Savitribai Phule Pune University

Department of Technology

STRUCTURE OF 2 YEARS FULL TIME DIPLOMA IN MECHATRONICS

The course consists of four Semesters. The semester wise courses are given below.

Eligibility :- 12th, NTVC, ITI

Intake:- 60

Semester-I		Subject Type	Credits
DM1	Mechanical Drawing and Drafting	Theory	4 Credits
DM2	Basic Mechanical Engineering	Theory + Practical	4 Credits
DM3	Basic Electrical and Electronics Engg	Theory + Practical	4 Credits
DM4	Applied Mechanics	Theory	4 Credits
DM5	Analog and Digital Electronics	Theory + Practical	4 Credits
DM6	Fundamental of Programming Language- Lab	Practical	2 Credits
		Total Credits	**22**

Semester-II		Subject Type	Credits
DM7	Manufacturing Process	Theory	4 Credits
DM8	Microcontroller Programming	Theory + Practical	4 Credits
DM9	PLC Programming and SCADA	Theory + Practical	4 Credits
DM10	Industrial Measurement	Theory + Practical	4 Credits
DM11	Computer Aided Mechatronics Drafting	Practical	4 Credits
DM12	Seminar-I	Practical	2 Credits
		Total Credits	**22**

Semester-III		Subject Type	Credits
DM13	Industrial Robotics	Theory + Practical	4 Credits
DM14	Elements of Automotive Energy Management	Theory	4 Credits
DM15	Automotive Mechatronics & Control System	Theory	4 Credits
DM16	CNC Machine and Tool Technology	Theory + Practical	4 Credits
DM17	Interim Project	-	6 Credits
		Total Credits	**22**

Semester-IV		Subject Type	Credits
DM18	Solid Modeling & Additive Manufacturing	Theory	4Credits
DM19	Internet of Things	Theory + Practical	2 Credits
DM20	Elective	Theory	4 Credits
DM21	Final Project	-	12 Credits
		Total Credits	**22**

List Of Electives
1. Safety and Automotive industrial Standards
2. Cloud Computing
3. Machine Learning

Subject Type	Credits
Practical	--

Subject Code: DM1

Subject Name: Mechanical Drawing and Drafting

Teaching Scheme: Credit 4

Lectures: 3 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total - 100

Unit 1:- Development of surface

Development of Lateral surfaces of Cube, prisms, cylinder, pyramids, cpne. Application of development of surfaces such as Tray, funnel.

Unit 2:- Intersection of Solids

Curves of intersection of surfaces of the regular solids on the following cases:-

Prism with prism (Tri-angular and square), cylinder with cylinder, square prism with cylinder when

(i) The axes are at 90 degree and bisecting (ii) The axes are at 90 degree and offset

Cylinder with cone: when axis of cylinder is parallel to both the reference planes, cone resting on base on HP with axis intersecting, and offset from axis of cylinder

Unit 3:- Conventional Representation

Conventional Breaks in Pipe, Rod and shaft. Conventional representation of common features like slotted head, radial rib, knurling, serrated shaft, splined shaft, ratchet and pinion, repeated parts, square on shafts, holes on circular pitch, internal and external thread. Conventional representation of standard parts like ball and roller bearing, gears, springs. Pipe joints and valves. Counter sunk and Counter bored holes.

Tapers (As per standard conventions using IS SP-46 (1988)

Unit 4:- Production Drawings

Limits, Fits and Tolerances: a) Definitions, introductions to ISO system of Tolerance.

b) Dimensional tolerance Terminology, selection and dimensional and grade representation tolerance-number of method. Definitions concerning Tolerancing and Limits system, unilateral and bilateral tolerance, Hole and shaft base systems, Types of fits- Clearance, transition and Interference, Selection of fit for engineering applications. Calculation of limit sizes and identification of type of fit from the given sizes like $50 H7/s6, $30 H7 /d9 etc.

Geometrical Tolerances: Types of geometrical tolerances, terminology for deviation, representation of geometrical tolerance on drawing.

General welding symbols, length and size of weld. surface contour and finish of weld, all round and site weld, symbolic representation in Engineering practices and its interpretation.

Machining symbol and surface texture: Indication of machining symbol showing direction of lay, sampling length, roughness grades, machining allowances, manufacturing methods. Representation of surface roughness on drawing.

Unit 5:- Details to Assembly

Introduction, types of assembly drawing, accepted norms to be observed for assembly drawings, sequence for preparing assembly drawing. Bill of Material. Couplings: Oldham and Universal couplings.

Bearing: Roller, Foot Step and Pedestal Bearing. Lathe Single (pillar type) and Square tool Post.

Bench vice and Pipe Vice. Screw Jack. Valve: Steam stop, Non-return valve. Piston and connecting rod of IC engine. Lathe machine: tail stock. Drill Ji. Any other assembly consisting of 6 - 10 parts.

Unit 6:- Assembly to Details

Principles of process of dismantling the assembly into Basic components. Details of all assemblies mentioned in unit.

Subject Code: DM2

Subject Name: Basic Mechanical Engineering

Teaching Scheme: Credit 4

Lectures: 3 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total - 100

Unit 1:- Introduction to Mechanical Engineering

Mechanical Elements: Function, Sketch, Description, Uses of - Shaft, Axle, Key (Parallel key), Coupling (Rigid Flanged Coupling), Bearing - (Ball bearing), Clutch - Single Plate Clutch, Brake - Disc Brake. Power Transmission Devices: Construction, working, comparison and applications of: Belt Drive (Flat and V Belt). Chain Drive and Spur Gear Drive arranged with simple gear train.

Unit 2:- Design Fundamental

Design: Steps in design process, Mechanical Properties (Strength, Toughness, Hardness, Ductility, Malleability. Brittleness, Elasticity, Plasticity, Resilience, Fatigue, Creep) and selection of Engineering materials, Applications of following materials in engineering - Aluminum, Plastic, Steel, Brass, Cast Iron, Copper, Rubber, Mechanism (Descriptive treatment only): Definition and comparison of Mechanism and Machine, Four Bar Mechanism, Slider Crank Mechanism.

