MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical & Mechatronics Engineering
Department of Mechatronics Engineering
Scheme of Bachelor of Technology, Mechatronics Engineering

Scheme of B. Tech. Second Year

III-Semester											
Course Code	Course Name	L	T	P	C	Exam duration (Hrs.)		Relative weightage			
						Theory	Practical	CWS	MTE	PRE	ETE
EO1323	Economics	3	0	0	3	3	-	30	30	-	40
MA1313	Engineering Mathematics-III	3	0	0	3	3	-	30	30	-	40
MC1306	Strength of Materials	3	1	0	4	3	-	30	30	-	40
MC1307	Electronic Measurement & Instrumentation	3	1	0	4	3	-	30	30	-	40
MC1308	Analogue System Design	3	1	0	4	3	-	30	30	-	40
MC1309	Theory of Machines	3	1	0	4	3	-	30	30	-	40
MC1331	Analogue System Design Lab	0	0	2	1	-	2	-	-	60	40
MC1332	Electronic Measurement & Instrumentation Lab	0	0	2	1	-	2	-	-	60	40
Total		**18**	**4**	**4**	**24**						

IV-Semester											
Course Code	Course Name	L	T	P	C	Exam duration (Hrs.)		Relative weightage			
						Theory	Practical	CWS	MTE	PRE	ETE
BB1101	Value, Ethics and Governance	2	0	0	2	3	-	30	30	-	40
MA1410	Engineering Mathematics-IV	3	0	0	3	3	-	30	30	-	40
XX14XX	**Open Elective-I**	3	0	0	3	3	-	30	30	-	40
MC1405	Design of Machine Elements	3	1	0	4	3	-	30	30	-	40
MC1406	Digital System Design	3	1	0	4	3	-	30	30	-	40
MC1407	Fluid Mechanics and Machines	3	1	0	4	3	-	30	30	-	40
MC1430	Computer Aided Drawing Lab	0	0	2	1	-	2	-	-	60	40
MC1431	Integrated Electronics Lab	0	0	2	1	-	2	-	-	60	40
Total		**18**	**3**	**4**	**22**						

OPEN ELECTIVE- I	
Course Code	Course Name
MC1492	Network And Project Management
MC1493	Introduction To Mechatronics System

Scheme of B. Tech. Third Year

V-Semester											
Course Code	Course Name	L	T	P	C	Exam duration (Hrs.)		Relative weightage			
						Theory	Practical	CWS	MTE	PRE	ETE
BB1540	Organization and Management	3	0	0	3	3	-	30	30	-	40
XX15XX	**Open Elective-II**	3	0	0	3	3	-	30	30	-	40
MC15XX	**Program Elective-I**	3	0	0	3	3	-	30	30	-	40
MC1507	Control System	3	1	0	4	3	-	30	30	-	40
MC1508	Mechatronics System Elements	3	1	0	4	3	-	30	30	-	40
MC1509	Microprocessors & Microcontrollers	3	1	0	4	3	-	30	30	-	40
MC1532	Microprocessors & Microcontrollers Lab	0	0	2	1	-	2	-	-	60	40
MC1533	Sensors & Control Lab	0	0	2	1	-	2	-	-	60	40
	Total	**18**	**3**	**4**	**23**						

VI-Semester											
Course Code	Course Name	L	T	P	C	Exam duration (Hrs.)		Relative weightage			
						Theory	Practical	CWS	MTE	PRE	ETE
XX16XX	**Open Elective-III**	3	0	0	3	3	-	30	30	-	40
MC16XX	**Program Elective-II**	3	0	0	3	3	-	30	30	-	40
MC1605	Pneumatics And Hydraulics Systems	3	0	0	3	3	-	30	30	-	40
MC1606	Programmable Logic Controller	3	0	0	3	3	-	30	30	-	40
MC1607	Industrial Robotics	3	1	0	4	3	-	30	30	-	40
MC1608	Electrical Drives And Machines	3	0	0	3	3	-	30	30	-	40
MC1631	Electrical Drives And Machines Lab	0	0	2	1	-	2	-	-	60	40
MC1632	Programmable Logic Control Lab	0	0	2	1	-	2	-	-	60	40
MC1633	Pneumatics And Hydraulics Lab	0	0	2	1	-	2	-	-	60	40
	Total	**18**	**1**	**6**	**22**						

Open Elective-II	
Course Code	Course Name
MC1590	Introduction To Robotics
MC1591	Quality Management
MC1592	Foundry Technology

Program Elective-I	
Course Code	Course Name
MC1550	Signals & Systems
MC1551	Material Science
MC1552	Manufacturing Process

Open Elective-III	
Course Code	Course Name
MC1693	Engineering Aspects Of Intellectual Property Rights
MC1694	Reliability Engineering
MC1695	Composite Materials
MC1696	Total Quality Management

Program Elective-II	
Course Code	Course Name
MC1654	Embedded System Design
MC1655	Modern Control System
MC1656	Production Technology
MC1657	Mechanical Vibration

Scheme of B. Tech. Final Year

Course Code	Course Name	L	T	P	C	Exam duration (Hrs.)		Relative weightage			
						Theory	**Practical**	**CWS**	**MTE**	**PRE**	**ETE**
MC1706	Mechatronics System Design	3	1	0	4	3	-	30	30	-	40
MC1707	Computer Integrated Manufacturing	3	0	0	3	3	-	30	30	-	40
MC17XX	**Program Elective-III**	3	0	0	3	3	-	30	30	-	40
MC17XX	**Program Elective-IV**	3	0	0	3	3	-	30	30	-	40
MC17XX	**Program Elective-V**	3	0	0	3	3	-	30	30	-	40
MC17XX	**Open Elective-IV**	3	0	0	3	3	-	30	30	-	40
MC1732	Mechatronics Lab	0	0	2	1	-	2	-	-	60	40
MC1733	CIM & Automation Lab	0	0	2	1	-	2	-	-	60	40
MC1780	Project Based Seminar	0	0	0	1	-	-	-	-	-	100
MC1781	Summer/Industrial Training*	0	0	0	1	-	-	-	-	-	100
	Total	**18**	**1**	**4**	**23**						

VII-Semester (table header spanning the above table)

* **Summer/Industrial Training will be conducted during the summer vacations after VI Semester and evaluated in VII Semester.**

Course Code	Open Electives-IV
MC1790	Arm Architecture Based System Design
MC1791	Introduction To Computational Fluid Dynamics Using OpenFoam

Course Code	Program Electives-III
MC1753	Digital Signal Processing
MC1755	Micro Electro Mechanical Systems
MC1756	Artificial Intelligence

Course Code	Program Electives -IV
MC1757	Biomedical Instrumentation
MC1758	Robot Path Planning and Control
MC1759	Computer Networking & Communication Protocol

Course Code	Program Electives -V
MC1761	Production and Operation Management
MC1762	Virtual Instrumentation

Course Code	Course Name	L	T	P	C	Relative weightage		
						Continuous Evaluation	**Mid Term Evaluation**	**End Term Evaluation**
MC1881	PROJECT WORK	0	0	0	12	30	40	30
	Total	**0**	**0**	**0**	**12**			

VIII-Semester (table header spanning the above table)

ABBREVIATION								
L	**T**	**P**	**C**	**CWS**	**MTE**	**PRE**	**PRS**	**ETS**
Lecture	Tutorial	Practical	Number of Credits	Class Work Sessional	Mid-Term Exam	End Term Practical Exam	Practical Sessional	End Term Exam

EO1323   **ECONOMICS**   **[3 0 0 3]**

Definition, nature and scope of Economics. Introduction to Micro and Macro Economics. Law of demand and supply, Elasticity of demand and supply. Cardinal and ordinal approaches of Utility. Production: Laws of production, Cost and revenue analysis, Various market situations, Break-even analysis, Capital Budgeting Macro Economics: National Income and it's Concepts, Value of money and its Changes, Foreign Exchange Rate, Monetary and fiscal Policies and other Macro concepts (Balance of Payment, Business Cycle etc.)

Text Book:
1. Peterson H C et.al. , Managerial Economics, Pearson, 9th edition, 2012.

References:
1. P L Mehta, *Managerial Economics,* Sultan Chand & Sons New Delhi, 20th Edition, 2014.
2. G. J.Tuesen & H. G. Tuesen, *Engineering Economics,* PHI, New Delhi, 2008.

[MA1313]   **ENGINEERING MATHEMATICS- III**   **[3 0 0 3]**

Vector Calculus: Gradient, Divergence and Curl, Vector integrals and related theorems. Laplace Transforms: Transforms of elementary functions, inverse transforms, convolution theorem. Application of Laplace in solution of ordinary differential equations with constant coefficients.Fourier series: Fourier series, Dirichlet's conditions, even and odd functions, half range series, change of interval, harmonic analysis.Fourier Transforms: Fourier integrals, complex Fourier transform, Fourier sine and cosine transforms, solution of heat and wave equations.Finite Differences and Interpolation: Finite difference operators, Newton's forward and backward interpolation formula, Lagrange's and Stirling interpolation formula. Numerical differentiation and integration.

Text Books:
1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Delhi, 43rd edition, 2014
2. Srimanta Pal, Subodh C. Bhunia, Engineering Mathematics, Oxford University Press, 1st edition, 2015
3. H.K. Das, Advanced Engineering Mathematics, S. Chand, 20th edition, 2015

Reference Book:
1. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Eastern, 10th edition, 2010.
2. B V Ramana, Higher Engineering Mathematics, Tata McGraw Hill Education Private Limited, New Delhi 2007.

[MC1306]   **STRENGTH OF MATERIALS**   **[3 1 0 4]**

Stress, Strain and Deformation of Solids: Rigid and Deformable bodies, Strength, Stiffness and Stability, Stresses; Tensile, Compressive and Shear, Deformation of simple and compound bars under axial load, Thermal stress, Elastic constants, Strain energy and unit strain energy, Strain energy in uniaxial loads, Beams-Loads and Stresses: Types of beams: Supports and Loads, Shear force and Bending Moment in beams, Cantilever, Simply supported and Overhanging beams, Stresses in beams, Theory of simple bending, Stress variation along the length and in the beam section , Effect of shape of beam section on stress induced , Shear stresses in beams, Shear flow, Torsion: Analysis of torsion of circular bars, Shear stress distribution, Bars of Solid and hollow circular section, Stepped shaft, Twist and torsion stiffness, Fixed and simply supported shafts, Beam deflection: Elastic curve of Neutral axis of the beam under normal loads, Evaluation of beam deflection and slope, Columns, End condition, Equivalent length of a column, Euler equation, Slenderness ratio, Rankine formula for columns, Analysis of stresses in two dimensions: Biaxial state of stresses, Thick & Thin cylindrical shells and spherical shells, Deformation in thick & thin cylindrical and spherical shells, Biaxial stresses at a point, Stresses on inclined plane, Principal planes and stresses, Mohr's circle for biaxial stresses, Maximum shear stress.

Text Books:
1. E. P. Popov, Engineering Mechanics of Solids, Prentice-Hall of India, New Delhi, 2nd edition, 1998
2. F. P. Beer and R. Johnston, Mechanics of Materials, McGraw-Hill Book Co, 7th edition, 2014.

References:
1. W. A. Nash, Theory and problems in Strength of Materials: Schaum's Outline Series, McGraw-Hill Book Co, 4th Edition, New York 2010.
2. S. M. A. Kazimi, Solid Mechanics, Tata McGraw-Hill, New Delhi, 1st edition, 2001.
3. G. H. Ryder, Strength of Materials, Macmillan India Ltd., 3rd Edition, 2002.
4. Ray Hulse, Keith Sherwin & Jack Cain, Solid Mechanics, Palgrave ANE Books, 2004.
5. D. K. Singh, Mechanics of Solids, Pearson Education, 1st edition, 2002.
6. S. Timoshenko, Elements of Strength of Materials, Tata McGraw-Hill, New Delhi, 5th edition, 2011.

