

**Rajasthan Technical University (RTU)**  
**Mechatronics Engineering**  
**B.Tech Program in Mechatronics Engineering**

Scheme of Teaching & Examination for III<sup>rd</sup> year B.Tech V<sup>th</sup> Semester

Course	Mechatronics Engineering				Code	MH	
SEMESTER-V	Hrs./Week				IA	Exam	Total
Subject Code	Title	L	T	P			
5MH1	Design of Machine Elements	3	0	Theory Subjects	20	80	100
5MH2	Power Electronics	3	0		20	80	100
5MH3	Sensors & Signal Processing	3	0		20	80	100
5MH4	Modeling and Simulation	3	1		20	80	100
5MH5	CNC Technology	3	0		20	80	100
5MH6.1	Principles of Turbo Machine	3	1		20	80	100
5MH6.2	I.C. Engine						
5MH6.3	Modern Control Engineering						
5MH7	Power Electronics Lab	Practical		3	60	40	100
5MH8	Sensors & Signal Processing Lab			2	45	30	75
5MH9	CNC Lab			3	60	40	100
5MH10	Electrical Machines & Drives Lab			2	45	30	75
5MH11	Discipline & Extra Curricular Activity						50
	Total	18	2	10			1000

**Rajasthan Technical University (RTU)**  
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Scheme of Teaching & Examination for III<sup>rd</sup> year B.Tech VI<sup>th</sup> Semester

Course	Mechatronics Engineering				Code	MH	
SEMESTER-VI	Hrs./Week				IA	Exam	Total
Subject Code	Title	L	T	P			
6MH1	Principles of Management	3	0	Theory Subjects	20	80	100
6MH2	Micro Controller & PLC	3	0		20	80	100
6MH3	Applied Hydraulics & Pneumatics	3	1		20	80	100
6MH4	Design of Mechatronics System	3	1		20	80	100
6MH5	Object Oriented Programming	3	0		20	80	100
6MH6.1	Automobile Engineering	3	0			20	80
6MH6.2	Robotics & Machine Vision System						
6MH6.3	Aircraft Electronics System						
6MH7	Micro Controller & PLC Lab	Practical		3	60	40	100
6MH8	Object Oriented Programming Lab			2	45	30	75
6MH9	Applied Hydraulics & Pneumatics Lab			3	60	40	100
6MH10	Automobile Engineering Lab			2	45	30	75
6MH11	Discipline & Extra Curricular Activity						50
Total		18	2	10			1000

## 5MH1 : DESIGN OF MACHINE ELEMENTS

B.Tech. (MH) 5<sup>th</sup> Sem.  
3L+0T

Max. Marks : 100  
Exam Hours : 3

Note : Approved Design Data Book is permitted in the examination.

UNIT	CONTENTS	CONTACT HOURS
I	<b>DESIGN FUNDAMENTALS</b> 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.	8
II	<b>DESIGN OF SHAFTS, KEYS AND COUPLINGS</b> 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.	8
III	<b>GEARS</b> 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.	8
IV	<b>BRAKES AND CLUTCHES</b> Dynamic and thermal aspects of braking – Design of brakes - Design of clutches- Single plate – Multi plate – Conical clutch.	8
V	<b>BEARINGS AND SPRINGS</b> Design of Bearings – Sliding contact – Rolling contact – Design of Journal Bearings – Calculation of Bearing dimensions – Design of helical and leaf springs.	8
<b>TOTAL</b>		<b>40</b>

### List of Recommended Books:

1. Joseph Edward Shigley and Charles R. Mischke, Mechanical Engineering Design, 6th Edition, McGraw-Hill International Edition, 2004.
2. Kulkarni.S.G., Machine Design - Solved Problems, Tata McGraw-Hill, New Delhi, 2003.
3. William Orthwein, Machine Component Design (Vol. I & II), M/s. Jaico Publishing house, Mumbai, 2003.
4. Maitra.G.M., and Prasad.LN., Hand Book of Mechanical Design, 2nd Edition, Tata McGraw Hill, New Delhi, 2005.
5. V.B. Bhandari, Design of Machine Elements (Tata McGraw Hill).

## 5MH2 : POWER ELECTRONICS

B.Tech. (MH) 5<sup>th</sup> Sem.  
3L+0T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>POWER SEMI CONDUCTOR DEVICES</b> Principle of operation – Characteristics of power diodes, SCR, TRIAC, GTO, Power BJT, Power MOSFET and IGBT – Thyristor protection circuits.	8
II	<b>PHASE CONTROLLED CONVERTERS</b> 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
III	<b>DC TO DC CHOPPERS</b> 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
IV	<b>INVERTERS</b> Voltage source inverters – series, parallel and bridge inverters – PWM techniques – sinusoidal PWM , modified sinusoidal PWM, multiple PWM – current source inverters.	8
V	<b>AC VOLTAGE CONTROLLERS AND CYCLOCONVERTERS</b> 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
	<b>TOTAL</b>	<b>40</b>

### List of Recommended Books:

1. Reshid, M.H., "Power Electronics – Circuits Devices and Application" Prentice Hall International, New Delhi, 3rd Edition, 2004.
2. Lander, W., "Power Electronics" McGraw-Hill and Company, 3rd Edition, 1993.
3. Singh, M.D., Khanchandani, K.B., "Power Electronics", Tata McGraw-Hill, 1998.
4. Dubey, G.K., Doradia, S.R., Joshi, A. and Singh, R.M., "Thyristorised Power Controllers", Wiley Eastern Limited, 1986.
5. Mohan Undeland and Robbins, "Power Electronics", John Wilry and Sons, New York, 1995.