Unit 3:- Manufacturing Processes

Introduction to Manufacturing Processes and their Applications (Casting, Forging, Sheet metal working and Metal joining processes), Description of the Casting process: Sand casting (Cope and Drag), Sheet metal Forming (shearing, bending, drawing), Forging (Hot working and cold working comparison), Electric Arc welding. Comparison of Welding, Soldering, Brazing.

Unit 4:- Machine Tools

Basic Elements, Working Principle, Types of Operations with block diagram: Lathe Machine -Centre Lathe, Drilling Machines, Grinding Machines.

Unit 5:- Thermal Engineering

Thermodynamics: Thermodynamics system (open, close, isolated), Thermodynamic Properties: Definition and Units of -Temperature, Pressure (atmospheric, absolute and gauge), Volume, Internal energy, Enthalpy, Concept of Mechanical work, Thermodynamics Laws with example - Zeroth Law, First Law, Limitations of first law, Concept of heat Sink, Source, heat engine, heat pump, refrigeration engine, 2nd Law of thermodynamics statements (Kelvin Plank, Claussius), Numerical on 2nd law only.

Measurement: Measurement of Temperature (Thermocouple Type according to temperature range and application), Measurement of Pressure (Barometer, Bourdon pressure gauge, Simple U tube Manometer with numerical).

Unit 6:- Applied Thermal Engineering

Power Plant Engineering: conventional and non-conventional energy resources, Hyper-electric, Thermal, Nuclear, wind, Solar [with block diagram]

Power Producing Devices: Boiler - Water tube and fire tube, internal combustion engine - Two stroke and four stroke (Spark ignition and compression ignition), Turbines - Impulse and reaction.

Power Absorbing Devices: Pump Reciprocating and Centrifugal, Compressor Single acting, single stage reciprocating air compressor, Refrigeration - Vapour compression refrigeration process, House hold refrigerator, Window air conditioner (Working with block diagrams).

Subject Code: DM3 **Examination Scheme:**

Subject Name: Basic Electrical and Electronics Engg **Mid Semester: 25**

Teaching Scheme: Credit 4 **Internal Assessment: 25**

Lectures: 3 **Hrs** / week **End Semester: 50**

Total - 100

Unit 01:- Electric and Magnetic Circuits

E.M.F., Current, Potential Difference, Power and Energy. M.M.F. Magnetic Force, Permeability, Hysteresis Loop, Reluctance, Leakage Factor and B-H Curve. Analogy between Electric and Magnetic Circuits. Electromagnetic Induction, Faraday's Laws of Electromagnetic Induction, Len's Law, Dynamically induced emf. Statically induced emf-(a) Self-induced emf (b) Mutually induced emf.; Equations of self and mutual inductance.

Unit 02:- A.C. Circuits

Cycle, Frequency, Periodic time, Amplitude, Angular velocity, RMS value, Average value, Form Factor, Peak Factor, impedance, phase angle and power factor. Mathematical and phasor representation of alternating emf and current; Voltage and Current relationship in Star and Delta connections. A.C. in resistors, inductors and capacitors; A.C. in R-L series, R-C series, R-L-C series and parallel circuits; Power in A.C. Circuits, power triangle.

Unit 03:- Transformer and Single phase Induction Motors

General construction and principle of different type of transformers, Emf equation and transformation ratio of transformers. Autotransformers. Construction and working principle of single phase A.C. motor.

Types of single-phase motors, applications of single-phase motors.

Unit 04:- Electronic Components and Signals

Active and Passive Components; Resistor, Capacitor, Inductor symbols, colour codes, Specifications.

Voltage and Current Sources. Signals: Waveform (sinusoidal, triangular and square), Time and Frequency domain representation, amplitude, Frequency, Phase, Wavelength, Integrated circuits: Analog and Digital.

Unit 05:- Diodes and Application.

PN junction diode: Symbol, construction, working and applications. Zener diode: Working, symbol, voltage regulator. Rectifiers: Half wave, Full wave and Bridge Rectifier, Performance parameters: PIV, ripple factor, efficiency. Filters: Circuit diagram and working of 'L', 'C' and 'n' filter. Light Emitting Diodes: Symbol, construction, working principle and applications.

Unit 06:- Bipolar junction Transistor

BJT: symbol, construction and working principle. Transistor as switch and amplifier.

Input and output characteristics CE, CB and CC configurations. Operating regions: Cut-off, saturation and Active. Transistor parameters: CB gain a, CE gain B, Input resistance, output resistance, relation between (a) and (B).

Subject Code: DM4

Subject Name: Applied Mechanics

Teaching Scheme: Credit 4

Lectures: 3 Hrs / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Unit 01:- Mechanics and Force system

Significance and relevance: Mechanics, applied mechanics, statics, dynamics. Space, time, mass, particle, body, rigid body. Scalar and vector quantity, Units of measurement (SI units) - Fundamental units and derived units. Force- unit, representation as a vector and by Bow's notation, characteristics and effects of a force, Principle of transmissibility of force, Force system and its classification.

Unit 02:- Simple lifting machine

Simple lifting machine, load, effort, mechanical advantage, applications and advantages. Velocity ratio, efficiency of machines, law of machine. Ideal machine, friction in machine, maximum Mechanical advantage and efficiency, reversible and non-reversible machines, condition for reversibility

Velocity ratios of Simple axle and wheel, Differential axle and wheel, Worm and worm wheel, Single purchase and double purchase crab winch, Simple screw jack, Weston's differential pulley block, geared pulley block. Graphs of Load verses Effort, Load verses ideal Effort, Load verses Effort lost in friction, Load verses MA, and Load verses Efficiency.

Unit 03:- Resolution and composition

Resolution of a force - Orthogonal and Non Orthogonal components of a force, moment of a force, Varignon's Theorem. Composition of forces - Resultant, analytical method of determination of resultant for concurrent, non-concurrent and parallel co-planar force systems - Law of triangle, parallelogram and polygon of forces. Graphic statics Graphical representation of force, Space diagram, force diagram, polar diagram and funicular polygon, Graphical method of determination of resultant for concurrent and parallel co- planar force systems.

