DEPARTMENT OF MECHATRONICS ENGINEERING

Mechatronics engineering is an emerging field of engineering which involves the combination of different disciplines viz. Mechanical, Electronics & Electrical, Instrumentation and Computer Science Engineering. The course curriculum has been designed aptly to cater the ever expanding demands of research and industry by consolidating the views of all stake holders. The main objective of the department is to impart a quality education and make the students industry ready.

The Department was established in the year 2012, offering B. Tech degree with an intake of 90. Faculty members in the department are well qualified and have rich teaching and research experience. The various specialization of faculties include interdisciplinary areas like Robotics & Automation, Industrial Engineering, Instrumentation & control and Micro-Electro-Mechanical Systems etc. The department has a team of 14 dedicated faculty members who are capable of providing state-of-art exposure to students with quality approach to research and development.

The Department has well equipped laboratory facilities having Sensoric and Hydraulic Labs with industrial level equipment's set up in collaboration with Bosch Rexroth India Ltd. Additionally, other laboratories includes Programmable Logic Controllers, Microcontroller, Mechatronics System Design, Pneumatics and Electronics Measurement & Instrumentation Lab. In addition, these laboratories are equipped with Quanser, Janatics, National Instruments and Siemens make equipments. To enhance the skills and foster the individual growth, the department has a robotics club in which the students develop robots and it also provides guidance to interested students apart from taking up specific projects.

〉 Programs offered

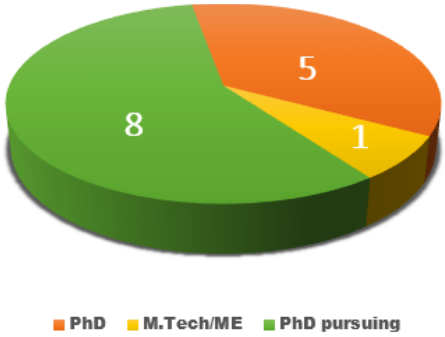
Under Graduate Program

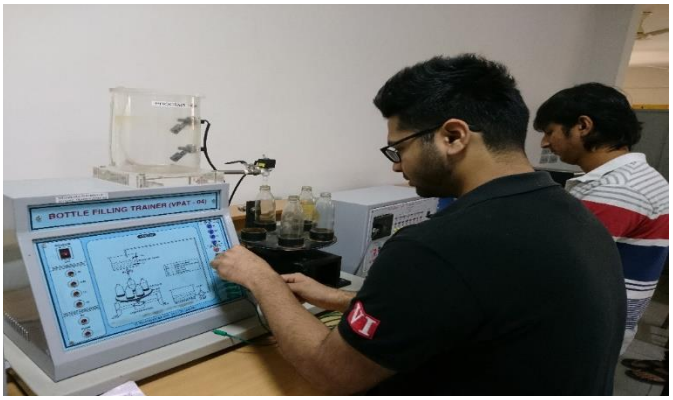
- B.Tech in Mechatronics

PhD

〉 Faculty Strength

Qualification-wise





BACHELOR OF TECHNOLOGY IN MECHATRONICS ENGINEERING

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	BB 0025	Value, Ethics and Governance	2	0	0	2	EO 2001	Economics	3	0	0	3
	MA 2102	Engineering Mathematics-III	2	1	0	3	MA 2204	Engineering Mathematics-IV	2	1	0	3
	MC 2101	Strength of Materials	3	1	0	4	MC 2201	Design of Machine Elements	3	1	0	4
	MC 2102	Linear Integrated Circuits	3	1	0	4	MC 2202	Digital System Design	3	0	0	3
	MC 2103	Theory of Machines	3	1	0	4	MC 2203	Fluid Mechanics	3	1	0	4
	MC 2104	Sensor and Instrumentation	3	0	0	3	** 20**	Open Elective-I	3	0	0	3
	MC 2130	Simulation and Modelling Lab	0	0	2	1	MC 2230	Programmable Logic Controller Lab	0	0	3	1
	MC 2131	Sensor& Instrumentation Lab	0	0	2	1	MC 2231	Integrated Electronics Lab	0	0	2	1
	MC 2170	Seminar	0	0	2	1	MC 2270	Project Based Learning-I	0	0	2	1
			16	**4**	**6**	**23**			**17**	**3**	**7**	**23**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L + T + P)+OE**		**27**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
III	BB 0026	Organization and Management	3	0	0	3	MC 3201	Robotics	3	1	0	4
	MC 3101	Signal and Systems	3	0	0	3	MC 3202	Computer Integrated Manufacturing	3	1	0	4
	MC 3102	Microcontroller Based System Design	3	1	0	4	MC 3203	Power Electronics and Electrical Drives	3	1	0	4
	MC 3103	Pneumatic and Hydraulic Systems	3	1	0	4	MC 32XX	Program Elective-I	3	0	0	3
	MC 3104	Linear Control Theory	3	1	0	4	MC 32XX	Program Elective-II	3	0	0	3
	** 30**	Open Elective-II	3	0	0	3	** 30**	Open Elective-III	3	0	0	3
	MC 3130	Microcontroller Lab	0	0	2	1	MC 3230	Industrial Automation Lab	0	0	2	1
	MC 3131	CAD and Kinematics Lab	0	0	2	1	MC 3231	Robotics Lab	0	0	2	1
	MC 3132	Pneumatics and Hydraulics Lab	0	0	2	1	MC 3232	Drives, Control and Simulation Lab	0	0	2	1
	MC 3170	Project Based Learning-II	0	0	2	1	MC 3270	Project Based Learning-III	0	0	2	1
			18	**3**	**8**	**25**			**18**	**3**	**8**	**25**
	Total Contact Hours (L + T + P)+OE		**29**				**Total Contact Hours (L + T + P)+OE**		**29**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
IV	MC 41XX	Program Elective-III	3	0	0	3	MC 4270	Major Project	0	0	0	12
	MC 41XX	Program Elective-IV	3	0	0	3						
	MC 41XX	Program Elective-V	3	0	0	3						
	MC 41XX	Program Elective-VI	3	0	0	3						
	MC 41XX	Program Elective-VII	3	0	0	3						
	MC 4170	Minor Project	0	0	2	1						
	MC 4171	Industrial Training	0	0	1	1						
			15	**0**	**3**	**17**			0	0	0	12
	Total Contact Hours (L + T + P)		**18**				**Total Contact Hours (L + T + P)**		**12**			