### 5MH3 : SENSORS AND SIGNAL PROCESSING

B.Tech. (MH) 5<sup>th</sup> Sem.  
3L+0T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>SCIENCE OF MEASUREMENT</b> Units and Standards – Calibration techniques –Errors in Measurements – Generalized Measurement System – Static and dynamic characteristics of transducers – Generalized Performance of Zero Order and First Order Systems - Response of transducers to different time varying inputs – Classification of transducers.	8
II	<b>MECHANICAL MEASUREMENTS</b> Temperature: Filled thermometer – Bimetallic thermometer – monometers – elastic transducers – bourdon gauge – bellows – diaphragm. Vacuum: McLeod gauge, thermal conductivity gauge – Ionization gauge, flow measurement: orifice, venture, nozzle, pilot tube, turbine flow meter, hot wire anemometer.	8
III	<b>ELECTRICAL MEASUREMENTS</b> Resistive transducers – Potentiometer– RTD – Thermistor – Thermocouple – Strain gauges – use in displacement, temperature, force measurement – Inductive transducer – LVDT – RVDT – use in displacement – Capacitive transducer – Piezo electric transducer – Digital displacement transducers.	8
IV	<b>SMART SENSORS</b> Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors – applications - Automobile, Aerospace, Home appliances, Manufacturing, Medical diagnostics, Environmental monitoring.	8
V	<b>SIGNAL CONDITIONING AND DATA ACQUISITION</b> Amplification – Filtering – Sample and Hold circuits –Data Acquisition: Single channel and multi channel data acquisition – Data logging.	8
<b>TOTAL</b>		<b>40</b>

**List of Recommended Books:**

1. E. O. Doebelin, 'Measurement Systems – Applications and Design', Tata McGraw Hill, edition 1992.
2. A. K. Sawhney, 'A course in Electrical and Electronic Measurement and Instrumentation', Dhanpat Rai and Co (P) Ltd, 2004.
3. Beckwith, Marangoni and Lienhard, 'Mechanical Measurements', Addison – Wesley, 5th Edition, 2000.
4. D. Roy Choudry, Sheil Jain, 'Linear Integrated Circuits', New Age International Pvt. Ltd., 2000.
5. Patranabis. D, "Sensors and Transducers", 2nd edition PHI, New Delhi, 2003.

## 5MH4 : MODELLING AND SIMULATION

B.Tech. (MH) 5<sup>th</sup> Sem.  
3L+1T

Max. Marks : 100  
Exam Hours : 3

### OBJECTIVE

To provide an exposure on how to simulate a system or a process or an activity for detailed analysis, optimization and decision making which is essential to reduce the product design and development cost and time.

UNIT	CONTENTS	CONTACT HOURS
I	<b>SYSTEM AND SYSTEM ENVIRONMENT</b> Component of a System – Continuous and discrete systems – Types of model; Steps in Simulation study; Simulation of an event occurrence using random number table – Single server queue –two server queues – inventory system.	8
II	<b>RANDOM NUMBER GENERATION</b> Properties of random numbers – Generation of Pseudo – random numbers – techniques of generating pseudo random numbers; Test for random numbers: the Chisquare test-the kolmogrov Smirnov test – Runs test – Gap test – poker test.	8
III	<b>RANDOM – VARIATE GENERATION</b> Inverse transform technique for Exponential, Uniform, triangular, weibull, empirical, uniform and discrete distribution, Acceptance rejection method for Poisson and gamma distribution; Direct Transformation for normal distribution.	8
IV	<b>ANALYSIS OF SIMULATED DATA</b> Data collection, identifying the distribution, Parameter estimation, goodness of fit tests, verification and validation of simulation models.	8
V	<b>CONCEPTS OF SYSTEM IDENTIFICATION</b> Identification using normal operating records (Integration method) – Identifiability conditions – System order determination.	8
	<b>TOTAL</b>	<b>40</b>

### List of Recommended Books:

1. Banks J., Carson J.S. and Nelson B.L., "Discrete – Event System Simulation", 3rd Edition, Pearson Education, Inc 2004 (ISBN 81-7808-505-4).
2. Geoffrey Gorden, "System Simulation", Prentice Hall of India, 2003.
3. Narsingh Deo., "System Simulation with Digital Computer", Prentice Hall of India, 2003.
4. Simulation Modeling and analysis by Law & Kelton.

## 5MH5 : CNC TECHNOLOGY

B.Tech. (MH) 5<sup>th</sup> Sem.  
3L+0T

Max. Marks : 100  
Exam Hours : 3

### OBJECTIVE

Now a day's industries are having lot of changes because of technological developments and the same creates better environment to manufacture components. CNC machining is one of the widely accepted machining methods, which provides lesser manufacturing lead-time and accuracy to the components. Therefore studying the fundamentals, construction details and other controls are very much essential for the Mechatronics engineering students.