Unit 04:- Equilibrium

Equilibrium and Equilibrant, Free body and Free body diagram, Analytical and graphical conditions of equilibrium. Equilibrium of force systems analytically Lami's Theorem. Types of beam, supports (simple, hinged, roller and fixed) and loads acting on beam (vertical and inclined point load, UD load, couple), span of beam. Beam reaction for cantilever, simply supported beam with or without overhang - subjected to combination of Point load and UD load or Vertical Point load and couple. Beam reaction graphically for simply supported beam subjected to vertical loads only.

Unit 05:- Friction

Friction and its relevance in engineering, types and laws of friction, limiting equilibrium, limiting friction, co-efficient of friction, angle of friction, angle of repose, relation between co-efficient of friction and angle of friction. Equilibrium of bodies on level surface subjected to force parallel and inclined to plane.

Equilibrium of bodies on inclined plane subjected to force parallel to the plane only.FBD of ladder in friction.

Unit 06:- Centroid and centre of gravity

Centroid of geometrical plane figures (square, rectangle, triangle, circle, semi- circle, quarter circle) Centroid of composite figures composed of not more than three geometrical figures

Centre of Gravity of simple solids (Cube, cuboid, cone, cylinder, sphere, hemisphere)

Centre of Gravity of composite solids composed of not more than two simple solids.

Subject Code: DM5

Subject Name: Analog and Digital Electronics

Teaching Scheme: Credit 4

Lectures: 3 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Unit 01:- Design of Combinational Circuit

Booleans algebra, De-Morgan theory etc., Karnaugh map: structure for two, three and four Variables. SOP and POS form reduction of Boolean expressions by K-map Design of combinational circuits using Boolean expression and K-map, encoder, decoder, half and full adder.

Unit 02:- Design of Sequential Circuit

Introduction to sequential circuit. Design of synchronous (K-map) and asynchronous counters. Up down counters, N modulo counters, Shift registers, ring and twisted ring counters.

Unit 03:-Digital Memories and Logic Families

(A) Digital memories: SRAM DRAM, ROM, EPROM.

(B) Digital logic families: PAL PLA, CPLD, FPGA.

Unit 04:- Operational Amplifier Applications

Open loop and close loop configuration of Op-Amp. Applications of Op-Amp-zero crossing detectors, Comparator. Schmitt trigger, V-l and I-V converters, Instrumentation amplifier, peak detector, Waveform generation using Op-amp-sine, square, saw tooth and triangular generator.

Unit 05:- Other Analog Circuits

Active filters-Its configuration with frequency response Analysis of first order low pass and high pass filters using OPAMP, IC 555-construction working and modes of operation- astable and monostable multi vibrators, Sequence generator, voltage regulators using IC78xx, 79, LM 317.

Unit 06:- Diode Rectifier

Single-phase half wave rectifier with R, RL loads. Single-phase full wave rectifier-Center tap and bridge rectifier supplying R and RL load and performance parameters. Three phase full wave bridge rectifier with R load.

Subject Code: DM6

Subject Name: Fundamental of Programming Language – Lab

Teaching Scheme: Credit 2

Lectures: 3 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Unit 01:- Program Planning Concepts

Algorithm; Advantages of Generalized Algorithms: How to Make Algorithms Generalized; Avoiding Infinite Loops in Algorithms - By Counting. By using a Sentinel Value; Different ways of Representing an Algorithm - As a Program. As a Flowchart. As a Pseudo code: Need for Planning a Program before Coding: Program Planning Tools - Flowcharts, Structure charts, Pseudo codes; Importance of use of Indentation in Programming: Structured Programming Concepts - Need for Careful Use of "Go to" statements, How all programs can be written using Sequence Logic, Selection Logic and Iteration (or looping) Logic, functions.

Unit 02:- Programming Languages

What is a Programming Language: Types of Programming Languages - Machine-level, Assembly-level and High-level Languages, Scripting Languages, Natural Languages; Their relative Advantages and Limitations; High-level Programming Language Tools - Compiler, Linker, Interpreter, Intermediate Language Compiler and Interpreter, Editor, Matlab, GUI: Overview of some popular High- level Languages- FORTRAN, COBOL, BASIC, Pascal, C, C++, JAVA, LISP, Characteristics of a Good Programming Language: Selecting a Language out of many Available Languages for Coding an Application: Subprograms.

Unit 03:- Program Testing and Debugging Definition of Testing & Debugging

Difference between Testing and Debugging: Types of Program Errors; Testing a Program, Debugging a Program for Syntax Errors; Debugging a Program for Logic Errors, Concept of APIs/Libraries.

Unit 04:- Program Documentation What is Documentation

Need for Documenting Programs and Software; Forms of Documentation - Comments, System Manual, User Manual; Documentation Standards and Notations.

Unit 05:- Programming in C Language

Character set, Constants, Variables, Keywords and Comments: Operators and Operator Precedence; Statements; I/O Operations: Preprocessor Directives; Pointers, Arrays and Strings: User Defined Data Types - Structure and Union; Control Structures Conditional and Unconditional Branching Using "if", "switch", "break", "continue", "go to" and "return" Statements; Loop Structures- Creating Pretest Loops using "for" and "while" Statements; Creating Posttest Loops using "do...while" statement; Functions - Creating Subprograms using Functions; Parameter Passing by Value; Parameter Passing by Reference: Main Function.

Subject Code: DM7

Subject Name: Manufacturing Process

Teaching Scheme: Credit 4

Lectures: 3 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Unit 01:- Fundamentals of Manufacturing and Machining Operation

Machining Process: Mechanics of Chip formation, Single point cutting Tool and its geometry. Methods of Machining, Types of Chips, Principal elements of Metal Machining. Lathe: classification, specifications of center lathe; Basic parts of center lathe and their functions; Lathe accessories: chucks (three jaw four jaw, and magnetic chuck), mandrels. Rests, face plates, centers, and angleplates; Lathe operations like facing. Plain turning, taper turning, thread cutting, chamfering, grooving, knurling. Cutting tool nomenclature and tool signature. Cutting parameters -- speed. feed, depth of cut and machining time.

