: microphone, response characteristics; Piezoelectric element: piezoelectric effect, charge and voltage co-efficient, crystal model, materials, natural & synthetic type, their comparison, force & stress sensing, ultrasonic sensors.	8
4	Thermal sensors: Material expansion type: solid, liquid, gas & vapor ; Resistance change type: RTD materials, tip sensitive & stem sensitive type, Thermister material, shape, ranges and accuracy specification; Thermoemf sensor: types, thermoelectric power, general consideration , Junction semiconductor type IC and PTAT type.; Radiation sensors: types, characteristics and comparison; Pyroelectric type. Magnetic sensors**:** Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics; Radiation sensors: LDR, Photovoltaic cells, photodiodes, photo emissive celltypes, materials, construction,, response, Geiger counters, Scintillation detectors; Introduction to smart sensors;	12
5	**Smart Sensors:** Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors – applications - Automobile, Aerospace, Home appliances, Manufacturing, Medical diagnostics, Environmental monitoring.	6
6	**Wireless Sensor Networks (WSNs):** Characteristic requirements for WSN - Challenges for WSNs – WSN vs Adhoc Networks - Sensor node architecture, Applications Of WSN: WSN Applications - Home Control - Building Automation - Medical Applications-Military Applications.	6
	TOTAL	40

5MH4-04: Electrical Machines

Credit: 3 **Max. Marks: 100 (IA: 30, ETE: 70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Magnetic Circuits**: Magnetic circuits, magneto motive force magnetic field strength, permeability, reluctance, analogy between electric and magnetic-circuits, B-H curve, hysteresis, series and parallel magnetic circuits, practical magnetic circuits, permanent magnet and their applications.	7
3	**DC Generators**: Introduction, construction, types, emf equation, lap and wave windings, armature reaction, commutation, methods of improving commutation, equalizer rings. Demagnetizing and cross magnetizing ampere turns, various characteristics of shunt, series and compound generators, voltage build up, losses and efficiency, condition for maximum efficiency.	8
4	**DC Motors:** Introduction, principals, back-emf, torque of motor, types, characteristics of shunt, series and compound motors, speed control (field and armature control methods), basic idea of solid state devices in controlling of DC motors. Starting of DC motors, three point and four point starters, losses and efficiency, testing (brake test and swimburnes test), electric braking of DC motors, Applications.	8
5	**Electromechanical energy conversion:** Basic principles, conservation of energy, physical phenomenon involved in conversion, energy balance, energy stored in magnetic field.	8
6	**Special Electric machines:** Stepper motor: Basic principle, different types, variable reluctance, permanent magnet, hybrid type, comparison, theory of operation and applications. Servo motors: AC & DC Servo motors, construction, principle of operation, performance characteristics and applications. Brushless DC motors(BLDC): Construction, principle of working and applications.	8
	TOTAL	40

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5MH4-05: Modern Control Engineering

Credit: 3 **Max. Marks: 100 (IA: 30, ETE: 70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Basic Concepts:** Concept of Linear vector space Linear Independence, Bases & Representation, domain and range. Concept of Linearity, relaxedness, time invariance, causality.	7
3	**State Space Approach of Control System Analysis:** Modern Vs conventional control theory, concept of state, state variable state vector, state space, state space equations, Writing state space equations of mechanical, Electrical systems, Analogous systems.	7
4	**State Space Representation:** State Space Representation using physical and phase variables, comparison form of system representation. Block diagram representation of state model. Signal flow graph representation. State space representation using canonical variables. Diagonal matrix.Jordan canonical form, Derivation of transfer functions from state-model.	7
5	**Solution of State Equations:** Eigenvalues and Eigen vectors. Matrix. Exponential, State transition matrix, Properties of state transition matrix. Computation of State transition matrix concepts of controllability & observability, Pole placement by state feedback.	6
6	**Digital Control Systems:** Introduction, sampled data control systems, signal reconstruction, difference equations. The z-transform, Z-Transfer Function. Block diagram analysis of sampled data systems, Z and S domain relationship.	6
7	**Stability Criterion:** Modeling of sample-hold circuit, steady state accuracy, stability in z-plane and Jury stability criterion, bilinear transformation. Routh-Hurwitz criterion on S -planes, digital PID controllers, Introduction to adaptive control.	6
	TOTAL	40

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5MH5-11: Linear Integrated Circuit