UNIT	CONTENTS	CONTACT HOURS
I	<b>FUNDAMENTALS OF CNC MACHINES</b> 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.	8
II	<b>CONSTRUCTIONAL FEATURES OF CNC MACHINES AND RETROFITTING</b> 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. Retrofitting of Conventional Machine Tools: Modification to be carried out on conventional machines for retrofitting.	8
III	<b>CONTROL SYSTEMS, FEED BACK DEVICES AND TOOLING</b> 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.	8
IV	<b>CNC PART PROGRAMMING</b> 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.	8
V	<b>ECONOMICS AND MAINTENANCE</b> 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.	8
<b>TOTAL</b>		<b>40</b>

### List of Recommended Books:

1. Yoreur Koren, "Computer Control of Manufacturing Systems", Pitman, London, 1987.
2. Radhakrishnan P., Computer Numerical Control Machines, New Central Book Agency, 1992.
3. BERRY LEATHAM – JONES, Computer Numerical Control, Pitman, London, 1987.
4. STEAVE KRAR and ARTHUR GILL, CNC Technology and Programming, McGraw–Hill Publishing Company, 1990.
5. HANS B.KIEF and T.FREDERICK WATERS, Computer Numerical Control Macmillan/McGraw-Hill, 1992.
6. G.E.THYER, Computer Numerical Control of Machine Tools. Second Edition, B/H NEWNES, 1993.
7. GROOVER, M.P., Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall, 1998.
8. MIKE MATTSON, "CNC Programming Thomson Learning, 2003.
9. P. N. Rao, CAD & CAM
10. Kundra Rao Tiwari, Computer Aided Manufacturing, Tata McGraw-Hill

## 5MH6.1 : PRINCIPLES OF TURBOMACHINES

B.Tech. (MH) 5<sup>th</sup> Sem.  
3L+1T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>BASIC CONCEPTS OF TURBO MACHINES</b> Definition of Turbo machine, classification, Basic laws and governing equations, continuity equation, steady flow energy equation(1st law of thermodynamics), 2nd law of thermodynamics applied to turbo machines, Newton's 2nd law of motion applied to turbomachines - Euler's pump equation and Euler's turbine equation, dimensional analysis applied to hydraulic machines, power coefficient, flow coefficient, head coefficient, non-dimensional specific speed, Range of specific speeds for various turbo machines, Dimensional analysis applied to compressible flow machines, pressure ratio as a Function of temperature ratio, mass flow rate parameter and speed parameter.	8
II	<b>CENTRIFUGAL PUMPS</b> Main parts, work done and velocity triangles, slip and slip factor, pump losses and efficiencies, minimum starting speed, net positive suction head, performance curve.	8
III	<b>AXIAL FLOW PUMPS</b> Description, velocity triangles, work done on the fluid, energy transfer, axial pump characteristics, cavitation.	8
IV	<b>CENTRIFUGAL COMPRESSORS AND FANS</b> Components and description, velocity diagrams, slip factor, energy transfer, power input factor, stage pressure rise and loading coefficient, pressure coefficient, degree of reaction, Centrifugal compressor characteristic, surging, rotating Stall and Choking.	8
V	<b>AXIAL FLOW COMPRESSORS AND FANS</b> Basic constructional features, turbine versus compressor blades Advantages of axial flow compressors, working principle, velocity triangle, elementary theory, stage work, work done factor, stage loading, degree of reaction; vortex theory, simple design calculations, introduction to blade design, cascade test, compressibility effects, operating characteristics.	8
<b>TOTAL</b>		<b>40</b>

### List of Recommended Books:

1. Principle of Turbo Machinery, Turton R.K., Springer Publication.
2. Fundamentals of Turbo Machinery, William W., John Wiley and Sons.
3. Gas Turbine Theory, Cohen and Roger, Pearson Education.
4. Turbo Machinery Basic Theory and Application, Logan E.J.
5. Principles of Turbo Machinery, Shepherd Dennis G., Mac Millan Publisher, New York.
6. Turbo Machines, A Valan Arasu, Vikas Publishing House Pvt. Ltd.

## 5MH6.2: I.C. ENGINES

B.Tech. (MH) 5<sup>th</sup> Sem.  
3L+1T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>HISTORY OF IC ENGINES:</b> Nomenclature, Classification & Comparison, SI & CI, 4stroke- 2 stroke, First Law analysis, Energy Balance. Fuel-air cycles, Actual cycles..	4
	<b>TESTING &amp; PERFORMANCE:</b> 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, Emission.	4
II	<b>FUEL &amp; COMBUSTION:</b> 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, Types of combustion chamber.	4
	<b>FUEL:</b> Conventional Petroleum, structure, Refining Fuels for SI & CI engines, Knock rating, Additives, Fuels for Turbine & Jet Propulsion.	2
	<b>ALTERNATIVE FUELS:</b> Methanol, Ethanol, Comparison with gasoline, Manufacturing, Engine performance with pure Methanol, Ethanol & blends, Alcohols with diesel engine, Vegetable oils, Bio gas.	2
III	<b>ENGINE SYSTEMS &amp; COMPONENTS:</b> Fuel System (SI Engine), Carburetion & Injection, process & parameters, properties of A/F mixture, Requirements of A/F ratios as per different operating conditions, Carburetors, types, Aircraft carburetor, comparison of carburetion & injection, F/A ratio calculations.	3
	<b>CI ENGINE:</b> Mixture requirements & constraints, Method of injection, Injection systems, CRDI etc. system components, pumps injectors.	2
	<b>IGNITION SYSTEM:</b> 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.	3
IV	<b>ENGINE FRICTION &amp; LUBRICATION:</b> 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, Additives, Lubrication systems. Engine Cooling: Requirements of cooling, Areas of heat flow, High temperature regions of combustion chamber. Heat Balance, Cooling Systems, Air, Water Cooling, Cooling system components.	5
	<b>SUPERCHARGING:</b> 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.	3
V	<b>DUAL &amp; MULTI FUEL ENGINES:</b> Principle, fuels, Combustion, performance Advantages, Modification in fuel system.	4
	<b>SPECIAL ENGINES:</b> Working principles of Rotary, Stratified charge, Free piston, Variable compression ratio engines.	4
	<b>TOTAL</b>	<b>40</b>