[MC1307]   ELECTRONIC MEASUREMENT AND INSTRUMENTATION   [3 1 0 4]

Basic concepts of measurements: System configuration, calibration - Errors in measurements, measuring instruments: Permanent magnet moving coil, Moving iron, Electrodynamometer type and Rectifier type instruments, Applications - Measurement of Resistance, Inductance & Capacitance: A.C. Bridges. Temperature Measurement: Temperature and heat, Definitions, temperature scales, bimetallic thermometers, filled-bulb and glass stem thermometers, Resistance Temperature Detector (RTD), principle and types, measuring circuits, Linear and Quadratic approximation Thermistors, Thermocouples, optical pyrometers, Pressure Measurement: Manometers, Elastic types, Bell gauges, Electrical types, Differential Pressure transmitters, Dead weight Pressure gauges, Low Pressure Measurement: Mc Leod gauge, Knudsen gauge, Pirani gauge, Thermal conductivity gauges, Ionization gauge. Flow measurement: Classification of flow meters, orifice meters, Venturi Flow meter, variable area flow meters, Laser Doppler Anemometer (LDA), ultrasonic flow meters, Doppler flow meters, V-cone flow meters, purge flow regulators,

Measurement of mass flow rate: Radiation, angular momentum, Displacement measurement (LDR, Photodiode, LVDT), Vibration measurement, Level Measurement, Angular Velocity Measurement

Text Books:
1. A.K. Sawhney, Electrical & Electronic Measurements and Instrumentation, Dhanpat Rai & Co, New Delhi, 19th Edition, 2011.
2. E. O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, New York, 6th Edition, 2012.

References:
1. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition, 2010.
2. A. K. Sawhney, A course in Mechanical Measurement and Instrumentation, Dhanpat Rai and Co, New Delhi, 12th edition, 2002.
3. Bela G. Liptak, Process Measurement and Analysis, Chilton Book Company, Pennsylvania, 4th Edition, 2012.

[MC1308]   **ANALOG SYSTEM DESIGN**   **[3 1 0 4]**

Operational Amplifier: Introduction: Introduction to analog system design, Review of Op-Amp basics, internal block diagram, characteristics of ideal operational amplifier, Linear applications of operational amplifier: Open loop and closed loop operation of operational amplifier, Inverting amplifier, non-inverting amplifier, various configuration of Op-Amp, Active filters: Design and analysis of first and higher order low pass, high pass, band pass and band elimination and all pass active filters, Non-linear applications of operational amplifier: Precision half wave and full wave rectifiers, peak detector, sample and hold circuit, log and antilog amplifiers, analog multipliers and dividers, comparators, window detector, Schmitt trigger, square wave, triangular wave generators and pulse generator, Timer: Introduction, pin details of 555 I.C., functional diagram of 555 IC, Multi-vibrators, linear ramp generator and FSK generator, Data converters: Principles of digital to analog converter (DAC) and analog to digital converters (ADC), specifications of ADC and DAC, Regulated power supplies using IC's: Analysis and design of linear series voltage regulators using 78XX and 79XX series, LM317. Current Feedback Op-Amp.

Text Books:
1. D. Stanley William, Operational Amplifiers with Linear Integrated Circuits, Prentice Hall, 4th edition, 2004.
2. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson Education, 4th edition, 2015.

References:
1. Milman Jacob, Microelectronics, McGraw Hill, 2nd edition, 2001.
2. Franco Sergio, Design with Op amps & Analog Integrated Circuits, Tata McGraw Hill, 4th edition, 2014.
3. D. L. Terrell, Op Amps Design, Application, and Troubleshooting, Elsevier Publications, 2nd edition, 1996.
4. D. Roy Choudhury., Shail B. Jain, Linear Integrated Circuits, New Age International Publication, 4th edition, 2011.

5. A. Anand Kumar, Fundamental of digital circuits, Prentice Hall of India, 2001.
6. R. L. Boylestad & L. Nashelsky, Electronic Devices and Circuit Theory, PHI Learning publications, 10th edition, 2009.

[MC1309]   **THEORY OF MACHINES**   **[3 1 0 4]**

Basic Concepts: Mechanism and machine, kinematic pair, link, chain and inversions, constrained and unconstrained motions, four bar mechanism, single and double slider crank mechanisms with inversions, quick return mechanism, toggle mechanism, Hooke's coupling. Velocity and Acceleration: Solution of simple mechanisms by relative velocity and acceleration method, Cams: Types of cams, Types of followers, Cam profiles, Graphical methods for simple harmonic motion, Uniform velocity and cycloidal motion, Radial and oscillating follower, Calculation of maximum velocity and acceleration of follower, Gears: Classifications, Law of gearing, Spur gear definitions, Involute tooth profile and involuntometry, Determination of length of path of contact, Arc of contact, Contact ratio, Interference in involute gear, Minimum number of teeth on pinion to avoid interference, Parallel and crossed helical gear, Gear trains: Simple, compound, reverted and epicyclic gear train, Solution by tabular column method only, Torque transmitted by epicyclic gear train, Bevel epicyclic gear train, Differential gear drive of an automobile, Static and dynamic balancing: Balancing of revolving masses in single plane and different planes (Graphical method). Balancing of in-line and V-Engine, Governors: Characteristics of governors, Porter and proell governor, Hartnell governor, Gyroscope: Gyroscopic couple of a spinning disc. Condition for stability of a four wheeler and two wheeler.

Text Books:
1. S. S. Rattan, Theory of machines, Tata McGraw Hills Publications, 4th edition, 2014.

Reference:
1. J. S. Rao & Dukkipati, Theory of machines and mechanisms, New Age International Publications, 2nd edition, 2014.
2. J. E. Shigley, Uicker, Theory of Machines and Mechanisms, Oxford University Press, 4th edition, 2010.
3. H. Mabie Hamilton and Oevirk, Mechanisms and dynamics of machines, John Wiley and Sons Publications, 2nd edition, 1987.

[MC1331]   **ANALOGUE SYSTEM DESIGN LAB**   **[0 0 2 1]**

Negative feedback amplifiers: inverting and non-inverting mode, Instrumentation amplifier, summer, Voltage follower, Integrators, Differentiators, Filters: low pass filter, high pass filter, Square wave generator, Triangular wave generator, Schmitt trigger: inverting and non- inverting mode, Multi-vibrators using IC 555: Astable multivibrator, Monostable multi-vibrator, Half wave and Full wave precision Rectifier using OPAMP. Voltage regulator using LM317, 7805 ICs.

Text Books:
1. D. Stanley William, Operational Amplifiers with Linear Integrated Circuits, Prentice Hall, 2nd edition, 2004.

2. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson Education, 4th edition, 2015.

References:
1. Franco Sergio, Design with Op amps & Analog Integrated Circuits, Tata McGraw Hill, 4th edition, 2014.
2. **D. L. Terrell, Op Amps Design, Application, and Troubleshooting, Elsevier Publications, 2nd edition, 1996.**
3. **R. L. Boylestad & L. Nashelsky, Electronic Devices and Circuit Theory, PHI Learning publications, 10th edition, 2009.**

[MC1332]   ELECTRONIC MEASUREMENT AND INSTRUMENTATION LAB [0 0 2 1]

Displacement measurement using LVDT; characteristics of Thermocouple, thermistor, RTD, Displacement measurement using capacitive transducer, Analog to digital converter , Digital to analog converter, Speed control and velocity measurement of DC servomotor, Characteristics of Photo-transistor, Photo Diode and LDR, Strain Measurement, Hall Effect, Inductive Pick-up, Piezoelectric sensor.

Text Books:
1. A.K. Sawhney, Electrical & Electronic Measurements and Instrumentation, Dhanpat Rai & Co, New Delhi, 19th Edition, 2011.
2. E. O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, New York, 6th Edition, 2012.

References:
1. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition, 2010.
2. A. K. Sawhney, A course in Mechanical Measurement and Instrumentation, Dhanpat Rai and Co, New Delhi, 12th edition, 2002.
3. Bela G. Liptak, Process Measurement and Analysis, Chilton Book Company, Pennsylvania, 4th Edition, 2012.

BB1101   **VALUE, ETHICS & GOVERNANCE**   **[2 0 0 2]**

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of ersonality, Attitude, Behaviour, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case Studies*.

Governance: Understanding of Public and Private sector Governance systems; Courts & CAG.

Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects. CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line

Text / Reference Books:

Reference Books:
1.   Professional Module of ICSI.
2.   Ghosh B.N., Business Ethics & Corporate Governance, McGraw Hill.
3.   Mandal S.K., Ethics in Business & Corporate Governance, McGraw Hill .
4.   Ray C.K., Corporate Governance, Value & Ethics, Vaya Education of India
5.   Chatterjee Abha, Professional Ethics, Oxford Publications.

Suggestive Case Studies:
1.   Uphar Theatre Tragedy- Engineering Ethics
2.   Bhopal Gas Tragedy- Operational Engineering Ethics
3.   Satyam Case- Financial Reporting Ethics
4.   Enron Case- Business Ethics
5.   Navin Modi Case- Financial Fraudulence

[MA1410]   **ENGINEERING MATHEMATICS IV**   **[3 0 0 3]**

Tensor: Introduction to tensors, Cartesian tensors, Rank of tensor, First, second and higher order tensors, Algebraic operation on tensors, contraction of tensors, Contravariant and convariant vectors and tensors, Theorems based on tensors. Solution of Non-Linear Equations: Bisection, Newton-Raphson, Regula Falsi, Secant methods. System of Simultaneous Linear Equations: Gauss elimination method, Gauss-Jacobi, Gauss-Seidel. Solution of Initial Value Problems:

Taylor's series method, Euler method, modified Euler method, Runge-Kutta 4th order method. Finite Difference Methods: Solution of Laplace and Poisson equations by standard five point formula, solution of heat equations by Crank-Nicolson method, solution of wave equations. Statistics: Correlation, Regression, random variables, probability distributions- Binomial, Poisson and Normal.

Text Books:
1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Delhi, 43rd edition, 2014
2. Srimanta Pal, Subodh C. Bhunia, Engineering Mathematics, Oxford University Press. 1st edition, 2015
4. H.K. Das, Advanced Engineering Mathematics, S. Chand, 20th edition, 2015

Reference Book:
1. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Eastern, 2006.
2. B V Ramana, Higher Engineering Mathematics, Tata McGraw Hill Education Privare Limited, New Delhi 2007.

[MC1405]   **DESIGN OF MACHINE ELEMENTS**   **[3 1 0 4]**

Basic Concepts: Fundamentals of Mechanical Design: The Design Process, Economics of Design, Reliability, Safety and Product Liability, Codes and Standards, Types of Materials, Stress-Strain Response, Types Of Loads and Stresses, Failure Modes, Factor of Safety, Strength Design. Static And Variable Stress Analysis: Static Strength, Failure Theories, Stress Concentration, Fatigue Strength, Stress-Life (S-N) Diagram, High Cycle Fatigue, Endurance Limit Modifying Factors, Effect of Mean Stress, Fluctuating Stresses, and Stresses due to Combined Loading. Design of Transmission Shaft: Materials, Permissible Stresses, Permissible Deflection And Permissible Angular Twist, Power Transmitting Elements, Design For Static And Fatigue Load, ASME Code For Shaft Design. Design of Keys: Types of Keys, Application, Stresses in the Key, Selection of Keys. Coil Springs: Helical Coil Spring: Compression Springs of Round/Square/Rectangular Wires, Spring Materials, Stress And Deflection of Spring Subjected to Steady, Fluctuating and Impact Loads, Spring Surge and Buckling, Concentric Springs. Power Screws: Types of Power Screws, Terminology, Torque for Power Screws, Collar Friction, Efficiency, Nut for The Power Screw, Stresses in Power Screws, Threaded Fasteners: Effect of Initial Tension, Load on Axially Loaded Bolt, and Bolts for Pressure Vessels. Gears: Spur and Helical Gears: Merits, Terminology, Tooth Profile, Pressure Angle, Lewis Equation for Beam Strength, Form Factor, Velocity Factor, Design for Static Loads, Design for Dynamic and Wear Loads.