Credit: 2 **Max. Marks: 100 (IA: 30, ETE: 70)**
2L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Operational Amplifiers**: Basic differential amplifier analysis, Single ended and double ended configurations, Op-amp configurations with feedback. 5 Op-amp parameters, Inverting and Non-Inverting configuration, Comparators, Adder.	6
3	**Operational Amplifier Applications**: Integrator, Differentiator, Voltage to frequency & Frequency to voltage converters. Oscillators: Phase shift oscillator, Wien Bridge oscillator, Quadrature oscillator, square wave oscillator, triangular wave oscillator, saw tooth oscillators. Voltage controlled oscillators.	6
4	**Active Filters**: Low pass filter, high pass filter, band pass and band reject filters, all pass filter. Switched capacitor filter, Butterworth filter design, Chebyshev Filter design.	4
5	**Phase-Locked Loops**: Operating Principles of PLL, Linear Model of PLL, Lock range, Capture range, Applications of PLL as FM detector, FSK demodulator. 4 AM detector, Frequency translator, phase shifter, tracking filter, signal synchronizer and frequency synthesizer, Building blocks of PLL, LM565 PLL.	4
6	**Linear IC's**: Four quadrant multiplier & its applications, Basic blocks of linear IC voltage regulators, three terminal voltage regulators, Positive and negative voltage regulators. The 555 timer as astable and monostable multivibrators. Zero crossing detector, Schmitt trigger.	5
	TOTAL	26

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3rd Year - V Semester: B.Tech. (Mechatronics Engineering)

5MH5-12: I.C. Engine

Credit: 2 **Max. Marks: 100 (IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**History of IC Engines:** Nomenclature, Classification & Comparison, SI & CI, 4stroke- 2 stroke, First Law analysis, Energy Balance. Fuel-air cycles, Actual cycles..	3
3	**Testing & Performance:** Performance parameters, Measurement of operating parameters e.g. speed, fuel & air consumption, Powers, IHP, BHP, FHP, Efficiencies Thermal, Mechanical, Volumetric, Emission Measurement, Indian & International standards of Testing.	4
4	**Fuel & Combustion:** Combustion in CI & SI engines, Ignition Limits, Stages of combustion, Combustion parameters. Delay period and Ignition Lag, Turbulence and Swirl, Effects of engine variables on combustion parameters, abnormal combustion in CI & SI engines, Detonation & knocking, Theories of detonation, Control of abnormal combustion, Combustion chamber design principles, **Fuel:** Conventional Petroleum, structure, Refining Fuels for SI & CI engines, Knock rating, Additives, Fuels for Turbine & Jet Propulsion.	5
5	**Engine Systems & Components:** Fuel System (SI Engine), Carburetion & Injection, process & parameters, properties of A/F mixture, Requirements of A/F ratios, Simple carburetor and its working, types of carburetors, MPFI, types of injection systems in CI engine, fuel pumps and injectors, types of nozzles, spray formation. **Ignition System:** Conventional & Modern ignition systems Magneto v/s Battery, CB point v/s Electronic ignition, Fuel Ignition Energy requirements. Spark advance, centrifugal, vacuum Firing order, spark plugs.	4
6	**Engine Friction & Lubrication:** Determination of friction, Lubrication principles, Types of lubrication, Places of lubrication Bearings and piston rings etc., Functions of Lubrication, Properties, Rating and Classification of lubricating oil,Engine Cooling: Requirements of cooling, Areas of heat flow, High temperature regions of combustion chamber. Heat Balance, Cooling Systems, Cooling system components.	5
7	**Supercharging:** Objectives, Thermodynamic cycle & performance of super charged SI & CI engines, Methods of super charging, Limitations, Two stroke engines: Comparison of 4s & 2s engines construction & valve lining scavenging. Process parameters, systems, supercharging of 2 stroke engines. **Dual & Multi Fuel Engines:** Principle, fuels, Combustion, performance Advantages, Modification in fuel system.	4
	TOTAL	26

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

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3rd Year - V Semester: B.Tech. (Mechatronics Engineering)