1.3 Drill Machine: Classification. Specifications of radial drilling machine. Basic parts of radial drilling machine. Sensitive drilling and their functions. Drilling machine operations like drilling, reaming, boring, counter sinking. Counter boring, spot facing. Cutting parameters - speed, feed, depth of cut and machining time.

Unit 02:- Shaping/ Slotting Machines

Shaping Machine: Principle of working, classification, specification of standard shaper. Basic parts of standard shaping machine and their functions. Quick return mechanism. Different shaping operations.

Slotting Machine: Principle of working, classification, specification. Basic parts of Slotting machine and their functions.

Unit 03:- Casting Process and Plastic Moulding

Pattern making: Basic steps in making pattern, types, materials and allowances. Color-coding of patterns

Moulding: Types of moulding sands, properties of sand, moulding methods, cores and core prints. Elements of gating system. Bench and floor moulding methods. Casting: Safety practices / precautions in foundry shop. Furnaces, construction and of cupola furnace, electric arc furnace. Centrifugal casting Method and applications. Casting defects Causes and remedies.

Plastic: Types of plastics: Plastic processing like Calendering and vacuum forming.

Plastic moulding methods - Compression moulding, Injection moulding. Blow moulding and Extrusion. Applications of plastic moulding methods.

Unit 04:- Forming Process

Drop forging: Introduction to forging. Upset forging, press forging, open die and closed die-forging operations. Rolling Principle of rolling, hot and cold rolling. Types and applications of rolling mill. Extrusion: Direct and indirect extrusion. Advantages, disadvantages, applications of extrusion processes.

Unit 05:- Joining Processes

Welding Processes: Gas welding, carbon arc welding, shielded metal arc welding, TIG welding, MIG welding, plasma arc welding, resistance welding types - spot, seam and projection. Electron beam welding, laser beam welding, welding defects. Introduction to soldering and brazing Process, fillers, heating methods and applications.

Subject Code: DM8

Subject Name: Microcontroller Programming

Teaching Scheme: Credit 4

Lectures: 3 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Unit 1:- Introduction to Microcontrollers

Microprocessor and Microcontroller- Basic introduction, Block diagram and Comparison.

Harvard and Von-Neumann architecture .8051 Microcontroller Architecture, Features, Pin configuration and internal memory organization. 8051 as a Boolean processor, power saving options-idle and power down mode. 8051 I/O Port structure.

Unit 2:- 8051 Microcontroller Programming in C

Development Tools-Editor, Assembler, Compiler. Cross-compiler, Debugger, Emulator. Programmer.

Comparison between embedded C programing and assembly language programming.

Embedded C data types, decision control and looping, preprocessor directives.

Embedded C programs on-data transfer with ports and memory.

Embedded C programs using arithmetic and logical operators.

Unit 3:- 8051 Timers, Interrupts and Serial Communication

Timers/Counters: SFRS- TMOD, TCON. Timer/ Counter Modes.C programs for Timer/Counter.

Interrupts: Polling and Interrupts, IE and IP SFR, Simple C program on interrupts.Serial Communication: SFRS- SCON, SBUF. Modes of serial communication.8051 C programs communication. on scrial

Serial communication standard RS232, DB9 pin functions, interfacing of 8051 microcontroller with MAX 232.

Unit 4:- Interfacing of Input/Outputs Devices with 8051

InterfaD OF Switch. Relay, and buzzwith-8051 and its programming in C. Interfacing of LED 7-segment display and 16 x 2 LCD with 8051 and its programming in C. Interfacing of ADC0808 with 8051 and its programming in C. Interfacing of DAC0808 with 8051 and its programming in C to generate square, triangular and waveforms saw tooth

Unit 5:- Interfacing of sensors and motors with 8051

Interfacing and programming of LM35 with 8051 microcontroller. Interfacing and Programming Sensors: IR sensor, PIR motion sensor and ultrasonic sensor. Interfacing and Programming of Motors: DC motor. Stepper motor & servo motor.

Unit 6:- Introduction to Advanced Processors.

ARM7TDMI- Introduction, Features and applications. Different versions of ARM and their features only.

Subject Code: DM9

Subject Name: PLC programming and SCADA

Teaching Scheme: Credit 4

Lectures: 3 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Unit 01:- Introduction to Industrial Automation

Introduction to automation. Evolution of industrial automation, its need & importance.

Automation Hierarchy (Field level, Control level, Supervisory level, Production Control level and Enterprise Level).Analog control, Digital control- supervisory control & Direct digital Control (DDC). Types of Automation - Fixed, Flexible, Programmable, Integrated. Different symbol used in industrial control circuit. Concept of Power Circuit & Control Circuit- DOL starter, Star Delta Starter. The need of PLC over Hardwired relay logic, benefits and limitations of PLC in Industrial Automation

Unit 02:- PLC Fundamentals

Block diagrain of PLC. Function of different parts of PLC Power supply, Memory, CPU, I/O modules, specialized I/O modules. Discrete I/O Module of PLC, Block diagram & Specification. Analog I/O Module of PLC, Block diagram & Specification. Concept of Sinking & sourcing, its connections with PLC. Overview of Commonly used 10 devices for PLC according to industry standards. Redundancy in PLC, PLC Types, Size & its Application, Selection of PLC

Unit 03:- Basics of PLC Programming

PLC Programming languages,Program SCAN cycle.I/O Addressing of PLC

PLC Programming Instructions: Relay Type Instruction; Timer Instruction: ON Delay, OFF delay, Retentive; Counter Instruction: UP, DOWN, High Speed; Internal Relay Instruction; Logical and parts Instruction; Arithmetic Instructions Datal Movement Instructions

Programming Examine If Open, Examine If Closed Instruction3.6 PLC & PC Interfacing, DO's and Dont's for PLC Installation

Unit 04:- PLC & IO Interfacing and Ladder Programming

Basics of Ladder programming. Ladder Diagram for seal in circuit.Simple programming-based examples using ladder logic language based on relay, timer, counter, logical, arithmetic, comparison and data handling instructions.PLC Based applications: Motor sequence control, Traffic Light Control, Elevator Control, Car Parking, Tank Level Control, Conveyor System,Stepper Motor Control, Reaction/ Reactor Control.