**List of Recommended Books:**

1. Mathur & Sharma, Internal Combustion Engines, Dhanpat Rai & Sons
2. Gupta H.N., Fundamentals of Internal Combustion Engines, Prentice Hall of India
3. F.Edward Obert, Internal Combustion Engines, Harper and Row Publisher.
4. John B. Heywood, Internal Combustion Engines Fundamentals, McGraw Hill.
5. Lichty, Internal Combustion Engines, McGraw Hill.
6. Gill, Smith, Ziurs, Fundamentals of Internal Combustion Engine, Oxford & IBH Publishing.
7. Rogowsky, IC Engines, International Book Co.
8. Ganeshan, V., Internal Combustion Engine, Tata Mc Graw Hill.
9. R. Yadav, I.C. Engine, Central Publishing House, Allahabad.

### 5MH6.3 : MODERN CONTROL ENGINEERING (Common for EE and EX)

B.Tech. (MH) 5<sup>th</sup> Sem.  
3L+1T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Introduction:</b> Concept of Linear vector space Linear Independence, Bases & Representation, domain and range. Concept of Linearity, relaxedness, time invariance, causality.	5
	<b>State Space Approach of Control System Analysis:</b> Modern Vs conventional control theory, concept of state, state variable state vector, state space, state space equations, Writing statespace equations of mechanical, Electrical systems, Analogous systems.	3
II	State Space Representation using physical and phase variables, comparison form of system representation. Block diagram representation of state model. Signal flow graph representation.	5
	State space representation using canonical variables. Diagonal matrix.	3
III	<b>Solution of State Equations:</b> Eigenvalues and Eigen vectors. Matrix.Exponential, State transition matrix, Properties of state transition matrix.	4
	Computation of State transition matrix concepts of controllability & observability, Pole placement by state feedback.	4
IV	<b>Digital Control Systems:</b> Introduction, sampled data control systems, signal reconstruction, difference equations.	4
	The z-transform, Z-Transfer Function. Block diagram analysis of sampled data systems, z and s domain relationship.	4
V	Modeling of sample-hold circuit, steady state accuracy, stability in z-plane and Jury stability criterion, bilinear transformation	4
	Routh-Hurwitz criterion on s-planes,digital PID controllers, Introductionto adaptive control.	4
<b>TOTAL</b>		<b>40</b>

**List of Recommended Books:**

S. No.	Name of authors'/books/publisher	Year of Pub.
1	I. J. Nagrath and M. Gopal: Control Systems Engineering, 3rd Ed, New Age Publication.	2008
2	S. K. Bhattacharya: Control Systems Engineering, 3e, Pearson Publishers.	2009
3	Dhannesh N. Manik: Control System, Cengage Learning.	2010
4	Richard C. Dorf, Robert H. Bishop: Modern Control Systems, Prentice-Hall.	2008
5	M. Gopal: Digital Control and State Variable Methods, MGH.	2012
6	B. C. Kuo: Digital Control System, Oxford.	1980
7	C. H. Houpis and G. B. Lamont, Digital Control Systems, MGH.	1992
8	Donald E. Kiv: Optimal Control Theory- An Introduction, Prentice Hall.	2009
9	D. Roy, Choudhary: Modern Control Engineering, Prentice Hall of India.	2005
10	C. T. Chen: System Theory &Design, Oxford University Press.	1999

**5MH7: POWER ELECTRONICS LAB**  
**MM: 100**

**LIST OF EXPERIMENTS**

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).

**LIST OF EQUIPMENT**

(for a batch of 30 students)

<b>S.No.</b>	<b>Equipments</b>	<b>Qty.</b>
1	Study of SCR, MOSFET & IGBT characteristics module	1
2	UJT, R, RC firing circuits for SCR module	1
3	Voltage & current commutated chopper module	1
4	SCR phase control circuit module	1
5	TRIAC phase control circuit module	1
6	Study of half controlled & fully controller converters module	1
7	Study of three phase AC regulator module	1
8	Speed control of DC shunt motor using three phase fully controlled converter module	1
9	SCR single phase cyclo converter module	1
10	SCR series and parallel inverters module	1
11	IGBT chopper module	1
12	IGBT based PWM inverter (single phase) module	1
13	Ammeter (0-5A) MC, (0-2A) MC, (0-2A) MI, (0-5V) MI	1
14	Voltmeter (0-300V) MC, (0-600V) MC, (0-300V) MI, (0-600V) MI, Multimeter	Each 3
15	CRO	6
16	Transformer 1KVA, 1:1, 230V	5

**5MH8: SENSORS AND SIGNAL PROCESSING LAB**  
**MM: 75**

**LIST OF EXPERIMENTS**

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
12. Study on the application of data acquisition system for industrial purposes

**TOTAL: 45 PERIODS**

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS**

<b>S.No.</b>	<b>EQUIPMENT</b>	<b>QTY</b>
1	Cathode Ray Oscilloscope	5
2	Function Generator	5
3	Regulated power supply	7
4	Displacement Measurement Trainer using LVDT	1
5	Capacitive pickup trainer module	1
6	Position and Velocity measurement using encoder kit	1
7	Servomotor Position control kit	1
8	Speed measurement and closed loop control of DC Motor using photo electric pickup kit	1
9	RTD module	1
10	Thermistor module	1
11	Thermocouple module	1
12	Absolute encoder	1
13	Potentiometer trainer pickup	1
14	Strain gauge module	1
15	Load cell module	1

**5MH9: CNC LAB**  
**MM: 100**

**OBJECTIVE**

To train the students in manual and computer assisted part programming, tool path generation and control, operation and control of CNC machines tools.