5MH5-13: CNC Technology

Credit: 2 **Max. Marks: 100 (IA: 30, ETE: 70)**
2L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Fundamentals of CNC Machines:** Introduction to Computer Numerical Control: CNC Systems – An Overview of Fundamental aspects of machine control, Different types of CNC machines – Advantages and disadvantages of CNC machines.	5
3	**Constructional Features of CNC Machines and Retrofitting:** Features of CNC Machines: Structure, Drive Mechanism, gearbox, Main drive, feed drive, Spindle Motors, Axes motors. Timing belts and pulleys, Spindle bearing – Arrangement and installation. Slide ways. Re - circulating ball screws – Backlash measurement and compensation, linear motion guide ways. Tool magazines, ATC, APC, Chip conveyors. Retrofittingof Conventional Machine Tools: Modification to be carried out on conventional machines for retrofitting.	6
4	**Control Systems, Feedback Devices and Tooling:** Description of a simple CNC control system. Interpolation systems. Features available in a CNC system – introduction to some widely used CNC control systems. Types of measuring systems in CNC machines – Incremental and absolute rotary encoders, linear scale – resolver – Linear inductosyn – Magnetic Sensors for Spindle Orientation. Qualified and pre-set tooling – Principles of location – Principles of clamping – Work holding devices.	5
5	**CNC Part Programming:** Part Program Terminology-G and M Codes – Types of interpolation Methods of CNC part programming– Manual part programming– Computer Assisted part programming– APT language – CNC part programming using CAD/CAM-Introduction to Computer Automated Part Programming.	5
6	**Economics and Maintenance:** Factors influencing selection of CNC Machines – Cost of operation of CNC Machines–Practical aspects of introducing CNC machines in industries– Maintenance features of CNC Machines–Preventive Maintenance, Other maintenance requirements.	4
		26

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5MH4-21: Power Electronics Lab

Credit: 1.5 **Max. Marks: 100 (IA:60, ETE:40)**

0L+0T+3P

SN	Contents
1	Study of SCR, MOSFET & IGBT characteristics.
2	Detail Descriptions of UJT, R, RC firing circuits for SCR.
3	Detail Descriptions of Voltage & current commutated chopper.
4	Detail Descriptions of SCR phase control circuit.
5	Detail Descriptions of TRIAC phase control circuit.
6	Study of half controlled & fully controller converters.
7	Study of three phase AC regulator.
8	Detail Descriptions of Speed control of DC shunt motor using three phase fully controlled converter.
9	Detail Descriptions of SCR single-phase cyclo converter.
10	Detail Descriptions of SCR series and parallel inverters.
11	Detail Descriptions of IGBT Chopper.
12	Detail Descriptions of IGBT based PWM inverter (single phase).
	Important Note: It is mandatory for every student to undertake a Mini project. Mini project shall be a group activity. A group shall consist of maximum five students. Final evaluation shall include 30% weight age to mini project.

5MH4-22: Sensors Lab

Credit: 1 **Max. Marks: 100 (IA:60, ETE:40)**
0L+0T+2P

SN	Contents
1	Measurement of temperature using thermocouple, thermistor and RTD.
2	Measurement of displacement using POT, LVDT & Capacitive transducer.
3	Torque measurement using torque measuring devices.
4	Strain Measurement using strain gauge.
5	Servomotor position control using photo electric pickup.
6	Wave Shaping circuit.
7	Analog to Digital Converters.
8	Digital Comparator
9	Voltage to frequency converter.
10	Frequency to Voltage Converter.
11	Position and velocity measurement using encoders.
	Important Note: It is mandatory for every student to undertake a Mini project. Mini project shall be a group activity. A group shall consist of maximum five students. Final evaluation shall include 30% weight age to mini project.

5MH4-23: Electrical Machines Lab

Credit: 1.5 **Max. Marks: 100 (IA:60, ETE:40)**
0L+0T+3P

SN	Contents
1	Load test on D.C. Shunt motor.
2	Speed control of D.C. Shunt Motor.
3	Speed control of Brushless D.C. Motor.
4	Swinburne's test.
5	Load test on three phase induction motor.
6	No load and blocked rotor tests on three-phase induction motor.
7	Load test on single phase induction motor.
8	No load and blocked rotor tests on single phase induction motor.
9	Load test on Synchronous motors.
10	Performance characteristics of Stepper motor.
11	Performance characteristics of Servo motor
	Important Note: It is mandatory for every student to undertake a Mini project. Mini project shall be a group activity. A group shall consist of maximum five students. Final evaluation shall include 30% weight age to mini project.