Text Books:
1. J. E. Shigley and C. R. Mischke, Mechanical Engineering Design, McGraw Hill Inc, New York, 9th Edition, 2013.
2. V. B. Bhandari, Design Of Machine Elements, Tata McGraw-Hill, New Delhi, 3rd Edition, , 2010.

References:
1. R. L. Norton, Machine Design - An Integrated Approach, Prentice Hall Inc., New Jersy, 2nd Edition, 2013.
2. R. C. Juvenile and K. M. Marshek, Fundamentals of Machine Component Design, John Wiley and Sons Publications, New York, 5th Edition, 2011.
3. Maleev and Hartman, Machine Design, Cbs Publishers, New Delhi, 5th Edition, 2011.
4. U. C. Jindal, Machine Design, Pearson, New Delhi, 1st Edition, 2014.
5. V. B. Bhandari, Machine Design Data Book, Tata McGraw-Hill, New Delhi, 3rd Edition, 2016.

[MC1406]   **DIGITAL SYSTEM DESIGN**   **[3 1 0 4]**

Combinational Logic Design: Minimization of Boolean functions using K-Map for 5 variables, Design of Arithmetic Circuits, Parity Generators and Checkers, Design of Code Converters, Comparators, Encoders and Decoders, Quine McClusky Minimization Technique VEM, plotting & reading theory,, Discussion of display devices and drivers, Design of display units. Logic Families: Introduction, Characteristics, RTL, TTL-Totem Pole-Open Collector Output, DTL, ECL, MOS-NMOS, PMOS, CMOS-Comparisons. Synchronous Sequential Circuit Diagram-Introduction to Flip-flops, Latches, Fundamentals of Synchronous Sequential circuits, Counters-Ring, Twisted-Ring, Decade counter, Shift Registers-Applications, Analysis and Design of Finite State Machines, Sequence Generator and Sequence Detector-Lock out condition, Design examples such as elevator control, traffic light controllers, stepper motor controllers, Introduction to ASM charts. Asynchronous Sequential Circuits: Fundamentals of Asynchronous Sequential Circuits, Analysis and Design of Asynchronous Sequential circuits, Cycles, Races and Hazards in Asynchronous circuits. Design examples such as vending machine using Asynchronous sequential circuits.

Text Books:
1. Donald D. Givone, Digital Principles and Design, Tata McGraw Hill Publications, 2002.
2. Morris Mano, Digital design, Prentice Hall Publishers, 4th edition, 2007.
3. G.K Kharate, Digital Electronics,Oxford university Express,6th Edition,2010.
4. S Salivahanan, S Arivazhagan, Vikas publishing house Pvt. Ltd., 3rd Edition,2007

References:
1. David J. Comer, Digital Logic State Machine Design, Oxford University Press, 3rd edition,
2. A. Ananda Kumar, Switching Theory and Logic Design, Prentice Hall of India Publishers, 2009

[MC1407]   **FLUID MECHANICS AND MACHINES**   **[3 1 0 4]**

Fundamentals: Definition and properties of fluids, intensity of pressure, variation of pressure in a static fluid, Absolute, Gauge, Atmospheric and Vacuum pressure Manometers, Fluid statics: Hydro static forces and centre of Pressure on vertical and inclined plane surfaces, Buoyancy, centre of Buoyancy, Metacentre and Meta-centric height, Analytical method for determination of Meta-centric height, Stability of floating and sub-merged bodies, Kinematics and Dynamics of fluid flow : Types of fluid flow, continuity equation, one dimensional Euler's equation of motion, Bernoulli's

energy equation, Fluid flow measurements: Pitot tube, orifice meter and venture meter, Fluid flow in pipes: Darcy weisbach equation. Losses in pipes - Minor and major losses, Dimensional analysis and Similitude: Methods of dimensional analysis, similitude, Impact of jet: Force exerted by the jet on stationery vanes and moving vanes, Hydraulic turbines: Pelton turbine, Francis turbine and Kaplan turbine (Constructional feature, working principle Velocity triangle, governing mechanisms and simple problems), Centrifugal pumps: Single-stage and multi-stage pumps - constructional feature, working principle, velocity triangles and simple problems.

Text Books:
1. Frank M. White, Fluid Mechanics, McGraw Hill, 7th edition, 2011.
2. Yunus A Cengel and John M. Cimbala, Tata McGraw-Hill Education, 3rd edition, 2010

References:
1. Victor Lyle Streeter, E. Benjamin Wylie, Fluid mechanics, McGraw Hill, 7th edition, 2007
2. Jagadish Lal, Hydraulic Machines, Metropolitan Book Company Pvt. Ltd., Delhi, 1971.

[MC1430]   **COMPUTER AIDED DRAWING LAB**   **[0 0 2 1]**

Introduction: Modelling Using Pro Engineer; Protrusion, shell; Revolve, sweep; Chamfer, fillet, hole, parallel blend; Rotational blend Sketcher, rotational pattern, reference pattern, Part Assembly; Finite Element Analysis using ANSYS: 2D spur 2D beam element; 2D solid element, 2D thermal element; Shell element; 3D sold element

Text Books:
1. I. Zeid, CAD/CAM Theory and Practice 2ED, 2nd edition, McGraw Hill Education, 2012

References:
1. Pro E wildfire 4.0/creo 2.0, 2013

[MC1431]   **INTEGRATED ELECTRONICS LABORATORY**   **[0 0 2 1]**

Regulator using 78XX and LM 317.Digital circuit design, combinational circuits – Implementation of Boolean functions and Arithmetic circuits, Multiplexers and implementation of circuits using multiplexers, Decoders and implementation of circuits using decoders, code converters, display driver interfaces, ripple counters, shift registers and ring counters, synchronous counters.

Text Books:
1. Donald D. Givone, Digital Principles and Design, Tata McGraw Hill Publications, 2002.
2. Morris Mano, Digital design, Prentice Hall Publishers, 4th edition, 2007.

3. D. Stanley William, Operational Amplifiers with Linear Integrated Circuits, Prentice Hall 2004.

References:
1. David J. Comer, Digital Logic State Machine Design, Oxford University Press, 3rd edition.
2. A. Ananda Kumar, Switching Theory and Logic Design, Prentice Hall of India Publishers, 2009.

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OPEN ELECTIVE-I
</div>

MC1492   **NETWORKS AND PROJECT MANAGEMENT**   **[3 0 0 3]**

Project Management: Introduction, Project planning, Scheduling, Controlling, Role of decision in project management, Techniques of analyzing alternatives: operations research, Methods of planning and programming, defining the project, estimating the cost and fixing the price, Bar Charts and Milestone Charts: Introduction, Development of bar charts, Illustrative examples, Short comings of bar charts and remedial measures, Milestone charts, Development of PERT network, Problems, Elements of Network: Introduction, Event, Activity, Dummy, Network rules, Graphical guidelines for network, Common partial situations in network, Numbering of events, Illustrative examples, Cycles, Problems, Development Of Network: Introduction, Planning for network construction, Modes of network construction, Steps in development of network, Work breakdown structure, Hierarchies, Illustrative examples, Problems, PERT: Time Estimates: Introduction, Uncertainties: Use of PERT, Time estimates, Frequency distribution, Mean, variance and standard deviation, Pert Time Computations: Introduction, Earliest expected time, Formulation for TE, Latest allowable occurrence time, Formulation for TL, Combined tabular computations for TL and TE, PERT: Network Analysis: Slack, Critical path, Probability of meeting scheduled date, CPM: Network Analysis: Introduction, CPM: process, CPM, Cost Model: Introduction, Project cost, Indirect project cost, Direct project cost, Slope of direct cost curve, Total project cost and optimum duration, Contracting the network for cost optimization, Illustrative examples, Problems, Resources Allocation: Introduction, Resources usage profiles histograms, Resources smoothing, Resources leveling, Problems.

References:

1. L. Dennis, *Project management*, Gower Press Limited, Great Britain, 1983.
2. B. C. Punmia, K. K. Khandelwal, *Project planning and control with PERT and CPM*, Laxmi Publications, Delhi, 2002.

[MC1493]   **INTRODUCTION TO MECHATRONICS SYSTEM**   **[3 0 0 3]**

Introduction: Definition, basic concepts and elements of mechatronic systems, needs and benefits of mechatronics in manufacturing, Sensors and Transducers: Displacement Sensor, Strain gauges, Force, Motion sensors, Proximity sensors, Light sensors, tactile sensors, Piezoelectric sensors, Drives and Actuators: relays, Servo motor, stepper motors, Data Acquisition and Translation: Signal conditioning, amplifiers, filters, Data Presentation System: LED, LCD, Controllers and Algorithms, Applications: robots, temperature monitoring system, washing machine.

Text books:
1. Dan Nesculescu, Mechatronics, Pearson Education Pvt. Ltd, 2002.

References:
1. D. Shetty & R. Kolk, Mechatronics System Design, PWS Publishers
2. Mechatronics – HMT, Tata McGraw Hill Publishing Company Ltd, 1998.
3. Aditya P. Mathur, Introduction to Microprocessors, Tata McGraw Hill, 1989.
4. C. R. Venkataramana**,** Mechatronics, Sapna Book house, Bangalore, 2001.

[MC1690]   **INTRODUCTION TO ROBOTICS**   **[3 0 0 3]**

Introduction to robotics, sensors, actuators, transmission and drives used in robotic systems, power, torque, force calculations for robotic systems, degrees of freedom (DOF), robot configuration, spatial resolution, accuracy and repeatability, robot specifications, structure of robotic system, robot kinematics, robot dynamics and control, trajectory planning, features of future robots, interactions of robots with other technologies, characteristics of future robot tasks, robots in construction trades, coal mining, utilities, military and fighting operations, under sea robots, robots in space, service industry and similar applications.

Text Books:

1. M. Vidyasagar Mark W. Spong ,Robot Dynamics and Control, Wiley India Private Limited,2008

2. S. R. Deb, Robotics Technology and Flexible Automation, 2nd Edition, McGraw Hill Education,2012

References:
1. John J. Craig, Introduction to Robotics - Mechanics and Control, Pearson Education International, 2004.
2. FU, Robotics Control Sensing Vision And Intelligence,1st Edition, Mcgraw Hill Education,2010

MC1507	CONTROL SYSTEMS	[3 1 0 4]

Introduction: Feedback control systems, Physical systems, signal flow graph, Time domain specification. Frequency Domain Analysis, Routh Hurwitz criteria for absolute / relative stability. Root locus plots, Bode plots- gain margin and phase margin, Polar plots, Nyquist stability criterion, gain margin and phase margin, System Compensation: Using elementary lag, lead and lead- lag compensating networks. Phase lead design using Bode diagram and root locus. Phase lag design using Bode diagram and root locus. Phase lag- lead design using Bode diagram and root locus. Pole Placement using Root locus. State Space Analysis.

Text Books:
1. K. Ogata, *Modern Control Engineering*, Prentice Hall India Publishers, Delhi, 5th edition, 2009.
2. B. C. Kuo, F. Golnaraghi, *Automatic Control Systems*, Wiley Publishers, India, 8th edition, 2003.

Reference Books:
1. R. C. Dorfand, R. H. Bishop, *Modern Control System,* Addison Wesley Longman Publications, 8th edition, 1998.
2. J. J. D'Azzo, H. Houpis Constantine, *Feedback control system analysis and synthesis,* McGraw Hill publications, New York, 4th edition, 2007.
3. I. J. Nagrath, M. Gopal, *Control Systems engineering*, New Age International Publications, 4th edition, 2006.
4. J. J. Distefano, A. R. Stubberud, I. J. Williams, *Feedback and Control Systems*, Tata McGraw Hills Publications, 2nd edition, 2007.
5. N. S. Nise, *Control Systems Engineerin*, Wiley India publications, 4th edition, 2003.