**LIST OF EXPERIMENTS**

1. Manual part programming using G and M codes for Turning, step turning, Taper turning, thread cutting and radius turning on cylindrical components.
2. Programming and Simulation of machining using the following features.
  - (i) Linear and Circular interpolation
  - (ii) Pocket milling, slotting, peck drilling and other fixed canned cycles.
  - (iii) Machining of Prismatic Components.
3. Given a component drawing to write the manual part programming and execute on CNC Lathe and Milling Machine.

**LIST OF FACILITIES REQUIRED**

1. CNC Lathe with Fanuc control
2. CNC Milling Machine with Fanuc control
3. Master CAM software
4. Computer nodes

**TOTAL = 45 PERIODS**

**5MH10: ELECTRICAL MACHINES AND DRIVES LAB**  
**MM: 75**

**OBJECTIVE**

To expose the students the operation of electric drives and give them hands on experience.

**LIST OF EXPERIMENTS**

1. Load test on D.C. shunt motor.
2. Speed control of D.C. shunt motor.
3. Swinburne's test.
4. Load test on three phase induction motor.
5. No load and blocked rotor tests on three – phase induction motor.
6. Load test on single phase induction motor.
7. No load and blocked rotor tests on single phase induction motor.
8. Load test on Synchronous motors.
9. Performance characteristics of Stepper motor.
10. Performance characteristics of single phase transformer.

**TOTAL: 45**

**PERIODS**

**LIST OF EQUIPMENT**

(for a batch of 30 students)

<b>S.No</b>	<b>Equipments</b>	<b>Qty.</b>
1	Shunt motor 5HP	3
2	Single phase Induction Motor 2HP	2
3	Three phase induction Motor 5HP	2
4	Single phase transformer 2KVA	1
5	Three phase quto transformer	2
6	Single phase auto transformer	2
7	3 point starter	3
8	DPST, TPST Each	2
9	DC source 300v, 100A	1
10	Ammeter(0-5A),(0-10A)MC Each	2
11	Ammeter(0-5A),(0-10A)MI Each	2
12	Voltmeter(0-300V) MC	3
13	Voltmeter(0-150V),(0-300V),(0-600V)MI Each	2
14	Wattmeter 150/300V, 5/10A UPF	2
15	Wattmeter 300/600V,5/10A UPF	2
16	Wattmeter 150/300V,5/10A LPF	2
17	Wattmeter 300/600V,5/10A LPF	2
18	Stepper motor 5Kg	1
19	Synchronous motor 5KW	1
20	Rheostat 360 ohm/1.2A	3
21	Rheostat 50 ohm/5A	3
22	Tachometer	5

## 6MH1: PRINCIPLES OF MANAGEMENT

B.Tech. (MH) 6<sup>th</sup> Sem.  
3L+0T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>BASICS OF GLOBAL MANAGEMENT</b> 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.	8
II	<b>PLANNING</b> 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
III	<b>ORGANISING</b> Nature and Purpose – Formal and informal organization – Organization Chart – Structure and Process – Departmentation by difference strategies – Line and Staff authority – Benefits and Limitations – De-Centralization and Delegation of Authority – Staffing – Selection Process - Techniques – HRD – Managerial Effectiveness.	8
IV	<b>LEADING</b> 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
V	<b>CONTROLLING</b> 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
	<b>TOTAL</b>	<b>40</b>

### List of Recommended Books:

1. Harold Koontz & Heinz Weihrich "Essentials of Management", Tata McGraw-Hill, 1998 53
2. Joseph L Massie "Essentials of Management", Prentice Hall of India, (Pearson) Fourth Edition, 2003.
3. Tripathy PC And Reddy PN, "Principles of Management", Tata McGraw-Hill, 1999.
4. JAF Stomer, Freeman R. E and Daniel R Gilbert Management, Pearson Education, Sixth Edition, 2004.
5. Fraidon Mazda, "Engineering Management", Addison Wesley, 2000.