Syllabus of

UNDERGRADUATE DEGREE COURSE

B.Tech. VI Semester

Mechatronics Engineering

Rajasthan Technical University, Kota

Effective from session: 2022 – 2023

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

3rd Year - VI Semester: B.Tech. (Mechatronics Engineering)

6MH3-01: Automobile Engineering

Credit: 2 **Max. Marks: 100 (IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Frame and Body:** Layout of chassis, types of chassis frames and bodies, their constructional features and materials. **Transmission system:** Clutch, single plate, multi plate, cone clutch, semi centrifugal, electromagnetic, vacuum and hydraulic clutches, Fluid coupling.	5
3	**Gear Boxes:** Sliding mesh, constant mesh, synchromesh and epicyclic gear boxes, automatic transmission system, Hydraulic torque converter, overdrive, propeller shaft, universal joints, front wheel drive, differential, Rear axle drives, hotchkiss and torque tube drives; rear axle types, Two wheel and four wheel drive.	5
4	**Running Gear:** Types or wheels and tyres, Tyre construction, tyre inflation pressure, tyre wear and their causes, re-treading of the tyre, steering system, steering gear boxes, steering linkages, steering mechanism, under and over steering, steering geometry, effect of camber, caster, king pin inclination, toe in and toe out, power steering, integral and linkage types suspension system, objects and requirements, suspension spring, front and rear suspension systems, Independent suspension system shock absorber. **Brakes:** Classification and function, mechanical, hydraulic, vacuum air and self engineering brakes, brake shoes and lining materials.	6
5	**Automotive Electrical System:** Battery construction, charging and testing, battery types, starting and battery charging system, starter motor construction, types of drive, alternator construction, regulation and rectification. **Ignition System:** Magneto and coil ignition systems, system components and requirements. **Automotive Lighting:** Wiring systems, electrical instruments, head lamp, electric horn, fuel level indicator.	6
6	**Automotive Air Conditioning:** Introduction, loads, air conditioning system components, refrigerants, fault diagnosis. **Automotive Safety:** Safety requirements, Safety Devices, Air bags, belts, radio ranging, NVS (Night Vision System) GPS (Global Positioning System) etc.	4
	TOTAL	27

6MH4-02: MICROPROCESSOR AND EMBEDDED SYSTEM

Credit: 3 **Max. Marks: 100 (IA: 30, ETE: 70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	Introduction to computer architecture and organization, Architecture of 8-bit (8085) and 16-bit microprocessors, Bus configurations, CPU module. Introduction to Assembly language and machine language programming, Instruction set of typical 8-bit and 16-bit microprocessor, subroutines and stacks programming exercise. Timing diagrams, Memory families, Memory Interfacing, programmable peripheral interface chips.	07
3	**The 8086 Microprocessor Family:** 8086 ARCHITECTURE-Hardware specifications, Pins and signals, Internal data operations and Registers, Minimum and maximum mode, System Bus Timing, Linking and execution of Programs. **Software & Instruction Set:** Assembly language programming: addressing mode and instructions of 8086, Strings, Procedures and Macros, 8086 interrupts. Assembler Directives and operators.	03
4	**Multiprocessor Configurations:** - Multiuser / Multi tasking operating system concepts, 8086 based Multiprocessor systems. Introduction and basic features of 286, 386, 486 & Pentium processors. Introduction to ARM, DSP, MSP 430 and Ardino processor.	08
5	**Analog Interfacing:** A/D and D/A converter interfacing, keyboard and display interfacing, RS 232 & IEEE 488 communication standards. An 8086 based Process Control Systems. **Digital Interfacing:** Programmable parallel ports, Interfacing microprocessor to keyboard and alphanumeric displays, Memory interfacing and Decoding, DMA controller.	07

6	**THE 8051 MICROCONTROLLER**: Introduction, The 8051 microcontroller hardware, I/O pins, Ports, External memory, Counters and Timers, Serial data. **8051 ASSEMBLY LANGUAGE PROGRAMMING:** Addressing modes, External data moves, Stack, Push and Pop opcodes, Logical operations, Byte level and bit level logical operations. Arithmetic operations, Jump and call instructions, Interrupts & returns. **REAL TIME CONTROL**: Interrupts, Multiple sources of interrupts, Non maskable sources of interrupts, Interrupt structure in 8051, Timers, Free running counter & Real Time control.	**07**
7	**INTRODUCTION TO EMBEDDED SYSTEM:** Application of Microcontrollers in interfacing, MCU based measuring instruments. Real Time Operating System for System Design, Multitasking System, Task Definition in a Multitasking System, Round Robin Scheduling, Full Pre emptive Scheduling, Basic study and Features of Commercial RTOS :WINCE and Embedded Linux. **SYSTEM DESIGN**: Serial I/O interface, Parallel I/O ports interface, Digital and Analog interfacing methods, LED array, keyboard, Printer, Flash memory interfacing.	**07**
	Total	**40**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