MC1508	MECHATRONICS SYSTEMS ELEMENTS	[3 1 0 4]

Introduction of mechatronic systems, needs and benefits of mechatronics in manufacturing, Sensors and Transducers: Displacement Sensor Strain - Strain gauges, Force/Torque, Motion & Velocity sensors, Proximity and Range sensors – Eddy current sensor, ultrasonic sensor, laser interferometer transducer, Hall Effect sensor, inductive proximity switch, Light sensors, phototransistors, Flow sensors, laser Doppler anemometer, tactile sensors, micro-switch & reed switch, Piezoelectric sensors, vision sensor, Drives and Actuators: Solenoids, relays, diodes, Thyristors, TRIACS, BJT, FET, DC motor, Servo motor, BLDC Motor, AC Motor, stepper motors, Piezoelectric actuators, Shape memory alloys, Hydraulic & Pneumatic devices, Power supplies, valves, cylinder sequencing, Data Acquisition & Translation: Signal conditioning, Multiplexer, Pulse width Modulation, Signal Analysis, Linearization of data, Compensation, Signal Averaging, Fourier analysis, Data Presentation System: Display - Cathode ray oscilloscope,

LED, LCD, Printers, Magnetic Recording. Controllers and Algorithms: PID controller and controller tuning.

Text Books:
1. D. A. Bradley, *Mechatronics*, Chapman & Hall Publications, 2002.
2. D.G. Alciatore & M. B. Histand., *Introduction to Mechatronics and Measurement systems*, Tata McGraw Hill, 3rd edition, 2003.

Reference Books:
1. D. Shetty & R. Kolk, *Mechatronics System Design*, PWS Publishers, 2nd edition, 2010.
2. D. Nesculescu, *Mechatronics*, Pearson Education Pvt. Ltd, 1st edition, 2002.
3. C. R. Venkataramana**,** *Mechatronics*, Sapna Book house, Bangalore, 2nd edition, 2001.

MC1509   MICROPROCESSORS AND MICROCONTROLLERS   [3 1 0 4]

Introduction: General block diagram of 8085, & 8086 with their instruction set. Introduction to microcontroller: History of Micro controllers, Embedded versus External memory devices, Microcontroller survey, CISC and RISC Microcontrollers, Harvard and von Neumann Architecture, Introduction to 8051 family: History of 8051, Addressing Mode, Instruction set of 8051 and Programming, Programming the 8051 resources, Counters, Timers, Serial Interface, Multiprocessor communication and Interrupts, Measurement of frequency, period and pulse width of a signal, Peripheral Interfacing: memory interfacing, Key board, LCD, stepper motor, Seven Segment Display, Digital to analog Converter, Analog to Digital converters. 8051 based system design- case studies, Traffic light control, and Washing machine control, mining problem, Turbine monitor, Introduction to PIC Microcontrollers- Architectural and Peripheral features, ALU, CPU, Memory map, clock, pipelining, addressing and I/O ports.

Text Books:
1. K. Kant, *Microprocessors and Micro controllers*, PHI learning publications, 3rd edition, 2007.
2. M. A. Mazidi, J. G. Mazidi, & R. D. Mckinlay, *8051 Microcontroller and Embedded Systems Using Assembly and C,* Pearson Education, 2nd edition, 2010.

Reference Books:
1. A.V. Deshmukh, "Micro controllers- Theory and Applications", Tata McGraw Hill, New Delhi, 5th edition,2008.
2. J. A. Kenneth, **"**The 8051 Microcontroller Architecture, programming and applications", Penram International Publications, Mumbai, 5th edition, 2008.

MC1532   MICROPROCESSORS & MICROCONTROLLERS LAB   [0 0 2 1]

Introduction to 8085 trainer kit and instruction set, Programming for Arithmetic and Logic operations, Array sorting, Code conversion, generate & sum of Fibonacci series, display of message. Introduction to 8051 simulation software and familiarization of 8051 instruction set, Arithmetic and Logic related programs, Array handling and code conversion programs, I/O port and Timer/ Counter programming, Programming using 8051 trainer kit in serial mode, DAC

Interfacing Programs, Keyboard and LCD Interface, Analog to Digital converter Interface, Seven segment Interfacing Programs, Logic Controller Interfacing Programs, Stepper motor Interfacing Programs, DC motor interface.

Text Books:
1. K. Kant, *Microprocessors and Micro controllers*, PHI learning publications, 3rd edition, 2007.
2. M. A. Mazidi, J. G. Mazidi, & R. D. Mckinlay, *8051 Microcontroller and Embedded Systems Using Assembly and C,* Pearson Education, 2nd edition, 2010.

Reference Books:
1. J. A. Kenneth, *The 8051 Microcontroller Architecture, programming and applications*, Penram International Publications, Mumbai, 5th edition, 2008

MC1533   **SENSORS & CONTROL LAB**   **[0 0 2 1]**

Study of Infrared Sensing and design of IR sensor using photodiode and TSOP. Experiment on optical sensors. Study of H-Bridge & design using Transistors. Implementation of motor driver circuit using LM293. Study of PWM (Pulse Width Modulation) & its use to control the speed of a DC motor.Study of Stepper Motor & its control circuit.
Study of Servo Motor & its control circuit. Study of feedback, feed forward, and ratio controller. Study of inverted pendulum.

Text Books:
1. D. A. Bradley, *Mechatronics*, Chapman & Hall Publications, 2002.
2. D.G. Alciatore & M. B. Histand., *Introduction to Mechatronics and Measurement systems*, Tata McGraw Hill, 3rd edition, 2003.

Reference Books:
1. D. Shetty & R. Kolk, *Mechatronics System Design*, PWS Publishers, 2nd edition, 2010.
2. D. Nesculescu, *Mechatronics*, Pearson Education Pvt. Ltd, 1st edition, 2002.
3. C. R. Venkataramana**, *Mechatronics*, Sapna Book house, Bangalore, 2nd edition, 2001.

SIXTH SEMESTER

MC1605   **PNEUMATIC & HYDRAULIC SYSTEMS**   **[3 0 0 3]**

Introduction to Fluid Power: Hydraulics and Pneumatics, Fluid power and fluid transport system, advantages, disadvantages and applications. Components: Hydraulic components: losses in valves and fittings, hydraulic circuit analysis, pumping theory, classification of pumps, Volumetric displacement and flow rate for gear, vane and axial piston pump, performance and selection. Cylinder: construction and mountings, force, velocity and power,. Motors: types, torque, power and flow rate, performance. Valves: DC valves, check, pilot, 3-way, 4-way, manually, ,Servo valves, Pressure control valves Pressure relief valve, pressure reducing valve, pressure

compensation valve, symbols of valves. Hydraulic Circuits: with different components and objectives, hose size calculations. Pneumatics: Compressor types, capacity ratings, sizing of receiver, FRL, sizing of valves, actuators- cylinders and motors. Circuits: design considerations, air losses in pipe lines. Pneumatic circuit analysis. .Circuit design: Motion diagram, Cascading method, Karnaugh –Veitch method.

Text Books:
1. W. Deppert and K. Stoll, *Pneumatic Control*, VOGEL Buchverlag Wurzburg Publications, Germany, 3rd edition,1992.

Reference Books:
1. S. R. Majumdar, *Pneumatic Systems Principles and Maintenance*, Tata McGraw Hill, New Delhi, 1st edition, 2000.
2. P. Croser, F. Ebel, *Pneumatics Basic Level TP 101*, Festo Didactic GMBH & Co, Germany, 2nd edition, 2002.
3. G. Prede and D. Scholz, *Electro-pneumatics Basic Level*, Festo Didactic GMBH & Co, Germany, 1st edition, 2002.
4. J. P. Hasebrink and R. Kobler, *Fundamentals of Pneumatic Control Engineering*, Festo Didactic GMBH & Co, Germany, 1st edition, 2002.

MC1606   **PROGRAMMABLE LOGIC CONTROL**   **[2 0 0 2]**

Introduction of PLC, 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, Diagnostics of PLCs with Computers, PLC programming: Simple instructions Programming, EXAMINE ON and EXAMINE OFF instructions, Electromagnetic control relays, Motor starters, 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, Timer instructions, ON DELAY timer and OFF DELAY timer, counter instructions, Up/Down counters. Timer and Counter applications program, control instructions, Data manipulating instructions, math instructions, Applications of PLC: Simple materials handling applications, Automatic control of warehouse, door, Automatic lubricating oil supplier, Conveyor belt motor control, Automatic car, washing machine, Bottle label detection, Process control application, PID control of continuous processes, Networking of PLCs, Controlling a robot with a PLC, PLC data move, jump functions, SKIP and MCR function, PLC arithmetic, number comparison, PLC Installation, troubleshooting and maintains.

Text Books:
1. F D. Petruzella, *Programmable Logic Controllers*, McGraw- Hills Publications, 4th edition, 2010.
2. Siemens, PLC Handbook.

Reference Books:

1. W I. Fletcher, *An Engineering Approach to Digital Design*", Prentice Hall of India Publishers, New Delhi, 3rd edition, 1999.
2. C H. Roth, *Fundamentals of Logic Design*,, Jaico Publishing house, 4th Edition, 1999.
3. Reis & Reis, *Programmable Logic Controllers*, PHI Learning Publications, 5th edition, 2002.

MC1607   **INDUSTRIAL ROBOTICS**   **[3 1 0 4]**

Introduction: Definition of Robots, Types of Robots, Degrees of Freedom, Degrees of Movements, Robot Configuration, Definition and factor affecting the Control Resolution, Spatial Resolution, Accuracy and Repeatability; Specification of a robot; MTBF; MTTR; Actuators & Sensors in Robot, Moire Fringes technique; Robot Vision; Rapid Review of Kinematics: Homogeneous Transformations, Forward and Inverse Kinematics, Jacobians. Dynamics: Euler-Lagrange Equations of Motion, Properties of Robot Dynamics, Examples. Independent Joint Control: Actuator Dynamics, PI/PID Control, Drive-Train Dynamics, Feedforward Control, Multivariable Control: Inverse Dynamics, Passivity-Based Robust and Adaptive Control.

Text Books:
1. Y Kozyhev, *Industrial Robots Handbook*, MIR Publications, 2nd edition, 1999.
2. K. C. Jain, L. N. Aggarwal, *Robotics Principles and Practice*, Khanna Publishers, 3rd edition, 2002.

Reference Books:
1. M. P. Groover, *Cam and Automation*, Prentice Hall Publications, 2nd edition, 2001.
2. P. A. Janakiraman, *Robotics and image processing*, Tata McGraw Hill, 2nd edition, 2002.
3. K. Yoram, *Robotics*, McGraw Hill Publications, 1992.

MC1608   **ELECTRIC DRIVES & MACHINES**   **[3 0 0 3]**

Introduction to semiconductor devices: SCR, GTO, IGBT, etc. Electric Motors: DC Motors: construction, principle, types, speed-torque characteristics, starting, speed control, AC Motors: Asynchronous motors: review of Induction Motors; Synchronous Motors: construction, principle, types, starting, speed control, Electric Drives: Components of electric drives, factors affecting choice of drives, dynamics of electrical drives, fundamental torque equation, speed-torque conventions, multi-quadrant operation of electric drives, load torque components, nature and classification of load torque, equivalent moment of inertia, steady state stability, load equalization; Determination of motor power rating, motor duty cycles; Electric braking, Power Modulators: Power semiconductor switches: power diodes, SCR, power transistor, IGBT, MOSFETs; Power converters: ac to ac, ac to dc, dc to ac, dc to dc. Special Machines: Stepper Motors, Brushless DC Motors, Permanent Magnet Synchronous Motor, Synchronous Reluctance Motors, Universal Motors, Linear motors – LIM, LSM.

Text Books:
1. G. K. Dubey, *Fundamentals of Electric Drives*, Narosa publications, 2nd edition, 2001.

Reference Books:
1. I. J. Nagrath and D. P. Kothari, *Electric Machines*, Tata McGraw Hill, New Delhi, 4th edition, 2010.
2. J. D. Edwards, *Electrical Machines and Drives*, Macmillan publications, UK, 3rd edition, 1991.

MC1631 ELECTRICAL DRIVES AND MACHINE LAB [0 0 2 1]

Speed-torque characteristics, starting, speed control of AC Motors: Asynchronous motors: Induction Motors; and Synchronous Motors Electric Drives: Components of electric drives, Determination of motor power rating, Power Modulators: Use of power semiconductor switches: power diodes, SCR, power transistor, IGBT, MOSFETs; Power converters: ac to ac, ac to dc, dc to ac, dc to dc, Special Machines: Methods of applications of Stepper Motors, Brushless DC Motors.