Total number of credits =169 (out of which 125 credits from higher semester i.e. 3rd sem. To 8th sem. and 44 credits from first year i.e. 1st Sem. To 2nd Sem.)

Minor Specializations

I. Robotics and Automation

1. MC 3250 : Autonomous Robots
2. MC 3251 : Robot Path Planning and Mobile Robots
3. MC 4162 : Machine Learning
4. MC 4163 : Industrial Automation

II. Industrial IoT System

1. MC 3252 : Wireless Sensor Network
2. MC 3253 : IoT System
3. MC 4163 : Industrial Automation
4. MC 4164 : Automated Manufacturing System

Other Programme Electives

1. MC 3240 : Big Data Analytics
2. MC 3241 : Computer Architecture and Real-time Systems
3. MC 3242 : Design of Mechanical Drives
4. MC 3243 : Digital Signal Processing
5. MC 3244 : Embedded Systems Design
6. MC 3245 : Engineering Materials
7. MC 3246 : Advance Robotics
8. MC 3247 : Hybrid Vehicle Technology
9. MC 3248 : Mechanical Vibrations
10. MC 3249 : Manufacturing Process
11. MC 4140 : Industrial Instrumentation
12. MC 4141 : Micro Electro Mechanical Systems
13. MC 4142 : Micro-manufacturing Systems
14. MC 4143 : Nanotechnology
15. MC 4144 : Non-linear Control System
16. MC 4145 : Production Operations and Management
17. MC 4146 : Statistical Quality Control Methods
18. MC 4147 : Reliability Engineering
19. MC 4148 : System Modelling and Simulation
20. MC 4149 : Virtual Instrumentation
21. MC 4150 : Production Technology
22. MC 4151 : Industrial Ergonomics
23. MC 4152 : Project Management
24. MC 4153 : Information System in Manufacturing
25. MC 4154 : Artificial Intelligence
26. MC 4155 : Building Automation
27. MC 4156 : Energy Conservation, Audit and Management
28. MC 4157 : Machine Tool Technology
29. MC 4158 : Machine Vision and Image Processing
30. MC 4159 : Dynamics and Controls of Mechatronics Systems
31. MC 4160 : Electric Vehicle Machines and Drives
32. MC 4161 : Computer Networks and Communication Protocols

Open Electives

1. MC 2080 : Introduction to Robotics
2. MC 2081 : Mechatronics System
3. MC 2082 : Automation in Industrial System
4. MC 2083 : Arm Architecture Based System Design
5. MC 3080 : Hydraulic and Pneumatic Systems
6. MC 3081 : Quality Control and Management
7. MC 3082 : Reliability and Maintenance Engineering
8. MC 3083 : Biomedical Instrumentation
9. MC 3084 : Sensors & Transducers

Syllabus of Second, Third and Final Year

BB 0025: 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 Personality, Attitude, Behavior, 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. Suggestive Case Studies: Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. Ghosh B.N., *Business Ethics & Corporate Governance*, (1e) McGraw Hill, 2011.
3. Mandal S.K., *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. Ray C.K., *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. Chatterjee Abha, *Professional Ethics*, (2e) Oxford Publications

MA 2102: ENGINEERING MATHEMATICS – III [2 1 0 3]

Gradient, divergence and curl, Line, surface and volume integrals. Green's, divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential equation-Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit methods.

References:

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
2. S.S. Sastry, *Introductory methods for Numerical Analysis*, (5e), PHI Learning Private Limited, 2012.
3. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.