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3rd Year - VI Semester: B.Tech. (Mechatronics Engineering)

6MH4-03: Applied Hydraulics & Pneumatics

Credit: 3 **Max. Marks: 100 (IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Fluid Power Systems and Fundamentals:** Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids – General types of fluids – Fluid power symbols. Basics of Hydraulics-Applications of Pascals Law- Laminar and Turbulent flow – Reynold's number – Darcy's equation – Losses in pipe, valves and fittings.	7
3	**Hydraulic System & Components:** Sources of Hydraulic Power: Pumping theory – Pump classification – Gear pump, Vane Pump, piston pump, construction and working of pumps – pump performance – Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting special cylinders like tandem, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators – Fluid motors, Gear, Vane and Piston motors.	8
4	**Design of Hydraulic Circuits:** Construction of Control Components : Directional control valve – 3/2 way valve – 4/2 way valve – Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram. Accumulators and Intensifiers: Types of accumulators – Accumulators circuits, sizing of accumulators, intensifier – Applications of Intensifier – Intensifier circuit.	8
5	**Pneumatic Systems and Components:** Pneumatic Components: Properties of air – Compressors – Filter, Regulator, Lubricator Unit – Air control valves, Quick exhaust valves, pneumatic actuators. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Penumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.	8
6	**Design of Pneumatic Circuits:** Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting.	8
	TOTAL	40

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6MH4-04: MEMS & Microsystems

Credit: 3 **Max. Marks: 100 (IA: 30, ETE: 70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Overview of MEMS and Microsystems:** Microelectromechanical Systems (MEMS) and Microsystems, Typical MEMS and Microsystem products, Evaluation of Microfabrication, Microsystem and microelectronics, the multidisciplinary nature of microsystem design and manufacture, Microsystems and miniaturization, Application of Microsystems in the automotive industry, applications of Microsystems in other industries. **Working Principles of Microsystems:** Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics.	7
3	**Engineering Science for Microsystem Design and Fabrication:** Introduction, atomic structure of matter, ions and ionization, moleculat theory of matter and intermolecular forces, doping of semiconductors, the diffusion process, plasma physics, electrochemistry, quantum physics. **Engineering Mechanics for Microsystem design:** Introduction, static bending of thin plates, mechanical vibration, thermomechanics, fracture mechanics, thin-film mechanics, overview of finite element stress analysis.	8
4	**Thermofluid Engineering and Microsystem design:** Introduction, overview of the basics of fluid mechanics in Macro and mesoscales, Basic equations in continuum fluid dyanimics, laminar fluid flow in circular conduits, computational fluid dynamics, Incompressible fluid flow in microconduits, fluid flow in submicrometer and nanoscale, overview of heat conduction in solids, heat conduction in multilayered thin films, heat conduction in solids in submicrometer scale. **Scaling laws in Miniaurization:** Introduction to scaling, scaling in geometry, scaling in rigid-body dynamics, scaling in electrostatic forces, scaling in electromagnetic forces, scaling in electricity, scaling in fluid mechanics, scaling in heat transfer.	8

5	**Materials for MEMS and Microsystems:** Introduction, substrate and wafers, active substrate materials, silicon as a substrate material, silicon compounds, silicon piezoresistors, gallium arsenide, quartz, piezoelectric crystals, polymers, packaging materials. **Microsystem Fabrication Processes:** Introduction, Photolithography, Ionimplantation, diffusion, oxidation, chemical vapor deposition, physical vapor deposition-sputtering, deposition by epitaxy, etching.	**8**
6	**Overview of Micromanufacturing:** Introduction, bulk micromanufacturing, surface micromachining, LIGA. **Microsystem Design:** Introduction, design consideration, process design, mechanical design, mechanical design using finite element method, design of a silicon die for a micropressure sensor, design of microfluidic network systems, design case: capillary electrophoresis network system.	**8**
	TOTAL	**40**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

3rd Year - VI Semester: B.Tech. (Mechatronics Engineering)