Text Books:
1. G. K. Dubey, *Fundamentals of Electric Drives*, Narosa publications, 2nd edition, 2001.

Reference Books:
1. I. J. Nagrath and D. P. Kothari, *Electric Machines*, Tata McGraw Hill, New Delhi, 4th edition, 2010.
2. J. D. Edwards, *Electrical Machines and Drives*, Macmillan publications, UK, 3rd edition, 1991.

MC1632 PROGRAMMABLE LOGIC CONTROL LAB [0 0 2 1]

Implementation of Basic Logic Gates – AND, OR, EXOR, NOT, Latching with ON and OFF priorities, SR and JK Flip Flops. Timer Operations – ON delay, OFF delay retentive and non-retentive timers, all possible combination like pulse timer, latching on delay etc. Counter operations – up counter, down counter, up-down counters, High speed counters, Developing programs for Arithmetic operations, Logical Operations, Comparison operations, Analog PLC operations – Accessing Analog inputs, Process and control analog outputs, Conveyor control Systems, Stepper Motor Control, Traffic light Control, Lift Control, Mini project, Bottling Plant.

Text Books:
1. F. D. Petruzella, *Programmable Logic Controllers*, McGraw- Hills Publications, 4th edition, 2010.

Reference Books:
1. Siemens, PLC Handbook.
2. W. I. Fletcher, *An Engineering Approach to Digital Design*, Prentice Hall of India Publishers, New Delhi, 1st edition, 1999.
3. C. H. Roth, *Fundamentals of Logic Design*, Jaico Publishing house, 4th Edition, 1999.

4. Reis & Reis, *Programmable Logic Controllers*, PHI Learning Publications, 5th edition, 2002.

MC1633   **PNEUMATICS AND HYDRAULICS LAB**   **[0 0 2 1]**

Basic Pneumatics: Operation of a single acting cylinder, double acting cylinder by using pneumatic components, Electro Pneumatics: Operation of a Single Acting and Double Acting cylinder Operation of a Single Acting and Double Acting cylinder electro-pneumatically, Operation of a single acting cylinder- controlled from different positions using shuttle (OR) valve and Dual pressure (AND) Valve, Operation of a double acting cylinder using quick exhaust valve and time delay valve, Controlling the speed of double acting cylinder using METERING IN valve and METERING OUT valve, Apply AND/ OR Logic using two manual controls for forward stroke of a double acting cylinder and using relay for actuation, Single cycle automation of multiple cylinders in sequence. Single cycle automation of multiple cylinders using cascading method (Sequence of Motion: A+B+B-A-), Multi cycle automation of multiple cylinders using cascading method (Sequence of Motion :A+B+B-A-), Operate an electrical switch to make a double acting cylinder to attain a FWD stroke. Multi cycle operation of a double acting cylinder,

Text Books:
1. D. Waller, H. Werener and T. Ocker, *Electropneumatics workbook Advanced Level*, Festo Didactic GMBH & Co, Germany, 2002.
2. P. Rohner, *Industrial Hydraulic Control*, John Wiley & Sons, Brisbane, 1989.

Reference Books:
1. Denford, UK, *CNC MIRAC Turning Center and TRIAC Machining Center Manual*,
2. MTAB, Chennai, ARISTO, 6 Axis Robot Manual.
3. Waller D. and Werner H., *Pneumatics Workbook Basic Level*, Festo Didactic GMBH & Co, Germany, 1993.
4. C. Rouff, D. Waller and H. Werener, *Electropneumatics Workbook Basic Level*, Festo Didactic GMBH & Co, Germany, 1993.

PROGRAM ELECTIVE-1

MC1550   **SIGNALS AND SYSTEMS**   **[3 0 0 3]**

Introduction to signals and systems: Definitions, Overview of specific systems, Classification of signals, Basic operations on signals, Elementary signals and functions, Systems viewed as interconnections of operations, properties of systems. Time domain representations for linear time-invariant systems: Introduction, Convolution: Impulse response representation for LTI systems, properties of the impulse response representation for LTI systems, Differential and difference equation representations for LTI systems, Block diagram representations. Fourier representation for signals: The discrete-time Fourier series, continuous-time periodic signals: The Fourier series,

Discrete-time non-periodic signals: The discrete-time Fourier transform, continuous-time non-periodic signals: The Fourier transform, properties of Fourier representations, Discrete-time periodic signals, Fast Fourier transform. Z-transform and its applications: Review of z-transform, unilateral z-transform, solution of difference equations, Analysis of LTI system in z-domain-system function, pole-zero analysis, stability

Text Book:
1. A.V. Oppenheim, A. S. Willsky & A. Nawab, *Signals and Systems*, 2nd edition, PHI. /Pearson Education, New Delhi, 1996.

Reference Books:
1. S. Haykin & B. V. Veen, *Signals and Systems*, John Wiley &Sons, New Delhi, 2nd edition, 2002.
2. J.G. Proakis, D.G. Manolakis, D. Mimitris, *Introduction to Digital Signal Processing*, Prentice Hall, India, 4th Edition, 2006.
3. A.V. Oppenheim & R.W. Schafer, *Discrete Time Signal Processing*, Pearson education, 3rd Edition, 2011.

MC1551   **MATERIALS SCIENCE**   **[3 0 0 3]**

Introduction: Crystal Structures, computations of packing factor of cubic and HCP structure, co-ordination number, Miller indices, crystal imperfections-point & line defects. Solidification: degree of super cooling, homogeneous & heterogeneous nucleation. Mechanism of solidification , nucleation and crystal growth, dendritic growth, Phases in solids: Phases-Single phase and multiphase, Gibb's phase rule, Solid solutions and types, Intermediate phases, Equilibrium diagrams (only binary), construction and explanation of isomorphous and eutectic systems, equilibrium and non-equilibrium cooling, invariant reactions Lever rule and its application on isomorphous and eutectic systems, Equilibrium and non-equilibrium cooling of an alloy, congruent melting alloy phase and super lattices, Iron-Carbon systems: cooling curve for pure iron, types of Fe-C equilibrium diagrams, study of iron-carbon system in detail with emphasis on the invariant reactions, Heat treatment: Principle heat treatments, isothermal transformation diagram-Construction and explanation, factors affecting shape and position of isothermal transformation diagram, continuous cooling curves isothermal transformation diagram, processes like annealing, normalizing, hardening, tempering and case hardening with heat treatment cycle, Jominy hardness test, Ferrous-alloys: Composition, properties and applications of alloy steels

Text Books:
1. Callister, *Materials Science and Engineering,* Wiley, 2nd edition, 2014.
2. Yu. Lakhtin, *Engineering Physical metallurgy and heat treatment*, MIR Publishers, Moscow, 1985.
3. V. Raghavan, *Material Science and Engineering*, Prentice Hall of India, Delhi, 5th edition ,2007.

Reference Books:
1. R. A. Higgins, *Engineering Metallurgy*, ELBS Publications, London, 5th edition, 1983.

2. S. H. Avner, *Introduction to Physical Metallurg*, Tata McGraw Hill, New Delhi, 3rd edition, 2004.
3. H. Lawrence, Van Vlack, *Elements of Material Science and Engineering*, Addision Wesley Publishing Company, Massachusetts, 6th edition, 1998.
4. Arzamasov, *Material Science*, MIR Publishers, Moscow, 1989.

MC1552   **MANUFACUTRING PROCESS**   **[3 0 0 3]**

Metal Casting Process: Classification of metal casting, Pattern Allowances, Molding Materials, Gating system design. Casting defects: Causes and remedies, Inspection of castings Introduction to Machine Tools: Classification of machine tool, Mechanics of Metal Cutting: Principles of metal machining, cutting tools and tool materials, tool signature, mechanics of chip removal, tool wear, tool life, economics of machining. Metal Joining Processes: Principle of welding, soldering, Brazing and adhesive bonding. Classification of welding and allied processes. Resistance welding: Spot, Projection and seam welding process, Atomic hydrogen, ultrasonic, Plasma and laser beam welding, Electron beam welding, and special welding processes e.g. TIG, MIG, friction and explosive welding. Metal Shaping and Forming: Metal working, Elastic and plastic deformation, Hot and cold working, Rolling, Principle and operations, Forging, Forging operations, extrusion, Wire and tube drawing processes. Forging: Principle of forging tool design, Cold working processes: Shearing, Drawing Squeezing, Blanking, Piercing, deep drawing, Coining and embossing.

Text Books:
1. S. Kalpakjian, and S. R. Schmid, *Manufacturing Engineering and Technology*, Pearson Education, 6th Edition, 2009.
2. A. Ghosh, and A. K. Malik, *Manufacturing Science*, Affiliated East West Press Pvt. Ltd., 2nd Edition, 2010.

Reference Books:
1. P.C. Sharma, *A text book of Production Technology*. S. Chand and Company, 4th Edition, 2006.
2. R. K. Jain., *Production Technology: Manufacturing Processes, Technology and Automation*, Khanna Publishers, 17th Edition, 2011.
3. P. N. Rao, *Manufacturing Technology* Volume-1, Tata McGraw-Hill Education, 4th Edition, 2013.

MC1553   **HEAT TRANSFER**   **[3 0 0 3]**

Introduction to heat transfer, Basic laws for conduction, convection and radiation heat transfer, combined modes, Thermal diffusivity, thermal resistance and conductance. Conduction: Conduction Heat Transfer, One dimensional heat conduction equation, Variable thermal conductivity, Heat Transfer from Extended Surfaces, fin efficiency. Convection :Free and forced convection heat transfer, Application of dimensional analysis to free and forced convection,

Reynold, Prandtl, Grashoff, Nusselt and Stanton numbers, Hydrodynamic and thermal boundary layer, Heat exchangers: LMTD, effectiveness. Radiation: Radiative exchange among black and grey and spectral surfaces. Applications of heat transfer in electronic devices.

Text Books:
1. I. Dewitt, *Fundamental of Heat and Mass transfe*Wiley, 7th edition, 2011.

Reference Books:
1. J P Holman, *Heat Transfer,* McGraw Hill, 8th edition, 1997.
2**.** Baehr, H. Dieter, Stephan, Karl**,** *Heat and Mass Transfer*, Springer-Verlag Berlin Heidelberg, 2nd edition, 2011.

PROGRAM ELECTIVE-II

MC1654   **EMBEDDED SYSTEM DESIGN**   **[3 0 0 3]**

Introduction, Classification and major application areas of Embedded System, Embedded System Design: Code design issues in System development process, the typical embedded system, Characteristics and quality attributes of embedded system. Embedded system- Applications and Domain specific, Design cycle in the development phase for an embedded system, designing embedded system with 8 bit microcontrollers, Role of processor selection in Embedded System. Hardware software Co-design and program modeling, fundamental issues, computational models in embedded system design, hardware software trade-offs, Operating system: basics, Real Time Operating System: Types of operating systems, Tasks, Process and Threads. Semaphores and shared Data, Task scheduling, Multiprocessing and multitasking, Operating system Services-Message queues-Timer Function-Events-Memory Management, device drivers, basic design Using RTOS, Networks for Embedded Systems: The I2C Bus, The CAN bus, Ethernet, Introduction to Blue tooth: Specification, IEEE 1149.1 (JTAG) Testability: Boundary Scan Architecture, Control Systems, Open loop and closed loop control systems; Cruise controller, General control systems and PID controller, software coding of PID controller, Practical issues related to computer based control.

Text Books:
1. R. Kamal, *Embedded Systems: Architecture, Programming and Design*, Tata McGraw Hill, 2nd edition, 2008.
2. K. J. Ayala, Dhananjay, V. Gadre, *The 8051 Microcontroller and Embedded systems*, Cengage Learning Publishers, 2010.