## 6MH2: MICRO CONTROLLER AND PLC

B.Tech. (MH) 6<sup>th</sup> Sem.  
3L+0T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>8051 ARCHITECTURE</b> Microcontroller Hardware – I/O Pins, Ports – External memory – Counters and Timers – Serial data I/O – Interrupts – 8051 Assembly Language Programming: Instruction set of 8051, Addressing modes, Data transfer instructions, Arithmetic and Logical Instructions, Jump and Call Instructions, interrupts and returns interrupts and returns interrupt handling.	8
II	<b>8051 MICROCONTROLLER DESIGN</b> 8051 Microcontroller Specification 8051 – Microcontroller System Design – Testing the Design, Timing Subroutines, Look up Tables – Serial Data Transmission.	8
III	<b>8051 MICROCONTROLLER APPLICATIONS</b> Interfacing of Keyboards – Interfacing of Display Devices – Pulse measurement – Analog to Digital and Digital to Analog Converter – Interfacing Hardware Circuit – Multiple interrupts – Serial Data Communication – Network Configuration.	8
IV	<b>PROGRAMMABLE LOGIC CONTROLLERS</b> Introduction – Parts of PLC – Principles of operation – PLC sizes – PLC hardware components – I/O section Analog I/O Section Analog I/O modules – digital I/O modules CPU processor memory module – Programming devices – PLC programming Simple instructions – Manually operated switches – Mechanically operated and Proximity switches - Output control devices - Latching relays PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram.	8
V	Timer instructions ON DELAY, OFF DELAY and RETENTIVE Timers, UP COUNTER, DOWN COUNTER and UP DOWN COUNTERS, control instructions – Data manipulating instructions, math instructions; Applications of PLC – Simple materials handling applications, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, motor control, Automatic car washing machine, Bottle label detection and process control application.	8
	<b>TOTAL</b>	<b>40</b>

### List of Recommended Books:

1. Kenneth J. Ayala. The 8051 Microcontroller Architecture, Programming and Applications, Penram International Publishing (India), Second Edition, Mumbai.
2. Frank D. Petruzella. "Programmable Logic Controllers", McGraw-Hill Book, Company, 1989.
3. B.P. Singh, Microprocessors and Microcontrollers, Galcotia Publications (P) Ltd, First edition, New Delhi, 1997.
4. Embedded Controller Hand book, Intel Corporation, USA.
5. Microcontroller Hand Book, INTEL, 1984.

### 6MH3: APPLIED HYDRAULICS AND PNEUMATICS

B.Tech. (MH) 6<sup>th</sup> Sem.  
3L+1T

Max. Marks : 100  
Exam Hours : 3

#### OBJECTIVES:

To know the advantages and applications of Fluid Power Engineering and Power.

To learn the Applications of Fluid Power System in automation of Machine Tools and others Equipments.

UNIT	CONTENTS	CONTACT HOURS
I	<b>FLUID POWER SYSTEMS AND FUNDAMENTALS</b> 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.	8
II	<b>HYDRAULIC SYSTEM &amp; COMPONENTS</b> 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
III	<b>DESIGN OF HYDRAULIC CIRCUITS</b> 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
IV	<b>PNEUMATIC SYSTEMS AND COMPONENTS</b> 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
V	<b>DESIGN OF PNEUMATIC CIRCUITS</b> 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
	<b>TOTAL</b>	<b>40</b>

#### List of Recommended Books:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education 2005.
2. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw-Hill, 2001.
3. Srinivasan.R, "Hydraulic and Pneumatic controls", Vijay Nicole, 2006.
4. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.
5. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995
6. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
7. Harry L. Stevart D.B, "Practical guide to fluid power", Taraoeala sons and Port Ltd. Broadey, 1976.
8. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.
9. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.

## 6MH4: DESIGN OF MECHATRONICS SYSTEM

B.Tech. (MH) 6<sup>th</sup> Sem.  
3L+1T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>FUNDAMENTALS</b> Introduction to Mechatronics system – Key elements – Mechatronics Design process – Types of Design – Design Parameter– Traditional and Mechatronics designs – Advanced approaches in Mechatronics - Industrial design and ergonomics, safety.	8
II	<b>SYSTEM MODELLING</b> Introduction-model categories-fields of application-model development-model verification-model validation-model simulation-design of mixed systems-electro mechanics design-model transformation-domain-independent description forms-simulator coupling.	8
III	<b>SYSTEM INTERFACING</b> Introduction-selection of interface cards-DAQ card-single channel-multichannel-RS232/422/485 communication- IEEE 488 standard interface-GUI card-GPIB-Ethernet switch -Man machine interface.	8
IV	<b>CASE STUDIES ON MECHATRONIC SYSTEM</b> Introduction –Fuzzy based Washing machine – pH control system – Autofocus Camera, exposure control– Motion control using D.C.Motor & Solenoids – Engine management systems. – Controlling temperature of a hot/cold reservoir using PID- Control of pick and place robot – Part identification and tracking using RFID – Online surface measurement using image processing	8
V	<b>MICRO MECHATRONIC SYSTEM</b> Introduction- System principle - Component design – System design – Scaling laws – Micro actuation – Micro robot – Micro pump – Applications of micro mechatronic components.	8
	<b>TOTAL</b>	<b>40</b>

### List of Recommended Books:

1. Georg pelz, Mechatronic Systems: Modeling and simulation with HDL's, John wiley and sons Ltd, 2003
2. Devdas shetty, Richard A. Kolk, "Mechatronics System Design", Thomson Learning Publishing Company, Vikas publishing house, 2001.
3. Bolton, -Mechatronics - Electronic Control systems in Mechanical and Electrical Engineering-2nd Edition, Addison Wesley Longman Ltd., 1999.
4. Bishop, Robert H, Mechatronics Hand book, CRC Press, 2002.
5. Bradley, D.Dawson, N.C. Burd and A.J. Loader, Mechatronics: Electronics in Products and Processes, Chapman and Hall, London, 1991.