6MH4-05: Object Oriented Programming

Credit: 3 **Max. Marks: 100 (IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**OOP Paradigm:** Software crisis – Software evolution – A look at procedure oriented programming – Object oriented programming paradigm – Basic concepts of object oriented programming – Benefits of OOP – Reusability – Security – Object oriented programming fundamental – Abstraction – Encapsulation – Derivation – Object oriented languages and packages–Applications of OOP - What is C++? – A simple C++ program – More C++ statements – Structure of C++ Program.	7
3	**Introduction to C++:** Tokens – Keywords – Identifiers and constants – Basic data types – User defined data types – Derived data types – Symbolic constants – Declaration of variables – Dynamic initialization of variables – Reference variables – Operators in C++ – Scope resolution operator – Manipulators – Type cast operator – Expressions and their types – Special assignment expressions – Control structures - The main function – Function prototyping – Call by reference – Return by reference – Inline functions – Default arguments – Function overloading.	8
4	**Classes and Objects:** Specifying a class – Defining member functions – Private member functions –Arrays within a class – Memory allocation for objects – Static data members – Static member functions – Arrays of objects – Objects as function arguments –Friendly functions – Returning objects. Constructors: Parameterized constructors – Multiple constructors in a class – Constructors with default arguments – Dynamic initialization of objects – Copy constructor – Dynamic constructors – Destructors.	8
5	**Operator Overloading, Inheritance and Polymorphism:** Defining operator overloading: Overloading unary, binary operators. Manipulation of strings using operators – Rules for overloading operators – Type Conversions - Defining derived classes – Single inheritance – Multilevel inheritance – Multiple inheritance – Hierarchical inheritance – Hybrid inheritance – Virtual base classes – Abstract classes - Introduction to pointers to objects: This pointer – Pointers to derived classes – Virtual functions – Pure virtual functions.	8
6	**Case Studies:** Over view of typical object oriented systems – Case studies - Applications.	8
	TOTAL	40

6MH5-11: Principles of Management

Credit: 3 **Max. Marks: 100 (IA: 30, ETE: 70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Basics of Global Management:** Definition of Management – Science or Art – Management thought and Patterns of management analysis – System approach to the Management process – Functions of Manager – Responsibilities of Manager – Ethics in managing – International management and multinational corporations.	7
3	**Planning:** Types of Plans – Steps involved in Planning – Objectives – Setting Objectives – Benefits and weaknesses of Management by Objectives – Strategies, Policies & Planning Premises- Forecasting – Decision-making.	8
4	**Organising:** Nature and Purpose – Formal and informal organization – Organization Chart – Structure and Process – difference strategies – Line and Staff authority – Benefits and Limitations – De-Centralization and Delegation of Authority – Staffing – Selection Process - Techniques – HRD – Managerial Effectiveness.	8
5	**Leading:** Scope – Human Factors – Creativity and Innovation – Harmonizing Objectives – Leadership – Types of Leadership Motivation – Hierarchy of needs – Motivation theories – Motivational Techniques – Job Enrichment – Communication – Process of Communication – Barriers and Breakdown – Effective Communication – Electronic media in Communication.	8
6	**Controlling:** System and process of Controlling – Requirements for effective control – The Budget as Control Technique – Information Technology in Controlling – Use of computers in handling the information – Productivity – Problems and Management – Control of Overall Performance – Direct and Preventive Control – Reporting – The Global Environment – Globalization and Liberalization – International Management and Global theory of Management.	8
	TOTAL	40

6MH5-12: Thermal Engineering

Credit: 3 **Max. Marks: 100 (IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Conduction:** Fourier's law of heat conduction, Heat conduction equation for homogeneous isotropic materials in Fourier's law of heat conduction, Heat conduction equation for homogeneous isotropic materials in Plane wall temperature distribution and heat transfer, Electrical analogy of heat transfer, Composite walls, critical thickness of insulation, Fins – General Equation of fins, Different cases of fins, Effectiveness and Efficiency.	7
3	**Convection** - Forced Convection Fundamentals, no-slip and no temperature-jump conditions, local and average heat transfer coefficients, Nusselt number, Forced convection over a flat plate: momentum and thermal boundary layer, Prandtl number, Prandtl number range for various fluids, Natural Convection, Physical mechanism, Steady laminar free convection from an isothermal vertical plate: correlations of local and average Nusselt numbers; Concept of Grashoff number.	8
4	**Radiation:** Planck's law, Stefan-Boltzmann law, Wien's displacement law, Intensity of radiation: total and spectral, relation to irradiation, Absorptivity, reflectivity and transmissivity, emissivity; definition of black, gray& diffuse surfaces; Kirchhoff's law; View Factor, reciprocity theorem, Fij for plane, convex and concave surfaces.	8
5	**Heat Exchangers:** Classification: parallel flow & counter flow, Overall heat transfer coefficient, Fouling factor, Analysis of heat exchangers: derivation of the expression of LMTD, effectiveness, NTU method: applicability, physical significance of NTU.	8
6	**Refrigeration and Air Conditioning:** Refrigerants – Vapour Compression Refrigeration cycle- super heat, sub cooling – Performance calculations – Working Principle of vapour absorption system, Ammonia – Water, Lithium bromide, - water systems (Description only). Air conditioning system- Processes, Types and Working Principles. Concept of RSHF, GSHF, ESHF – Cooling load calculations	8
	TOTAL	40