Reference Books:
1. K. V. Shibu, *Introduction to Embedded systems*, Tata McGraw Hill, 2009.
2. S. Siewert, *Real time embedded systems and component*, Cengage Learning, 2007.
3. F. Vahid, T. Givargis, *Embedded Systems* Indian Edition, Wiley Publications, 2002.

MC1655   **MODERN CONTROL SYSTEMS**   **[3 0 0 3]**

Sampled Data Control Systems, Signal Reconstruction, sampling process, ZOH, mapping between s and z planes – pulse transfer functions – step response – stability analysis – Jury's stability test, Bilinear Transformation, Bode plot, Root Locus models for Discrete Time system, Diagonalization, State Transition Matrix, Solution of equation for discrete time system by recursion and z-transform method, Concepts of Controllability and Observability, pole placement by state feedback-Ackerman's Formula- State Observers, Properties of non-linear systems - common physical   non-linearity - dead zone, relay, and saturation nonlinearities - phase plane method-singular points phase trajectories, Isocline Method , Liapunov's stability criterion.

Text Books:
1. K Ogata, *Discrete Time Control System* , Pearson , 2nd edition, 2005
2. M. Gopal , *Digital Control and State Variable Methods* , Tata McGraw Hill New Delhi , 2nd edition, 2005
3. B.C Kuo, *Digital Control Systems*, Oxford University press, 2nd edition ,1992.
4. S. M. Shinners, *Advanced Modern Control System Theory and Design*, John Wiley & Sons, 1998

Reference Books:
1. B. C. Kuo, F. Golnaraghi, *Automatic Control Systems*, Wiley Publishers, India, 8th edition, 2003.
2. R. C. Dorfand, R. H. Bishop, *Modern Control Systems,* Addison Wesley Longman Publications, 8th edition, 1998.
3. J. Nagrath and M. Gopal, *Control Systems engineering*, New Age International Publications. 4th edition, 2004

MC1656   **PRODUCTION TECHNOLOGY**   **[3 0 0 3]**

Non-conventional Machining: EDM, IBM, ECM, ECG, CM, AJM, Wire cut EDM, USM, LBM, Gear and Thread Manufacturing: Different types of Threads manufacturing methods, and tools involved, Different gear forming and generating methods. Gears finishing processes. Powder Metallurgy: Production of metal powders, compaction and sintering. Polymers and Composites: Introduction to polymers and composites; plastic processing – injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites. Press Tool: Classification of presses, Classification of dies, cutting actions in dies, clearance, Methods of reducing cutting forces, Minimum Diameter of Piercing Centre of Pressure, Blanking, Piercing, Drawing, Bending and Progressive Die design, scrap reduction, strip layout. Jigs and Fixtures: Differences between Jigs and Fixtures, Design principles, 3-2-1 location principle, Types of locators, Concept of work piece control, Geometric control, Dimensional control and Mechanical control, Jigs and fixtures for various machining operations

Text Books:
1. S. Kalpakjian, and Steven R. Schmid, *Manufacturing Engineering and Technology*, Pearson Education, 6th Edition, 2009.
2. A. Ghosh, and Asok Kumar Malik, *Manufacturing Science*, Affiliated East West Press Pvt. Ltd., 2nd Edition, 2010.
3. P.C. Sharma, *A text book of Production Technology*, S. Chand and Company, 4th Edition, 2006.
4. R.K. Jain, *Production Technology: Manufacturing Processes, Technology and Automation*, Khanna Publishers, 17th Edition, 2011.
5. P. N. Rao, *Manufacturing Technology Volume-1*, Tata McGraw-Hill Education, 4th Edition, 2013.

Reference Books:
1. M. C. Shaw, *Metal Cutting principles*, Oxford University press, 2nd edition, 2004.
2. Boothroyd, *Fundamentals of machining and machine tools*, CRC publication, 2005.
3. HMT Bangalore, *Production Technology H.M.T.*, Tata McGraw Hill Pub, 2001.
4. Donaldson, *Tool Design*, Tata McGraw Hill Pub, 4th edition, 2012.
5. Trent, *Metal cutting Principles*, Tata McGraw Hill Pub, 4th edition, 2000.

MC1657　　　　　　　**MECHANICAL VIBRATIONS**　　　　　　**[3 0 0 3]**

Introduction: mechanical vibration, vibration system and types, vibration analysis - degrees of freedom, mathematical modeling, equations of motion, SHM, Single degree of freedom systems: natural frequency, mathematical modeling, derivation of governing differential equation of motion for free undamped and damped systems, forced vibration single degree of freedom system under harmonic excitation, steady state, reciprocating and rotating unbalance, transmissibility and isolation, base excitation with harmonic input. Two degree of freedom systems - natural frequencies and mode shapes, forced vibration. Natural frequency of multi-degree of freedom systems, vibration control, vibration testing and measurement.

Text Books:
1. G.K. Groover, *Mechanical Vibration*, Nemchand and Bros, Roorkee, 8th edition, 2012
2. S .S. Rao, *Mechanical Vibration*, Pearson Education, Delhi, 5th edition, 2010

Reference Books:
1. V. D. Rao., *Text Book of Mechanical Vibration*, Prentice Hall of India Ltd, 1st edition, 2004.
2. J. D. Imnan. *Engineering Vibration*, Prentice Hall, New Delhi,4th edition, 2001
3. W.T. Thomson, *Theory of Vibrations with Applications*, Chapman and Hall, 4th Edition, 1993

MC1590   **INTRODUCTION TO ROBOTICS**   **[3 0 0 3]**

Introduction to robotics, sensors, actuators, transmission and drives used in robotic systems, power, torque, force calculations for robotic systems, degrees of freedom (DOF), robot configuration, spatial resolution, accuracy and repeatability, robot specifications, structure of robotic system, robot motion analysis, robot dynamics and control, trajectory planning, features of future robots, interactions of robots with other technologies, characteristics of future robot tasks, robots in construction trades, coal mining, utilities, military and fighting operations, under sea robots, robots in space, service industry and similar applications.

Text Books:
1. K Sun Fu, Gonzalez, *Robotics- Control, Sensing, Vision, and Intelligence*, McGraw-Hill, 2nd edition, 2010.

Reference Books:
1. John, J. Craig, *Introduction to Robotics – Mechanics and Control*, Pearson Education International, 3rd edition, 2004.
2. Yu Kozyhev, *Industrial Robots Handbook*, MIR Publishers, 1985.

MC1591   **QUALITY MANAGEMENT**   **[3 0 0 3]**

Quality Control: Meaning of quality and need of quality control, Assignable and non-assignable causes of variation, normal curve and other frequency distributions. Need of SQC, Statistical tolerances. Statistical methods for Quality Control in Manufacturing: An introduction to statistics for Quality applications, Process capability, Theory of control charts, control limits and specification limits; Control charts for variable. X, R charts, control charts for attributes, p, np charts, c-charts and u-charts. Study of special control charts; Moving range and moving average charts, CUSUM charts. Acceptance sampling: Some fundamental concepts in acceptance sampling, O.C. curve, sampling terms, sampling plans with different criteria. Quality Management: Introduction to Total Quality Control, Quality Assurance, ISO-9000, Quality Control tools, Kaizen, Benchmarking, cost of poor quality, Philosophies of Quality gurus like W.E. Deming, J.M. Juran, K. Ishikawa and Philip B. Crosby. Reliability: Basic concept, definition and its importance, Measures of Reliability, System Reliability: Series, Parallel systems.

Text Books:
1. K. ishikawa, *Introduction to Quality Control*, Springer Netherlands, 1st edition, 1991.
2. E. R. Ott, E. G. Schilling , D. V. Neubauer, *Process quality control*, American Society for Quality, 4th edition, 2005.
3. R. Dennis, Arter, *Quality audits for improved performance*, ASQ Quality Press, 1st edition, 2001.
4. Juran and Gryna, *Quality planning and analysis*, Mcgraw Hill Education, 5th edition, 2007.

MC1592 **FOUNDRY TECHNOLOGY** **[3 0 0 3]**

Introduction to casting: Steps involved in casting, advantages, limitations and applications of casting process. Pattern types, allowances for pattern, pattern, materials color coding and storing of patterns. Moulding methods: Molding methods and processes-materials, equipment, molding sand ingredients, essential requirements, sand preparation and control, testing, cores and core making. Design considerations in casting, gating and Risering, directional solidification in castings. Sand castings-pressure die casting-permanent mould casting-centrifugal casting-precision investment casting, shell moulding, CO_2 moulding, continuous casting-squeeze casting-electro slag casting. Fettling and finishing, defects in Castings. Foundry melting furnaces: Selection of furnace-crucibles oil fired furnaces, electric furnacescupola, calculation of cupola charges, hot blast, cupola-Degasifications, inoculation-pouring equipment, Inspection of castings.

Text Books:
1. H.F Taylor, M.C. Flemings & J. Wulff , *Foundry Engineering*, Wiley Eastern Limited, 1st edition 1993.
2. Serope Kalpakjian, *Manufacturing engineering and Technology*, Addision-Wesley Publishing Co., 3rd edition, 1995.

MC1693 **Engineering Aspects of Intellectual Property Rights** **[3 0 0 3]**

Introduction to Intellectual Property Rights, evolution of Intellectual Property Rights law in India; International Treaties and Conventions for protection of Intellectual Property Rights; Patents: Evolution of patent systems; Criteria of patentability: Novelty, industrial application and inventive step; Invention not patentable; Patent procedure in India; Compulsory licensing; Drafting Patent specification; Protection of design, software, semiconductor chip layout, domain name, geographical indication and traditional knowledge. Copyright and trademark.

Text Book:
1. P. Ganguli, *Intellectual Property Rights*, McGraw Hill Education (India) Private Limited, 2008.
2. B. L. Wadehra, *Law related to Intellectual Property*, Universal Law Publishing, 1st edition, 2010.

Reference Books:
1. V. K. Ahuja, *Intellectual Property Rights in India*, Lexis-Nexis, 2nd edition, 2009.
2. *Bare Act of Patent, Trademark, Copyright*, Universal Law Publishing.
3. G. Dutfield, U. Suthersanen, *Global Intellectual Property Law*, Edward Elgar Publishing Limited, 2nd edition, 2017.

MC1694   **RELIABILITY ENGINEERING**   **[3 0 0 3]**

Fundamentals of reliability: Scope of reliability engineering, concept of bath tub curve, types of failure data, reliability estimations, constant failure rate models, time dependent failure rate models, concept of failure on demand. System reliability assessment: Reliability estimation of series/parallel/mixed/complex system configurations. Design for reliability: Capturing user"s reliability requirements, reliability and/or redundancy allocation/optimization, design methods, FMEA/FMECA, reliability testing (burn-in testing, reliability assurance testing, reliability growth testing, accelerated life testing), fault tree analysis. Availability assessment: Point, mission and steady state availability, Markov modeling approach for availability estimation. Maintainability and maintenance: Maintainability assessment, and design for maintainability, concept of maintenance, types of maintenance, maintenance optimization. Warranty management: Types of warranty, reliability and warranty. Practical applications of reliability engineering to systems, products and processes: Case studies.

Text Book:
1. C Ebeling, *An Introduction to Reliability and Maintainability engineering*, Waveland Pr Inc, 2nd edition, 2009.
2. I Bazovsky, *Reliability Theory and Practice*, Dover Publications, 2004.

Reference Books:
1. P. O'Connor, *Practical Reliability Engineering*, John Wiley & Sons Inc. 2002.
2. G K. Hobbs, *Accelerated Reliability Engineering: HALT and HASS*, Wiley, 2000.

MC1695   **COMPOSITE MATERIALS**   **[3 0 0 3]**

Introduction to composite materials: Definition, Classification, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepregs, sandwich construction. Glass, carbon and advanced fiber manufacturing methods, applications, advantages, disadvantages and properties, Micro mechanical analysis of a lamina: Introduction, Derivation of stress, strain, Modulus of elasticity of fiber reinforced composites. Rule of mixture, problems to find density, mechanical properties of composites by using Rule of mixture, Manufacturing of polymer composites: description of method, advantages, disadvantages and application. Open and closed mold processing, Hand-lay-up technique, Spray up process, Bag molding, Filament winding, Pultrusion, Thermoforming, Injection molding, Resin Transfer Molding, Sheet Molding Compound, Dough Molding Compound, Thick Molding Compound, Machining and joining, Tooling, Quality assurance – Introduction, Material qualification, type of defects, NDT methods, Application developments: Aircrafts, missiles, space, automobile, electrical and electronics, marine, recreational and sports equipment's, construction, Potential future applications of composites, Metal matrix composites and ceramic matrix

composites: Reinforcement, Matrix materials, Characteristics and selection, base metal selection, applications.