Unit 05:- Introduction to SCADA

Introduction to SCADA, Benefits of SCADA, Various editors of SCADA.

Data Communication Protocol- Data Highway DH-485, RS -232, ControlNet, Device Net, Ethernet, MODBUS, Fieldbus, Profibus-DP, Interfacing SCADA system with PLC: Typical connection diagram, Object linking and embedding for Process. Control (OPC).Steps for creating SCADA screen for simple object. SCADA architecture: Monolithic, distributed and networked. Use of HMI, Concept of DCS.Applications of SCADA: Water Reservoir SCADA System, SCADA Water treatment facility, Electrical generating plant SCADA System, Traffic Light Control

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Subject Code: DM10

Subject Name: Industrial Measurements

Teaching Scheme: Credit 4

Lectures: 3 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Unit 01:- Transducer

Instrumentation System: Block diagram of Instrumentation system, Function of each block, Explanation of baisc instrumentation systems. Transducer: Need of Transducer, Classification of transducers, Active and Passive, Analog and Digital, Primary and Secondary.

Electrical Transducers transducers Resistive Linear & Angular potentiometers, Capacitive transducer, Inductive transducer - LVDT, RVDT (As a displacement transducer), Piezoelectric transducer (Principle of operation and applications of above),Selection criterion of transducers.

Unit 02:- Pressure Measurement

Pressure: Definition, Types Absolute, - Gauge, Atmospheric, Vacuum (Definition, Units) Classification of Pressure measuring devices.Non elastic pressure transducer: U tube, Inclined Tube, Well type manometeElastic pressure transducer : Bourdon Tube, Bellows, Diaphragm, Capsule. Electronic pressure transducers : Bourdon tube with LVDT, Diaphragm with Strain gauge.Calibration of pressure gauge using dead weight tester.

Unit 03:- Flow Measurement

Flow: Definition, Types of Flow - Laminar, turbulent, Reynolds number.Classification of flow measuring transducers: Variable head flow meter - Venturimeter, orifice plate meter Variable area flow meter Rota meter, Electromagnetic Flow meter Ultrasonic flow meter Time difference and Doppler Type.

Unit 04:- Level Measurement

Level: Definition, Need of level measurement.Classification of level measurement methods: Float type - linear and rotary potentiometer (Contact type), Capacitive type (Contact type), Ultrasonic type (Non-contact type), Radiation type (Non-contact type), RADAR type (Non-contact type)

Unit 05:- Temperature Measurement

Temperature: Definition and units, First law of thermodynamics. Different temperature scales and their conversions. Classification of temperature measuring transducers. Filled system type thermometer. Bimetallic thermometer. Thermistors RTD (PT-100), 2/3/4 wire systems (circuit diagram only).Thermocouple - Seeback and Peltier effect, Types J, K, R, S, T etc. (Based on material, temperature ranges) Pyrometer - Optical, Radiation.

Unit 06:- Special Transducers & Measurements, Humidity:

Definition, Types- Absolute and Relative,Humidity Measurement devices : Psychrometer-Dry and wet bulb, Thermometer type Hygrometer- Hair hygrometer, capacitive, resistive type. Speed: Definition, Classification of speed measurement methods, photoelectric pick- up type (non-contact type), Magnetic pick- up type (non-contact type), pH Measurement.

Subject Code: DM11 **Examination Scheme:**

Subject Name: Computer Aided Mechatronics Drafting **Mid Semester: 25**

Teaching Scheme: Credit 4 **Internal Assessment: 25**

Lectures: 3 **Hrs** / week **End Semester: 50**

Total: 100

Unit 1:- Fundamentals of CAD Drawing Setup

Fundamentals of Computer Aided Drafting (CAD) and its applications, Various Software for Computer Aided Drafting.Co-ordinate System- Cartesian and Polar Absolute, Relative mode, UCS, WCS.CAD initial setting commands- Snap, grid, Ortho, Osnap, Limits, Units, Ltscale, Object tracking.Object Selection methods- picking, window, and crossing, fence, last and previous.Opening, saving and closing a new and existing drawing/template

Unit 2:- Draw, Enquiry, Zoom and Formating Commands

Zoom Commands - all, previous, out, in, extent, Realtime, dynamic, window, pan. Formatting commands - Layers, block, linetype, lineweight, color. Draw Command Line, arc, circle, rectangle, polygon, ellipse, spline, block, and hatch. Enquiry commands-distance, area.

Unit 3:- Edit and Modify Commands

Modify Command - Erase, trim, extend, copy, move, mirror, offset, fillet, chamfer, array, rotate, scale, lengthen, stretch, measure, break, divide, explode, and align . Grips editing- Move, Copy, Stretch.

Unit 4:- Dimensioning commands

Dimensioning commands - Dimension styles, Dimensional Tolerances and Geometrical Tolerances, Modify dimension style. Text commands dtext, mtext command. Plotting a drawing - paper space, model space, creating table, plot commands.

Unit 5:- Schematic components and Editing

Catalog brews Circuit builder, insert pneumatic hydraulic and P&ID components Command. Edit, Copy, Move, Delete. Scoot. Toggle NO/NC, Reverse connector. Retag and Swap command. Insert- Wire, Multiple bus, 3-phase, Source arrow, Ladder. Edit Wire number, Wire trim. Add rung, Stretch wire, Toggle wire, Flip wire gap.

Subject Code: DM13 **Examination Scheme:**

Subject Name: Industrial Robotics **Mid Semester: 25**

Teaching Scheme: Credit 4 **Internal Assessment: 25**

Lectures: 3 **Hrs** / week **End Semester: 50**

Total: 100

Unit 01:- Basic Compenents of Robotics System.