## 6MH5: OBJECT ORIENTED PROGRAMMING

B.Tech. (MH) 6<sup>th</sup> Sem.  
3L+0T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>OOP PARADIGM</b> 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.	8
II	<b>INTRODUCTION TO C++</b> 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
III	<b>CLASSES AND OBJECTS</b> 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
IV	<b>OPERATOR OVERLOADING, INHERITANCE AND POLYMORPHISM</b> 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
V	<b>CASE STUDIES</b> Over view of typical object oriented systems – Case studies - Applications.	8
	<b>TOTAL</b>	<b>40</b>

### List of Recommended Books:

1. E.Balagurusamy, "Object Oriented Programming with C++", Tata McGraw Hill, 1997.
2. Herbert Schildt, "C++ The Complete Reference", Tata McGrawHill Edition, 2003
3. Bjanne Stroustrup, "The C++ Programming Language", 3rd Edition, Addison Wesley, 2000
4. Stanley, B.Lippman, Jove Lagrie, "C++Primer", 3rd Edition, Addison Wesley, 1998
5. Baarkakati. N., 'Object Oriented Programming in C++', Prentice Hall of India, 1997.

## 6MH6.1: AUTOMOBILE ENGINEERING

B.Tech. (MH) 6<sup>th</sup> Sem.  
3L+0T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>FRAME AND BODY</b> Layout of chassis, types of chassis frames and bodies, their constructional features and materials. <b>TRANSMISSION SYSTEM</b> Clutch, single plate, multi plate, cone clutch, semi centrifugal, electromagnetic, vacuum and hydraulic clutches, Fluid coupling.	8
II	<b>GEAR BOXES</b> 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.	8
III	<b>RUNNING GEAR</b> Types of 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. <b>BRAKES</b> Classification and function, mechanical, hydraulic, vacuum air and self engineering brakes, brake shoes and lining materials.	8
IV	<b>AUTOMOTIVE ELECTRICAL SYSTEM</b> Battery construction, charging and testing, battery types, starting and battery charging system, starter motor construction, types of drive, alternator construction, regulation and rectification. <b>IGNITION SYSTEM</b> Magneto and coil ignition systems, system components and requirements. <b>AUTOMOTIVE LIGHTING</b> Wiring systems, electrical instruments, head lamp, electric horn, fuel level indicator.	8
V	<b>AUTOMOTIVE AIR CONDITIONING</b> Introduction, loads, air conditioning system components, refrigerants, fault diagnosis. <b>AUTOMOTIVE SAFETY</b> Safety requirements, Safety Devices, Air bags, belts, radio ranging, NVS (Night Vision System) GPS (Global Positioning System) etc.	8
	<b>TOTAL</b>	<b>40</b>

### List of Recommended Books:

1. Automobile Engineering, Sharma R.P., Dhanpat Rai & Sons.
2. Automobile Engineering, Gupta R.B., Satya Prakashan.
3. Vehicle and Engine Technology, Heniz Heisler, Elsevier Publication.
4. Automobile Engineering (Vol. 1 & 2), Kohli P.L., Tata McGraw Hill.
5. Automatic Transmission, Brejcha M.F., Prentice Hall India.

## 6MH6.2: ROBOTICS AND MACHINE VISION SYSTEM

B.Tech. (MH) 6<sup>th</sup> Sem.  
3L+0T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>BASICS OF ROBOTICS</b> Introduction- Basic components of robot-Laws of robotics- classification of robot-work space- accuracy-resolution –repeatability of robot. Power transmission system: Rotary to rotary motion, Rotary to linear motion, Harmonics drives	8
II	<b>ROBOT END EFFECTORS</b> Robot End effectors: Introduction- types of End effectors- Mechanical gripper-types of gripper mechanism- gripper force analysis- other types of gripper-special purpose grippers.	8
III	<b>ROBOT MECHANICS</b> Robot kinematics: Introduction- Matrix representation- rigid motion & homogeneous transformation- forward & inverse kinematics- trajectory planning. Robot Dynamics: Introduction - Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation	8
IV	<b>MACHINE VISION FUNDAMENTALS</b> Machine vision: image acquisition, digital images-sampling and quantization-levels of computation Feature extraction-windowing technique- segmentation- Thresholding- edge detection- binary morphology - grey morphology	8
V	<b>ROBOT PROGRAMMING</b> Robot programming: Robot Languages- Classification of robot language- Computer control and robot software-Val system and Languages- application of robots.	8
	<b>TOTAL</b>	<b>40</b>

### List of Recommended Books:

1. Sathya Ranjan Deb, robotics Technology & flexible Automation Sixth edition, Tata Mcgraw-Hill Publication, 2003.
2. Gorden M.Dair, Industrial Robotics, PHI 1988.
3. K.S.Fu, R.C.Gonzalez, C.S.G.Lee, Robotics: Sensing, Vision& Intelligence, Tata Mcgraw-Hill Publication, 1987.
4. John.J.Craig, Introduction to Robotics: Mechanics & control, Second edition-2002.
5. M.P.Groover, Industrial robotics- Technology, programming and Applications, McGraw-Hill, 1986

### 6MH6.3: AIRCRAFT ELECTRONICS SYSTEM

B.Tech. (MH) 6<sup>th</sup> Sem.  
3L+0T

Max. Marks : 100  
Exam Hours : 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>AIRCRAFT ELECTRICAL POWER</b> A.C. Power generation, D.C. Power generation, emergency power generation, voltage regulation, power distribution, inverters, transformers, rectifiers, circuit protection, external/ground power,	5
	Batteries installation and operation, Electronic emergency equipment requirements, cabin entertainment equipment, internal and external lightings of aircraft.	3
II	<b>AIRCRAFT INSTRUMENTS</b> 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.	4
	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	4
III	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. <b>AIRBORNE EQUIPMENTS</b> Classification, Atmosphere, Pressure measuring devices and systems, Pitot static system, Altimeters, Vertical speed indicators, Air speed indicator, Mach meter, Altitude reporting/alerting system,	3
	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.	3
	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.	4
IV	<b>TYPICAL ELECTRONIC//DIGITAL AIRCRAFT SYSTEMS</b> ECAM (Electronic Centralized Aircraft Monitoring) EFIS (Electronic Flight Instrument Systems)	3
	EICAS (Engine Indicating & Crew Alerting Systems) FMS (Flight Management Systems)	4