Text Books:
1. M. Schwartz, *Composite Materials handbook,* McGraw Hill Book Company, 1984.
2. K. Kaw Autar, *Mechanics of composite materials*, CRC Press, New York, 2010.

Reference Books:
1. K. K. Chawla, *Composite material science and Engineering*, Springer, 1975.
2. P. C. Mallik, *Fiber reinforced composites*, Marcel Decker Publications, 1993.
3. R. M. Joness, *Mechanics of composite materials*, McGraw Hill Kogakusha Ltd., 2008.
4. W. Michael, Hyer, *Stress analysis of fiber Reinforced composite materials*, McGraw Hill International Publications, 1998.
5. M. C. Gupta, A. P. Gupta, *Polymer Composites*, New age international Publications, 2005.

MC1696　　　　　　　　**TOTAL QUALITY MANAGEMENT**　　　　　　**[3 0 0 3]**

Different Philosophies by Quality Gurus. TQM Principles: Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality. Customer Retention, Employee Involvement - Motivation, Empowerment teams, Continuous Process Improvement - Juran Trilogy, PDSA Cycle, Kaizen, Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures - Basic Concepts, Strategy, Performance Measure, Case studies, TQM Tools: Benchmarking - Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) - House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA - Stages of FMEA, Statistical Process Control: The seven tools of quality, Statistical Fundamentals - Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools. Quality Systems: Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System - Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 - Concept, Requirements and Benefits, Case Studies.

Text Books:
1. D. H. Besterfiled, *Total Quality Management*, Pearson Education Publications*,* Delhi, 3rd edition, 2011.
2. J. R. Evans & William M. Lidsay, *The Management and Control of Quality*, South-Western Thomson Learning, 5th edition, 2002.

Reference Books:
1. A.V. Feigenbaum, *Total Quality Management*, McGraw Hill Publications, 1991.
2. J. S. Oakland, *Total Quality Management*, Butterworth Heinemann Ltd, Oxford University Press, 1989.

3. V. Narayana and N. S. Sreenivasan, *Quality Management - Concepts and Tasks*, New Age International Publications, Delhi, 1996.
4. Zeiri, *Total Quality Management for Engineers*, Aditya Books, Delhi, 1992.
5. S. Ramasamy, *Total Quality Management*, Tata McGraw Hill, New Delhi, 2005.

MC1706   MECHATRONICS SYSTEM DESIGN   [3 1 0 4]

Introduction: Mechatronics Design process, Design Parameters, Traditional and Mechatronics designs – Advanced approaches in Mechatronics, Industrial design, and ergonomics, safety. System Modelling: 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. Actuators: Characteristics and applications of the Mechanical, electrical, Hydraulic and pneumatic actuator, shape memory alloys and their limitations. Sensors and transducers for motion measurement. Control parameters and system objectives, Mechanical configurations, popular control system configurations. Design with linear slides, Motion control Algorithms: significance of feedforward and feedback control loops, shortfalls, Architecture of Intelligent Machines: System design Classification, Motion control aspects of Design. Human and Machine, Machine Interfacing devices and strategy, Machine Vision: Feature and Pattern Recognition methods, concepts of perception and cognition in decision making. Case study: case study 1 and case study 2.

TEXT BOOKS:
1. C.W. Desi, *Control sensors and actuators*, Prentice Hall Publications.
2. Alcitore, Michael B. Histand, David G. Alciatore, *Introduction to mechatronics and measurement systems,* Tata MCGraw Hill**.**

REFERENCES:
1. M. B. Histand and D. G. Alciatore, *Designing Intelligent Machines,* Open University, London.
2. D.A. Bradley and others, *Mechatronics,* Chapman & Hall Publications.
3. W. Bolten, *Mechatronics*, Addison Wesley Longman Ltd, 1999.
4. D. Shetty & R. Kolk, *Mechatronics System Design*, PWS Publishing.
5. D. Nesculescu, *Mechatronics*, Pearson Education Pvt. Ltd. 2002.
6. HMT Limited, *Mechatronics and machine tools*, Tata McGraw Hill, 1998.
7. C.R. Venkataramana, *Mechatronics*, Sapna Book house, Bangalore, 2001.
8. B. Yegnanarayana, *Artificial Neural Networks,* PHI learning publications, 2001.
9. Timothy J. Ross, *Fuzzy logic with engineering applications,* Mcgraw Hill Publications, 1997.

Development in Machine Tools, Components of NC Machine, Problem with conventional NC, CNC Machine, CNC programming: Co-ordinate systems, Manual data input, Distributed Numerical Control, Adaptive Control Machining System, Group Technology , FMS and CIM: Part families − Part classification and coding, production flow analysis, Computer Integrated Manufacturing System, Automated Storage/Retrieval Systems, Flexible Manufacturing System, Single Station Manned /Automated Workstations: Single Station Automated Cells, Parts Storage Subsystem and Automatic Parts Transfer. Analysis Of Automated Flow Line & Line Balancing: General terminology and analysis, Analysis of Transfer Line Manual Assembly lines, line balancing problem. Computerized Manufacturing Planning Systems: Computer aided Process planning, Computer integrated planning systems, factory data collection systems, automatic identification systems.

TEXT BOOKS:
1. M. Thomas Crandell, *CNC Machining and Programming an Introduction,* Industrial Press Inc., New York, 2002.
2. P. Groover Mikell, *Automation, Production Systems, and computer Integrated manufacturing,* Prentice Hall of India, New Delhi, 2003.

REFERENCES:
1. K. Yoram, Ben and U. Joseph, *Numerical Control of Machine Tools,* Khanna Publishers, New Delhi, 2005.
2. Mikell P. Groover, and Emory W. Zimmers, *Computer aided design and manufacturing*, Prentice Hall of India, New Delhi, 2003.
3. P. Radhakrishnan, *Computer Numerical Control Machines,* New Central Book Agency Pvt. Ltd., Kolkata 2004 .
4. HMT Limited, *Mechatronics*, Tata McGraw Hill, New Delhi, 1998.
5. P.N Rao, *CAD/CAM*, Tata McGraw Hill, New Delhi, 2005.
6. James Madison, *CNC Machining Hand Book,* Industrial Press Inc, New York, 1996.
7. Smid Peter, *CNC programming Hand book*, Industrial Press Inc., New York, 2000.
8. K Yoram, *Computer Control of Manufacturing Systems, and Computer Integrated Manufacturing*, McGraw Hill Publications, Singapore, 1983.

MC1732   MECHATRONICS LAB   [0 0 2 1]

Design of an electro hydraulic circuit to control a double acting cylinder, Application of hydraulic simulation software to design Control circuits for automated functioning, servo motor interfacing and servo operation, speed control of induction motor using PLC, Application of software for driving stepper motor in full step resolution mode, half step resolution mode and milli step resolution mode, control of 3-axis robot, EMG signal processing and analysis using LabVIEW, Control of QUBE-Servo using LabVIEW, fundamentals of dynamic modelling and analysis using LabVIEW, Modelling of system using MATLAB: Case study 1 , Case Study 2.

REFERENCE BOOKS:
1. M. B. Histand and D. G. Alciatore, *Designing Intelligent Machines,* Open University, London.
2. D.A. Bradley and others, *Mechatronics,* Chapman & Hall Publications.
3. W. Bolten, *Mechatronics*, Addison Wesley Longman Ltd, 1999.
4. D. Shetty & R. Kolk, *Mechatronics System Design*, PWS Publishing.
5. D. Nesculescu, *Mechatronics*, Pearson Education Pvt. Ltd. 2002.
6. HMT Limited, *Mechatronics and machine tools*, Tata McGraw Hill, 1998.
7. C.R. Venkataramana, *Mechatronics*, Sapna Book house, Bangalore, 2001.
8. B. Yegnanarayana, *Artificial Neural Networks,* PHI learning publications, 2001.
9. Timothy J. Ross, *Fuzzy logic with engineering applications,* Mcgraw Hill Publications, 1997.

TEXT BOOKS:
1. C.W. Desi, *Control, sensors and actuators*, Prentice Hall Publications.
2. Alcitore, Michael B. Histand, David G. Alciatore, *Introduction to mechatronics and measurement systems,* Tata MCGraw Hill**.**

Pneumatics: Single cycle automation of multiple cylinders using cascading method; Intermediated positioning of a double acting cylinder ; Use of pneumatic counter; Use of pressure sequence valve; Use of back pressure valve; Use of pneumatic PLC for automation for single and multiple cycle; Application of AND/ OR Logic; Electro-pneumatics AND/ OR logic; single cycle automation using relay; ON and OFF delay timer application for solenoid actuation; Use of double solenoid valve with capacitive sensors (Use plastic or metal cam for sensing); Use of double solenoid valve and electrical limit switch. Use of PLC for multi-cycle and sequential operation of actuators.

REFERENCE BOOKS

1. Pneumatics Systems: By S. R majumdar
2. Industrial Automation & robotics :By A. K Gupta & S. K. arora

TEXT BOOKS

1. Advance Level Text book : Janatics
2. Advance Level Work book : Janatics
3. D. Waller, H. Werener and T. Ocker., Electropneumatics

MC 1753   DIGITAL SIGNAL PROCESSING   [3 0 0 3]

Review of time-domain and frequency domain properties of discrete-time signals and systems, sampling in time and frequency domain. Discrete Fourier transform –linear convolution using DFT. Computation of DFT-Fast Fourier Transform, Decimation in time and Decimation in frequency FFT algorithms, Computational considerations, Digital filters-digital filter structures, FIR and IIR Filters, finite word length effects. FIR filter design by Fourier approximation, Window method, frequency sampling method, Optimal FIR design, IIR filter design: Classical filter design using Butterworth and Chebyshev approximations, Impulse invariant and bilinear transformation methods, Frequency transformation technique for HP, BP and BS filter design, the direct design of IIR filters. DSP algorithms implementation in real-time applications.

TEXT BOOK:
1. John G. Proakis and Dimitris G.Manolakis, *"Digital Signal Processing – Principles, Algorithms & Applications"*, Fourth Edition, Pearson Education, Prentice Hall, 2007.

REFERENCE BOOK:
2. Emmanuel C.Ifeachor, and Barrie.W.Jervis, *"Digital Signal Processing"*, Second Edition, Pearson Education, Prentice Hall, 2002.
3. Sanjit K. Mitra, "*Digital Signal Processing – A Computer Based Approach*", Third Edition, Tata Mc Graw Hill, 2007.
4. A.V.Oppenheim, R.W. Schafer and J.R. Buck, *Discrete-Time Signal Processing, 8th Indian Reprint*, Pearson, 2004.
5. Andreas Antoniou, *"Digital Signal Processing",* Tata McGraw Hill, 2006.

Introduction to MEMS and Microsystems: Products, Evolution of micro-fabrication, microelectronics, miniaturization, application in the automotive and other industries, Working principles of Microsystems: Microsensors , Microactuation, Scaling laws in miniaturization: Scaling in geometry, Scaling in rigid body dynamics, Scaling in electrostatic, electromagnetic forces, Scaling in electricity, Scaling in heat transfer and fluid mechanics, Materials for MEMS and microsystems: Substrates and wafers, Silicon as a substrate material, silicon compounds, silicon piezo-resistors, Gallium arsenide, Quartz, Polymers, Packaging materials, Problems, Microsystems fabrication Processes: Photo lithography, Ion implantation, Diffusion, Oxidation, Chemical vapor deposition, Physical vapor deposition, Deposition by Epitaxy, Etching, Problems, Micro-manufacturing: Bulk manufacturing, Surface micromachining, LIGA process, Microsystems Design: Design consideration, Process design, Mechanical design, Design of a silicon die, Design of microfluidic Network system. Case studies.