Introduction, Definition, need, history, Laws of Robot. Robot configurations- Polar (Spherical), Cylindrical, Cartesian coordinate, Jointed arm (Articuted), SCARA (Selective Compliance Assembly Robot Arm). Basic elements of Robot system (Robot Anatomy): - Base, Manipulator arm, End Effectors, Sensors and transducers, Actuators and Drives,Control systems. Robot specification: - Work envelope, Load carrying capacity, Speed of movement, Accuracy, Repeatability, Special resolution Basic Robot motions: Vertical motions, Radial motions, Rotational motions, Pitch motions, Roll motions, Yaw

motions. Types mechanical joints used in Robotics system: Linear Joint, Orthogonal joint, Rotational Joint, Twisting Joint, Revolving Joint. Robots End Effectors: - Types of End Mechanical Grippers, Tools TATE BOARector effectors, Other Type of as End Vacuum, Adhesive, Hooks, Scoops etc.) Magnetic, Robot-End Effecter Interface. Considerations in Gripper Selections.

Unit 02:- Robotic Sensors and Vision

Robotic Sensors -Introduction to Sensors.Types of Sensors in Robotics - Tactile Sensors-Touch sensors, Force sensors, Force sensing wrist, Joint sensing, Tactile array sensors, Proximity and Range Sensors, Miscellaneous Sensors and Sensor-based Systems, Uses of Sensors in RoboticsDesirable features of sensors in Robotics.Robot Vision- Introduction, The Sensing and Digitizing Function- Imaging devices, Lighting techniques, Analog to Digital signal conversions (Sampling, Encoding, Image storage) Image Processing and Analysis- Image Data reduction, Segmentation, Thresholding, Region growing, Edge detection, Feature extraction, Object Recognition.Industrial application of vision controlled Robotic system.

Unit 03:- Introduction to Robot Languages and Programming

Introduction to Robot Languages: The Textual Robot Languages, Generations of Robot Programming Languages, Robot Language Structure, Constant, Variables and other Data Objects, Motion Commands, End Effecter and Sensor Commands, Computations and Operations, Program Control and Sub-routines, Communications and Data Processing, Monitor Mode Commands. Introduction to Robot Programming: Methods of Programming a Robot, Lead through Programming Methods, Robot Programme as a Path in Space, Motion Interpolation, WAIT, SIGNAL and DELAY Commands, Branching, Capabilities and Limitations of Lead through Methods. Introduction to Teach Pendant. Simple Program for Pick and place activity. Simple Program to palletize the object. Simple Program for Inspection (Bolt, Bearing etc.)

Unit 04:- Robot Application & Maintenance

Robot Applications: Robots in Material Handling- Pick and place Robot, Robots in palletizing and related operations. Robots in processing operations- Spot Welding, Continuous Arc Welding, Spray Coating, Die-casting, Plastic molding, forging operationRobots in automated assemblies. Robots in automated inspections. Robot maintenance: Need and types of maintenance. Common troubles and remedies in robot operation. General safety norms, aspects and precautions in robot handling. Introduction on interlocking of robot.

Unit 05:- Robot Technology of the Future

Introduction, Robot intelligence, Advanced sensor capabilities (3D Vision), Telepresence and related technologies, Mechanical design features (Direct Drive robot, Multiple arm coordinate robot), Mobility, locomotion and navigation, Universal hand, System integration and network. Future applications of Robots: - Military operations, Fire-fighting operations, under sea operations, Space operations, Industry 4.0 etc.

Subject Code: DM14

Subject Name: Elements of Automotive energy management

Teaching Scheme: Credit 4

Lectures: 3 Hrs/week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Unit 1: Modeling electrical sub systems Systems

Modelling and Simulation - Modelling methodologies for HEV energy management. - Control strategies for energy management and driveability. Electrical System Design - High voltage architecture options within HEVs and component selection. - Power electronics, including DC-DC converters (unidirectional and bidirectional) and machine drives. - Electrical machine designs, performance prediction, ancillary requirements and manufacturability. - Battery and ultra-capacitor technologies, vehicle integration, and performance characteristics (materials, performance, reliability, safety, recycling).

Unit 2: Regenerative Braking –

Real-world energy storage requirements and driver behavior assessment. - Brake feel and customer acceptance - Mechanical System Design: New transmission options including split path design approaches and systems (planetary, CVT, dual clutch). - Engine calibration and optimization. - New engine cycles and fuelling options. - Mechanical energy storage systems such as flywheels and hydraulic accumulators.

Unit 3: Systems Integration and Analytical Tools

Vehicle Development Process Overview - Requirements Development - Hybrid Components and Architectures - Major components in hybrid Power Train - Controls integration - Component sizing and integration trade-offs - Hybrid architecture overview - System Design and Development Considerations - Vehicle integration (ex. performance, drivability, NVH) - Power Train integration (ex. energy, power, efficiency, torque, thermal management) - HV/LV electrical systems (ex. safety, DC/AC voltage, charging system, efficiency, cables, connectors, fuses, - Chassis (ex. braking, vehicle dynamics, powertrain to chassis dynamics, ride and handling, steering, fuel system).

Subject Code: DM15

Subject Name: Automotive Mechatronics & control

Teaching Scheme: Credit 4

Lectures: 3 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Unit 01:- Aitomobile Fundamentals

Automobile: Definition, Need of Automobile, Classification of Automobiles,Major components of Automobile with their function and location.Power train control system: Electronic control system used inMPFI/GDI and CRDI System. Block diagram of general vehicle layout. Necessity, Functions and locations of following automobile systems.a. Transmission system, steering system. b. Suspension systemic. Cooling and lubrication system d. Fuel injection and Ignition system. e. Starting and charging system.

Unit 02:- Automotive Sensors and Actuators:

Automotive control system applications of sensors and actuators. Variables to be sensed. Sensors in Automotive: Air flow rate sensors, Engine speed sensor, Engine crankshaft angular, position sensor, Timing sensor, Throttle angle sensor, Pressure sensor, Temperature sensor, Exhaust gas oxygen sensor, Knock sensor, Engine torque sensor. Actuators: Automobile Engine control Actuators, Exhaust gas recirculation actuators. Variable valves timing.

Unit 03:- Engine Management System and Warning Systems

Electronic Engine Management -Introduction to system. Electronic Diesel Control (EDC) unit. Concepts of an Electronic Engine control system: Inputs to controller, Outputs from controller. Warning systems: Brake actuators warning system, oil pressure warning system, and engine over heat warning system, air pressure warning system, and speed warning system.