6MH5-13: Aircraft Electronics System

Credit: 3 **Max. Marks: 100 (IA: 30, ETE: 70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Aircraft Electrical Power:** A.C. Power generation, D.C. Power generation, emergency power generation, voltage regulation, power distribution, inverters, transformers, rectifiers, circuit protection, external/ground power. Batteries installationand operation, Electronic emergency equipment requirements, cabin entertainment equipment, internal and external lightings of aircraft.	7
3	**Aircraft instruments:** Generalized configurations and performance characteristics of instruments, motion requirement, relative displacement and velocity. Translational and seismic displacement, velocity and acceleration measurements. Torque measurement and rotating shaft, pressure and flow measurements. Fuel gauging systems, temperature based on expansion, electric resistance and radiation methods, Problems involved in temperature measurements, compensation techniques, magnetic compasses. Electrostatic Sensitive Devices, Electromagnetic Environment	7
4	**AIRBORNE EQUIPMENTS:** Requirements for airborne equipment, sensors for the measurement of position, altitude, air speed, acceleration, temperature, fuel flow and quantity. Instrument displays, panels and cockpit layout, flight instruments, gyroscopic instruments, power plant instruments, navigation instruments miscellaneous instruments RLG's. Classification, Atmosphere, Pressure measuring devices and systems, Pitot static system, Altimeters, Vertical speed indicators, Air speed indicator, Mach meter, Altitude reporting/alerting system, Air data computer, Instrument Pneumatic System, Direct reading pressure & temperature gauges, Temperature indicating system, Fuel quantity indicating system, Gyroscopic principles, Artificial horizon, Turn & slip indicator, Directional gyro, Ground proximity warning systems, Compass systems, Flight data recording systems, Instrument warning systems including master warning systems and centralized warning panels. Stall warning systems and angle of attack indicating system, Vibration measurement and Indication (HUMS), Compass system, Flight data recording system, Working principle of flight director system (FDS), Inertial navigation system, System operation: Electrical, fly by wire, Turn co-ordinator. Moving map displays, multifunction displays, head-up displays, glass cockpit. Cockpit lighting, panels: integral, glopanels.	10

5	**TYPICAL ELECTRONIC//DIGITAL AIRCRAFT SYSTEMS** ECAM (Electronic Centralized Aircraft Monitoring) EFIS (Electronic Flight Instrument Systems) EICAS (Engine Indicating & Crew Alerting Systems) FMS (Flight Management Systems) .	**7**
6	**AUTOFLIGHT (ATA 22)** Fundamental of automatic flight control including working principles and current terminology Command signal processing, Modes of operation; Roll, pitch and yaw channels, yaw dampers, Stability augmentation system in helicopter, Automatic trim control, Autopilot navigation aids interface, Auto throttle system **AUTOMATIC LANDING SYSTEM** Principles and categories, modes of operation, approach, glide slope, land; go- around, system monitors and failure conditions. **AVIONICS SYSTEMS** Fundamentals of System Layout	**8**
	TOTAL	**40**

6MH4-20: Automobile Engineering Lab

Credit: 1.5 **Max. Marks: 100 (IA:60, ETE:40)**

0L+0T+3P

SN	Contents
1	Demonstration of 2-stroke engine.
2	Demonstration of 4 stroke engine.
3	Demonstration of diesel engine.
4	Demonstration of petrol engine.
5	Valve refacing and valve seat grinding and checking for leakage of valves.
6	Trouble shooting in cooling system of an automotive vehicle.
7	Trouble shooting in the ignition system, setting of contact breaker points and spark plug gap.
8	Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.
9	Trouble shooting in braking system with specific reference to master cylinder, brake shoes, overhauling of system and the adjusting of the system and its testing.
10	Fault diagnosis in transmission system including clutches, gear box assembly and differential.
11	Replacing of ring and studying the method of replacing piston after repair.
	Important Note: • Study also includes Assembly and disassembly of above systems • It is mandatory for every student to present a term paper. Term paper shall be a group activity. A group shall consist of maximum two students. Final evaluation shall include 30% weight age to term paper. Term paper shall cover study or survey of new technologies in above systems.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