TEXT BOOKS:
1. T. R. Hsu, *MEMS and Microsystems- Design and Manufacturing,* Tata McGraw Hill.
2. Chang Liu, *Foundation of MEMS*, Pearson Education.

REFERENCE BOOKS:
1. Marc J. Madou**,** *Fundamentals of Micro fabrication: The Science of Miniaturization*, CRC Press, 2002.
2. W. Menz, J. Mohr, O. Paul, *Microsystem Technology*, Wiley Publications, 2001.
3. M. Gad-el-Hak, *The MEMS Handbook,* CRC Press, 2002.

Introduction to AI and intelligent agents. Uninformed search, Heuristic search, stochastic search, adversarial search, game playing. Machine Learning: basic concepts, linear models, perceptrons, neural networks, naive Bayes, Decision trees, ensemble, logistic regression, and unsupervised learning. Constraint satisfaction problems, Markov decision processes, reinforcement learning. Logical agents, propositional logic, and first-order logic, planning, partial-order planning, Bayesian Networks, natural language processing, AI applications.

TEXT BOOKS:
1. Stuart Russell and Peter Norvig, *"Artificial Intelligence, A Modern Approach",* 3rd Edition, Pearson Education, 2015.
2. Kevin Knight, Eline Rich B.Nair, *"Artificial Intelligence"*, McGraw Hill Education 3 rd edition 2012.

REFERENCE BOOK:
1. Dan W. Patterson, *"Introduction to AI and ES",* Pearson Education, 2007
2. George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, Pearson Education Asia (2009).

MC1757 BIOMEDICAL INSTRUMENTATION [3 0 0 3]

Fundamentals of Medical Instrumentation, Bioelectric Signals and Electrodes, Physiological Transducers, Biomedical Recorders-ECG, EEG, EMG, ERG, Blood Flow and Cardiac Output Measurement, Heart Rate, Biomedical Telemetry, Blood Gas Analysers, GSR, ESR measurements Blood Cell Counters , Patient Monitoring Systems, Magnetic Resonance Imaging Systems, Ultrasonic Imaging Systems, X-Ray Computed Tomography, Cardiac Pacemakers, Cardiac Defibrillators ,Dialyzers, Instruments for Surgery-Diathermy, Ventilators, Patient Safety.

TEXT BOOKS
1. R.S. Khandpur, 'Hand Book of Bio-Medical instrumentation', McGraw Hill Publishing Co Ltd.2003.
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, 'Bio-Medical Instrumentation and Measurements', II edition, Pearson Education, 2002.

REFERENCES BOOKS
1. M. Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.
2. L.A. Geddes and L.E.Baker, 'Principles of Applied Bio-Medical Instrumentation', John Wiley & Sons, 1975.
3. J.Webster, 'Medical Instrumentation', John Wiley & Sons, 1995.
4. C.Rajarao and S.K. Guha, 'Principles of Medical Electronics and Bio-medical Instrumentation', Universities press (India) Ltd, Orient Longman ltd, 2000.

MC1758   ROBOTIC PATH PLANNING AND CONTROL   [3 0 0 3]

Configuration space, obstacles space, dimensions, topology, parameterization, transformations, potential functions, obstacle avoidance, gradient descent, local minima problem, navigational potential functions, non-Euclidean potential functions, algorithms, analysis, running time, complexity, completeness. Graph Search A*, LRTA* and RTAA*, Generalized Voronoi Graph (GVG), opportunist path planning, cell decomposition, trapezoidal, Morse cell, visibility based decompositions. Sampling-based algorithms, the Probabilistic Road Map (PRM), Rapidly-Exploring Random Trees (ERT), motion planning, and control based planning, manipulation planning, optimal planning, feedback planning, planning under kinematics and dynamic constraints, trajectory planning, decoupled, direct planning, non-holonomic constraints, path planning, and control.

TEXT BOOKS:
1. Farbod Fahimi, *"Autonomous Robots- Modeling, Path Planning, and Control"* (1e) Springer, 2009.
2. H. Asada and J. J. Slotine, *"Robot Analysis and Control" Springer Verlag*, 1998.
3. Yasmina Bestaoui Sebbane, "*Planning and Decision Making for Aerial Robots*", (1e), Springer, 2014.

REFERENCE BOOK:
1. Choset H., Lynch K. M., *"Principles of Robot Motion: Theory "Algorithms, and Implementations"* (1e), MIT Press, Boston, 2005.

MC1759   COMPUTER NETWORKING & COMMUNICATION PROTOCOL   [3 0 0 3]

Introduction to reference models, data communication, network architecture, basics of OSI, and TCP/IP reference models. Transmission media, FDM, TDM and CDMA, Frame Relay and ATM switching, ISDN, Local area network protocols, IEEE standards for LAN. Data link layer design, functions and protocols, link layer, error detection and correction techniques, Ethernet, hubs and switches, PPP, Network layer, Transport layer: connectionless transport-UDP, FTP, Electronic Mall in the internet, P2P file sharing, HTTP, quality of services: ATM Differentiated service model, flow identification, scheduling, factors affecting QoS parameters and service categories, network management, protocol, SNMP, CMIP, concept of traffic and service. Voice and video data, ATM Traffic, Traffic contracting.

TEXT BOOKS:
1. James F. Kurose, Keith W. Ross, *Computer networking (A top-down approach featuring the internet)*, 3rd edition, Pearson Education, 2005
2. Charle Kaufman, Radia Perlman, Mike Specines, Uyless Black, *Computer networks: Protocols standards and interfaces*, Prentice Hall of India Pvt. Ltd. 2010

REFERENCE BOOK:
1. Andrew S. Tanenbaum, *Computer networks*, 5th edition, PHI, 2010
2. William Stallings, *Data and computer communications*, 7th edition, Prentice Hall of India Pvt. Ltd. 2004

Forecasting: Importance and uses of forecasting, Type of forecasts, Correlation analysis and Seasonality, Forecast control. Product Development and Design: Factors affecting product development and design, Standardization, Capacity Planning: Factors affecting system capacity, Aggregate Planning: Pure and mixed strategies of aggregate planning, Material Requirement Planning: Product structure tree, Bill of Material. Machine Scheduling: Factors affecting job shop scheduling, Different priority sequencing rules, Determination of mean flow time, average job lateness and average number of jobs in the system, Line balancing, Inventory Control: Economic order quantity, Different inventory control models, Effect of quantity discount, Quality Control: Meaning of Quality, Quality assurance system, Inspection and control of quality; Process control charts, Acceptance sampling, Concept of Six Sigma. Reliability and Maintenance Planning: Constant failure rate and Time-dependent failure rate models for system components; System reliability determination; Types of maintenance. Queuing Model: Introduction, Markov Chains and Markov Processes, Birth-Death Processes, Simple Queueing Models M/M/-/- Queues.

TEXT BOOKS:
1. E. Jr. Adam Everett and Ronald J Ebert., *Production and Operations Management*, Prentice Hall of India, New Delhi, 2002.
2. Joseph G. Monks, *Operations Management,* Tata McGraw-Hill, New Delhi, 2004.

REFERENCES:
1. Richard B. Chase, Nicholas J. Aquilano and Jacobs F. Roberts, *Production and Operations management,* Tata McGraw-Hill, New Delhi, 1999.
2. Eilon Samuel, *Elements of Production Planning and Control,* Universal Publishing Corporation, Mumbai, 1991.
3. Lee J. Krajewski and Larry P. Ritzman**,** *Operations Management,* Pearson Education, Singapore, 2005.
4. Gupta Prem Kumar and D. S**.** Hira**,** *Operations Research,* S. Chand & Co. Ltd., New Delhi, 2003.
3. Charles E. Ebeling, *An introduction to Reliability and Maintainability Engineering*, Tata McGraw-Hill Education (India) Edition 2000.

Basics of Virtual Instrumentation-Historical Perspective, Need/Advantages of VI, Defining VI, Block Diagram & Architecture of VI, Data flow techniques, Graphical Programming, Comparison with Conventional Programming.VI Programming Techniques-VIs and SUBVIs, Loops and Charts, Arrays, Clusters, Graphs, Case/Sequence Structures, Formula nodes, Local &Global Variables, Strings & File Input. Data Acquisition Basics with VI-ADC/DAC, DI/O, Counters/Timers, PC Hardware Structures, and Timing interrupts, DMA, Use of Analysis Tool-Fourier Transform, Power Spectrum, Correlation Methods, Fourier transform, Power spectrum Correlation, Windowing and filtering tools, Simple temperature indicator, ON/OFF controller PID controller, CRO emulation and Simulation of a simple second order system.

TEXT BOOKS:
1. Johnson, G., *LabVIEW Graphical Programming*, McGraw Hill (2006)
2. Sokoloft, L., *Basic Concepts of LabVIEW 4*, Prentice Hall Inc. (2004)
3. Wells, L.K. and Travis, J., *LabVIEW for Everyone*, Prentice Hall Inc. (1996)
4. Robert H. Bishop, '*Learning with Lab-view'*, Prentice Hall, 2003

REFERENCE BOOK:
1. Gupta, S. and Gupta, J.P., *PC Interfacing for Data Acquisition and Process Control*, Instrument Society of America (1988)
2. Kevin James, '*PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control'*, Newness, 2000
3. Gary W. Johnson, Richard Jennings, '*Lab-view Graphical Programming'*, McGraw Hill Professional Publishing, 2001

Introduction to reference models, data communication, network architecture, basics of OSI, and TCP/IP reference models. Transmission media, FDM, TDM and CDMA, Frame Relay and ATM switching, ISDN, Local area network protocols, IEEE standards for LAN. Data link layer design, functions and protocols, link layer, error detection and correction techniques, Ethernet, hubs and switches, PPP, Network layer, Transport layer: connectionless transport-UDP, FTP, Electronic Mall in the internet, P2P file sharing, HTTP, quality of services: ATM Differentiated service model, flow identification, scheduling, factors affecting QoS parameters and service categories, network management, protocol, SNMP, CMIP, concept of traffic and service. Voice and video data, ATM Traffic, Traffic contracting

TEXT BOOKS:
1. Andrew S. Tanenbaum, *Computer networks*, 5th edition, PHI, 2010
2. William Stallings, *Data and computer communications*, 7th edition, Prentice Hall of India Pvt. Ltd. 2004

REFERENCE BOOK:
1. James F. Kurose, Keith W. Ross, *Computer networking (A top-down approach featuring the internet)*, 3rd edition, Pearson Education, 2005
2. Charle Kaufman, Radia Perlman, Mike Specines, Uyless Black, *Computer networks: Protocols standards and interfaces*, Prentice Hall of India Pvt. Ltd. 2010

MC1791   INTRODUCTION TO COMPUTATIONAL FULID DYNAMICS   [3 0 0 3]
                        USING OPENFOAM

Introduction to CFD: Methods of prediction, potential and limitation of CFD; Review of numerical techniques: Solution of IVP and BVP, Euler method, Runga-Kutta method, accuracy and errors, solution of linear algebraic equations, convergence; Conservation laws, classification of PDE's, initial and boundary conditions. Discretization methods and Meshing in OpenFOAM; Modeling of diffusion problems, one dimensional steady state heat conduction, unsteady heat conduction; Modeling of convection diffusion problems, Modeling fluid flow and multiphase problems.

Prerequisites / Recommended Background: Basic programming skills (C, C++, MATLAB etc.) Basic Fluid Mechanics and Heat Transfer /Transport phenomena

TEXT BOOK
    1. H. K. Versteeg and W. Malalasekera, *"An Introduction to Computational Fluid Dynamics: The Finite Volume Method"*,
    2. S. V. Patankar, *"Numerical Heat Transfer and Fluid Flow",* ISBN: 0-89116-522-3

REFERENCE BOOK

    1. F. Moukalled, L. Mangani, M. Darwish,, *"The finite volume method in computational fluid dynamics"*, Springer