Unit 04:- Automotive Control and safety Systems

Automotive motion control systems: Cruise control system, Antilock Braking system (ABS), Electronic suspension systems, Electronic power steering system Traction control system, Stability control, Integrated Engine control. Automobile Safety systems: Air bags, Seat belt, park assist system, collapsible steering column, door lock system. Global positioning satellite (GPS). Pedestrian protection and night vision with pedestrian detection.

Unit 05:- Diagostics and Testing

Electronic control system diagnostics Service Bay Diagnostics tool Onboard Diagnostic (OBD II) Procedure of MPFI/CRDI system. Standalone diagnosis: Sensors and actuators. Six step approach for component testing. Diagnostic Fault codes Measuring Instruments: Digital multi-meters, Oscilloscope, scan tool, Frequency meters.

Subject Code: DM16

Subject Name: CNC Machine and Tool Technology

Teaching Scheme: Credit 4

Lectures: 3 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Unit 1:- Components of Conventional, NC and CNC Machine

Introduction of Turning and Milling machine.Various components used in NC and CNC machine and their functions. Classification of CNC machines. Advantages and disadvantages of CNC machine over conventional machines

Unit 2:- Constructional Features of CNC machine

Different drive systema) Servomotor b) Stepper motor Recirculating Ball screw and box nut, Tool magazines, ATC, APC, chip conveyer Cartesian co-ordinate system. Right hand rule Sensors: - Position sensors, velocity sensors. Pressure and torque sensors

Unit 3:- Control systems, Feedback devices and tooling

According to Machining control system, a) straight cut control b) Contouring control c) Point to point control**.** According to control loop system a) Open loop control system b) Close loop control system According to Programming and tool positioning a) Absolute system b) Incremental system**.** Pneumatic system and Hydraulic control systems and its different components Adaptive control system with block

diagram Function of feedback device in close loop. Control system benefits of feedback device. Types of feedback device

Unit 4:- CNC part programming

Introduction of part program me. Types of part programme a) Fixed block format b) Tab sequential

c) Word address format Different controls of CNC machines. Meaning and functions of G and M codes used for part programme Simple programmes on CNC turning and CNC milling by using different cycles.

Unit 5:- Maintenance of CNC Machine

Types of maintenance: a) Preventive maintenance b) Corrective maintenance TPM (Total Productive Maintenance) . Mechanical system, Electronic system, Drive system, Tool clamping system, lubrication system, Coolant system, Hydraulic system, Pneumatic systems. Standard procedure and carry maintenance practice for CNC machines. Daily maintenance checklist formats for CNC machines Various Causes and remedial actions for failure in electronics and mechanical systems in CNC system Different safety precaution taken during operating CNC machine

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Subject Code: DM18

Subject Name: Solid Modelling additive manufacturing

Teaching Scheme: Credit 4

Lectures: 3 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Unit 01:- Working in 2D environment.

Drawing tool: Line, Rectangle, Circle, Arc, Ellipse, Spline, etc. Editing tool: Trim, Extend, Erase, Mirror, etc. Modify tool: Chamfer, Fillet, Copy, Move, etc. Linear, angular dimensions. Dimensioning constraint and Geometrical constraint. Drawing template: prepare drawing template consisting of Name plate boundary lines and projection symbol.

Unit 02:- Development of solid Models

Working in 3D environment: Creating 3D Solid Models of simple machine parts. Part tool: Extrude, Hole, Revolve, Rib, Sweep, Swept blend, Pattern, etc. Part editing tool: Trim, Extend, Erase, Mirror, Part Modify tool: Chamfer, Round, Copy, Move, Draft, etc. Intersect 2 solid components by inserting new body option. Boolean operations: Union, subtract, intersection.

Unit 03:- Computer Aided Assembly

Assembly Drawing: Preparation of assembly drawing by using assembly command, Exploded view: Explode the assembly.

Unit 04:- Drafting of 3D assembly

Orthographic projections: Generate orthographic projections of the assembly. Bill of material: Prepare part list table.

Unit 05:- Plotting

Printer selection, paper size, orientation. Page set up.

Unit 06:- Additive Manufacturing

Additive manufacturing: 3D printing, Rapid prototyping. File format: STL (Stereo Lithography). 3D printer software: part import, orientation, processing and printing.

Subject Code: DM19

Subject Name: Internet of Things

Teaching Scheme: Credit 2

Lectures: 2 **Hrs** / week

Examination Scheme:

Mid Semester: 25

Internal Assessment: 25

End Semester: 50

Total: 100

Internet of Things: Introduction, Wireless sensor networks need for IoT, Edge resource pooling and caching, client side control, and configuration, Basics of Networking, Smart objects as building blocks for IoT, Embedded systems platforms for IoT, IO drivers.

Operating system for IoT: requirement of OS, examples: mbed, Contiki, RIOT

IoT Communication Protocols: IPV6, 6LowPAN, CoAP, MQTT, Machine-to-Machine Communications.

Software Defined Networks (SDN): From Cloud to Fog and MIST networking for IoT Communications, Principles of Edge/P2P networking, Cloud and Fog Ecosystem for IoT Review of architecture, Security and privacy in Fog

Database for IoT: OLAP and OLTP, NoSQL databases, Row and column Oriented databases, Introduction to Columnar DBMS CStore, Run: Length and Bit vector Encoding, Integrating Compression and Query Execution in Columnar databases.

Radar sensor Detectors for vehicle safety: Introduction to Radar sensor detectors, Types (Long range, medium, short range and ultra-short, mechanically scanning LIDAR), Working, Benefits.

Intelligent Transport Systems (ITS): Communication standards in IOT for ITS like, MQTT, DDS, AMQP, BLUETOOTH, ZIGBEE, WIFI, Security and surveillance systems

Advanced driver assistance systems (ADAS): ADAS domain controller, Automotive thermal Camera, Camera module without processing, conditionally automated drive controller, Drive Assist ECU, Driver monitoring, Driver vital sign monitoring, Front/Rear camera, and advance Features.