V	<b>AUTOFLIGHT (ATA 22)</b> 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.	4
	<b>AUTOMATIC LANDING SYSTEM</b> Principles and categories, modes of operation, approach, glideslope, land; go- around, system monitors and failure conditions. <b>AVIONICS SYSTEMS</b> Fundamentals of System Layout	3
	<b>TOTAL</b>	<b>40</b>

**List of Recommended Books:**

1. EHJ Pallet: Aircraft Instrument – Principles and Applications, Himalayan Books.
2. EHJ Pallet, Automatic Flight Control, Blackwell.
3. Leach Malvino, Digital Principles and Applications, Tata McGraw Hill.
4. AK Sawhney: Electrical Measurements and Measuring Instruments.
5. C.A. Williams: Aircraft Instruments, Galgotia.
6. Civil, Aircraft Inspection Procedures (CAP459) Two Volumes, Himalayan Books.

**6MH7: MICRO CONTROLLER AND PLC LABORATORY**  
**MM: 100**

**LIST OF EXPERIMENTS**

1. Study of Microcontroller Kits.
2. 8051 / 8031 Programming Exercises.
3. Stepper Motor interface.
4. D.C. motor controller interface.
5. Study of interrupt structure of 8051.
6. Interfacing high power devices to microcomputer port lines, LED relays and LCD displays.
7. Linear actuation of hydraulic cylinder with counter and speed control.
8. Hydraulic rotation with timer and speed control.
9. Sequential operation of pneumatic cylinders.
10. Traffic light controller.
11. Speed control of DC motor using PLC.
12. Testing of Relays using PLC.
13. Testing of MSP 430, Arm Processor, PIC Processor.

**TOTAL : 45 PERIODS**

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS**

<b>S.No</b>	<b>Equipments</b>	<b>Qty</b>
1	Regulated power supply	7
2	Pulse generator	1
3	Function generator	5
4	Cathode ray oscilloscope	5
5	8051 Micro Controller Kit	5
6	Stepper Motor	2
7	Stepper motor interfacing board	2
8	PLC trainer kit and related software	2
9	Hydraulic cylinder	1
10	Pneumatic cylinder	1
11	LED/LCD interface units	1
12	SCR/Triac/Power MOSFET interface unit	1

**6MH8: OBJECT ORIENTED PROGRAMMING LABORATORY**  
**MM: 75**

**LIST OF EXPERIMENTS**

1. Programs Using Functions
  - Functions with default arguments
  - Implementation of Call by Value, Call by Address and Call by Reference
  
2. Simple Classes for understanding objects, member functions and Constructors
  - Classes with primitive data members
  - Classes with arrays as data members
  - Classes with pointers as data members – String Class
  - Classes with constant data members
  - Classes with static member functions
  
3. Compile time Polymorphism
  - Operator Overloading including Unary and Binary Operators.
  - Function Overloading
  
4. Runtime Polymorphism
  - Inheritance
  - Virtual functions
  - Virtual Base Classes
  - Templates
  
5. File Handling
  - Sequential access
  - Random access

**6MH9: APPLIED HYDRAULICS AND PNEUMATIC LABORATORY**  
**MM: 100**

**LIST OF EXPERIMENTS**

- 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
  - v) 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.**

**LIST OF EQUIPMENT** (for a batch of 30 students)

<b>S.No</b>	<b>Equipments</b>	<b>Qty</b>
	<b>Hydraulic equipments</b>	
1	Pressure relief valve	4
2	Pressure reducing valves	2
3	Flow control valves	2
4	Pressure switch	1
5	Limit switches	2
6	Linear actuator	1
7	Rotary actuator	1
8	Double solenoid actuated DCV	2
9	Single solenoid actuated DCV	1
10	Hydraulic power pack with 2 pumps & 2 pressure relief valve	1
11	PLC	1
	<b>Pneumatic Equipments</b>	
1	Pneumatic trainer kit with FRL Unit, Single acting cylinder, push buttons	1
2	Pneumatic trainer kit with FRL unit, Double acting cylinder, manually actuated DCV	1
3	Pneumatic training kit with FRL unit, Double acting cylinder, pilot actuated DCV	1
4	Pneumatic trainer kit with FRL unit, Double acting cylinder, Double solenoid actuated DCV, DCV with sensor/ magnetic reed switches	1
5	PLC with Interface card	1
6	LABVIEW Software	1
7	Automation studio software	1

**6MH10: AUTOMOBILE ENGINEERING LAB.**  
**MM: 75**

1. Valve re-facing and valve seat grinding and checking for leakage of valves
2. Trouble shooting in cooling system of an automotive vehicle
3. Trouble shooting in the ignition system, setting of contact breaker points and spark plug gap
4. Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.
5. 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.
6. Fault diagnosis in transmission system including clutches, gear box assembly and differential.
7. Replacing of ring and studying the method of replacing piston after repair.