3rd Year - VI Semester: B.Tech. (Mechatronics Engineering)

6MH4-21: MICROPROCESSOR AND EMBEDDED SYSTEM

Credit: 1.5 **Max. Marks: 100 (IA:60, ETE:40)**

0L+0T+3P

SN	Contents
A	**Following exercises are to be done in 8085 assembly language**
	1. Arranging a set of data in Ascending and Descending order.
	2. Finding out number of Positive, Negative and Zeros from a Data Set.
	3. Searching the Existence of a certain data in a given data.
	4. BCD to Binary conversion.
	5. Multiply Two 8 Bit Numbers using Successive Addition and Shifting method.
	6. Find Factorial of a number.
	7. Solve the given Algebraic Equation.
	8. A program to display real time clock. Assume a periodic signal is interrupting RST 7.5 signal after every 0.5 seconds.
B	**Following exercises are to be done in 8051 Assembly Language**.
	1.Add 'N' 8 Bit Numbers
	2 .Transfer Data from Code Memory to Internal Memory
	3 .Convert a given Hex number to BCD
	4. Implement a Four Variable Boolean Function using K-Map Minimization.
	5 .Convert deg. Centigrade to deg. Fahrenheit.
	6 .16 bit Multiplication (use add and shift method)
	7 .Find Largest and Smallest Numbers among 10 Numbers.
	8 .Using Look up Table and DPTR as the Base find Square of a Number in the Accumulator
	9.Implement a Mathematical Calculator which executes various Arithmetic operations based on the choice entered in register R4.
C	**8051 Interfacing Programs**
	1. Interface LED Bank with 8051 to flash LED's using timer.
	2. Interface Seven Segment Display with 8051.
	3. Interface Stepper Motor with 8051 in Continuous and Step mode
	4. Interface D/A converter with 8051.
	5. .Interface A/D converter MCP3204 with 8051 usingSPI.
	Important Note: It is mandatory for every student to undertake a Mini project. Mini project shall be a group activity. A group shall consist of maximum five students. Final evaluation shall include 30% weight age to mini project.

6MH4-22: Object Oriented Programming Lab

Credit: 1.5 **Max. Marks: Max. Marks: 100 (IA:60, ETE:40)**

0L+0T+3P

SN	Contents
1	Programs Using Functions (i) Functions with default arguments (ii) Implementation of Call by Value, Call by Address and Call by Reference
2	Simple Classes for understanding objects, member functions and Constructors (i) Classes with primitive data members (ii) Classes with arrays as data members (iii) Classes with pointers as data members – String Class (iv) Classes with constant data members (v) Classes with static member functions
3	Compile time Polymorphism (i) Operator Overloading including Unary and Binary Operators. (ii) Function Overloading
4	Runtime Polymorphism (i) Inheritance (ii) Virtual functions (iii)Virtual Base Classes (iv) Templates
5	File Handling (i) Sequential access (ii) Random access
	Important Note: It is mandatory for every student to undertake a Mini project. Mini project shall be a group activity. A group shall consist of maximum five students. Final evaluation shall include 30% weight age to mini project.

6MH4-23: Applied Hydraulics & Pneumatics Lab

Credit: 1.5 **Max. Marks: 100 (IA:60, ETE:40)**

0L+0T+3P

SN	Contents
1	**Design and testing of hydraulic circuits such as** (i) Pressure control (ii) Flow control (iii)Direction control (iv) Design of circuit with programmed logic sequence, using an optional PLC in hydraulic Electro hydraulic Trainer.
2	**Design and testing of pneumatic circuits such as** (i) Pressure control (ii) Flow control (iii)Direction control (iv) Circuits with logic controls (iv)Circuits with timers (vi) Circuits with multiple cylinder sequences in Pneumatic Electro pneumatic Trainer.
3	Modeling and analysis of basic electrical, hydraulic, and pneumatic systems using **MATLAB/LABVIEW** software
4	Simulation of basic hydraulic, pneumatic and electrical circuits using Automation studio software
	Important Note: It is mandatory for every student to undertake a Mini project. Mini project shall be a group activity. A group shall consist of maximum five students. Final evaluation shall include 30% weight age to mini project.