Internet of vehicles and VANET: Types of IOV, Benefits of IOV, Difference between IOV and VANET, Connected cars IoT Transportation, Activity Monitoring.

ELECTIVES

A. Safety and Automotive Industrial Standards

Contents:

Importance of safety and general precautions. To be observed in the chemical plant. Personal safety and use of personal protective equipment's. Good housekeeping. Fire prevention and firefighting equipment's.

Properties of hazardous and toxic chemicals and safe handling procedures. Cause and prevention of accidents, first aid. Materials safety data sheets (MSDs), material handling.

General introduction of Chemical Plant, raw materials, intermediates and final products. Introduction of different pumps, pipes, valves, vessels, heat exchanges, dryers, evaporator, filtration unit etc.

Familiarization with plant utilities and service lines such as – steam, water, vacuum, compressed air, fuel line, refrigeration and air conditioning.

B. Cloud computing

Contents:

Unit I Introduction to Cloud Computing

Importance of Cloud Computing, Characteristics, Pros and Cons of Cloud Computing, Migrating into the Cloud, Seven-step model of migration into a Cloud, Trends in Computing. Cloud Service Models: SaaS, PaaS, IaaS, Storage. Cloud Architecture: Cloud Computing Logical Architecture, Developing Holistic Cloud Computing Reference Model, Cloud System Architecture, Cloud Deployment Models.

Unit II Data Storage and Cloud Computing

Data Storage: Introduction to Enterprise Data Storage, Direct Attached Storage, Storage Area Network, Network Attached Storage, Data Storage Management, File System, Cloud Data Stores, Using Grids for Data Storage. Cloud Storage: Data Management, Provisioning Cloud storage, Data Intensive Technologies for Cloud Computing. Cloud Storage from LANs to WANs: Cloud Characteristics, Distributed Data Storage.

Unit III Virtualization in Cloud Computing

Introduction: Definition of Virtualization, Adopting Virtualization, Types of Virtualization, Virtualization Architecture and Software, Virtual Clustering, Virtualization Application, Pitfalls of Virtualization. Grid, Cloud and Virtualization: Virtualization in Grid, Virtualization in Cloud, Virtualization and Cloud Security. Virtualization and Cloud Computing: Anatomy of Cloud Infrastructure, Virtual infrastructures, CPU Virtualization, Network and Storage Virtualization.

Unit IV Cloud Platforms and Cloud Applications

Amazon Web Services (AWS): Amazon Web Services and Components, Amazon Simple DB, Elastic Cloud Computing (EC2), Amazon Storage System, Amazon Database services (Dynamo DB).Microsoft Cloud Services: Azure core concepts, SQL Azure, Windows Azure Platform Appliance. Cloud Computing Applications: Healthcare: ECG Analysis in the Cloud, Biology: Protein Structure Prediction, Geosciences: Satellite Image Processing, Business and Consumer Applications: CRM and ERP, Social Networking, Google Cloud Application: Google App Engine. Overview of OpenStack architecture.

C. Machine Learning

Contents:

Unit I Introduction to Machine Learning

Introduction: What is Machine Learning, Definitions and Real-life applications, Comparison of Machine learning with traditional programming, ML vs AI vs Data Science. Learning Paradigms: Learning Tasks- Descriptive and Predictive Tasks, Supervised, Unsupervised, Semi-supervised and Reinforcement Learnings. Models of Machine learning: Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models. Feature Transformation: Dimensionality reduction techniques- PCA and LDA.

Unit II Regression

Introduction- Regression, Need of Regression, Difference between Regression and Correlation, Types of Regression: Univariate vs. Multivariate, Linear vs. Nonlinear, Simple Linear vs. Multiple Linear, Bias-Variance tradeoff, Overfitting and under fitting. Regression Techniques - Polynomial Regression, Stepwise Regression, Decision Tree Regression, Random Forest Regression, Support Vector Regression, Ridge Regression, Lasso Regression, Elastic Net Regression, Bayesian Linear Regression. Evaluation Metrics: Mean Squared Error (MSE), Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R-squared, Adjusted R-squared

Unit III Classification

Introduction: Need of Classification, Types of Classification (Binary and Multiclass), Binary-vs-Multiclass Classification, Balanced and Imbalanced Classification Problems. Binary Classification: Linear Classification model, Performance Evaluation- Confusion Matrix, Accuracy, Precision, Recall, F measures. Multiclass Classification: One-vs-One and One-vs-All classification techniques, Performance Evaluation- Confusion Matrix, Per Class Precision, Per Class Recall Classification Algorithms: K Nearest Neighbor, Linear Support Vector Machines (SVM) – Introduction, Soft Margin SVM, Kernel functions– Radial Basis Kernel, Gaussian, Polynomial, Sigmoid.

Unit IV Clustering

Introduction: What is clustering, Need of Clustering, Types of Clustering Hierarchical clustering algorithms /connectivity-based clustering): Agglomerative Hierarchical Clustering (AHC) algorithm, Divisive Hierarchical Clustering (DHC) algorithm. Centroid-based clustering algorithms / partitioning clustering algorithms: K-Means clustering algorithm, Advantages and disadvantages of K-Means clustering algorithm, Elbow method, The Silhouette method, K-Medoids, K-Prototype. Density-based clustering algorithms: DBSCAN algorithm, how it works, Advantages and disadvantages of DBSCAN. Distribution-based clustering algorithms: Gaussian mixture model. Application of Clustering Technique: Market Segmentation, Statistical data analysis, Social network analysis, Image segmentation, Anomaly detection.

Unit V Ensemble Learning

Ensemble Learning: Introduction to Ensemble Learning, Need of Ensemble Learning, Homogeneous and Heterogeneous ensemble methods, Advantages and Limitations of Ensemble methods, Applications of Ensemble Learning. Basic Ensemble Learning Techniques: Voting Ensemble, Types of Voting: Max Voting, Averaging, Weighted Average. Advanced Ensemble Learning Techniques: Bagging: Bootstrapping, Aggregation. Boosting: Adaptive Boosting (AdaBoost), Gradient Boosting, XGBoost. Stacking Variance Reduction, Blending, Random Forest Ensemble, Advantages of Random Forest.