MC 2101: STRENGTH OF MATERIALS [3 1 0 4]

Stress, Strain and Deformation of Solids: Concept of stress and strain. Deformation of simple and compound bars under axial load, Hooke's law, Stress-Strain diagrams for materials, factor of safety, Elongation of tapering bars of circular and rectangular cross sections, Saint Venant's principle, Thermal stress, Elastic constants, Strain energy, Biaxial state of stresses, Deformation in thick & thin cylindrical and spherical shells, Stresses on inclined plane, Principal planes and stresses, Shear force and Bending Moment in Cantilever, Simply supported and Overhanging beams, Theory of simple bending, Effect of shape of beam section on stress induced with different types of loading , Expression for transverse shear stress in beams, Bending and shear stress distribution diagrams for circular, rectangular, 'I', and 'T' sections, Torsion: Analysis of torsion of circular bars, Shear stress distribution for Solid and hollow circular section, Stepped shaft, Twist and torsion stiffness, Fixed and simply supported shafts, Introduction, short and long columns. Euler's theory; Assumptions, Buckling load for different end conditions, Limitations of Euler's theory. Rankine-Gordon's formula for columns.

References:

1. E. P. Popov, *Engineering Mechanics of Solids,* (2e), Prentice-Hall of India, New Delhi. 2015
2. F. P. Beer and R. Johnston, *Mechanics of Materials*, (3e), McGraw-Hill Book Co, 2002.
3. S. M. A. Kazimi, *Solid Mechanics*, Tata McGraw-Hill, New Delhi 2001.
4. G. H. Ryder, *Strength of Materials*, 3rd Edition, Macmillan India Ltd., 2002.

MC 2102: LINEAR INTEGRATED CIRCUITS [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.

References:

1. Franco Sergio, *Design with Op-amps and Analog Integrated Circuits*, McGraw Hill, 4th Edition, 2015.
2. Choudhury Roy D and Shail B. Jain, *Linear Integrated Circuits*, Wiley Eastern, 4th Edition, 2011.
3. Ramakant A. Gaikwad, *Op-Amps and Linear Integrated Circuits*, Prentice Hall of India, 4th Edition, 2009.
4. Stanley William D., *Operational Amplifiers with Linear Integrated Circuits*, Pearson, 4th Edition, 2004.

MC 2103: THEORY OF MACHINES [3 1 0 4]

Basic Concepts: Mechanism and machine, kinematic chain, constrained and unconstrained motions, four bar mechanism, Kutzbach criterion, Grashoph's law, single and double slider crank mechanisms with inversions, transmission angle, toggle positon and mechanism, Mechanical advantage, snap action mechanism, indexing mechanism. Position analysis: using graphical method, algebraic method, complex polar algebra method, vector (chace) method, Kennedy's theorem, coupler curve generation. Velocity and acceleration of slider–crank mechanism and crank & slotted lever mechanism: using graphical method, analytical method, complex polar method and vector (chace) method and I-Centre method. Synthesis of linkages: introduction to function generation and path generation, graphical method– two and three point synthesis, chebychev spacing, overlay method, cognate linkages, freudenstein's equation, introduction to analytical synthesis. Design of pantograph, straight line mechanisms and parallel linkages. Gears and gear train: introduction, gear terminology, simple gear train, compound gear train, reverted gear train, planetary or epicyclic gear train, differentials. Cams: introduction, cam terminology, motion of follower. Gyroscope: introduction, precessional angular motion, gyroscopic couple, effect of gyroscopic couple on aeroplane, naval ship, stability of a four wheel and two wheel drive moving in a curved path.

References:

1. S. S. Rattan, *Theory of Machines* (4e), McGraw Hill Educations, 2017
2. R.L Norton, *Kinematics & Dynamics of Machinery*, (5e), McGraw Hill Educations, 2017

3. Kevin Russell, *Kinematics and dynamics of mechanical systems Implementation in MATLAB and SimMechanics*, (2e), 2015
4. John J. Uicker, *Theory of Machines and Mechanisms*, (4e), Oxford, 2014

MC 2104: SENSOR AND INSTRUMENTATION [3 0 0 3]

Calibration, static and dynamic characteristics of an instrument, error analysis, electromechanical indicating Instruments. Analog and digital voltmeters, ammeters, multimeters, DC bridges, AC bridges, fault detection, potentiometers, physical quantities and their measurements- Sensor classification and characteristics, strain, force, acceleration, proximity and range, temperature, pressure, flow, level, light, Linear displacement, acoustic wave, vibration, Velocity. Display device- digital CRO, elements of data acquisition system, concept of signal conditioning.

References:

1. Clarence W. de Silva, *Sensors and Actuators: Engineering System Instrumentation*, (2e), CRC Press, 2015.
2. A.K. Sawhney, *A course in Electrical and Electronic Measurements and Instrumentation*, (19e), Dhanpat Rai & Co. Publishers, 2012.
3. Bela G. Liptak, *Process Measurement and Analysis*, (4e), CRC press, 2003.
4. John G. Webster, *The Measurement, Instrumentation, and Sensors: Handbook*, Springer Science & Business Media, 1999.

MC 2130: SIMULATION AND MODELLING LAB [0 0 2 1]

Basics of MATLAB, Loops, conditions and cases, if-then-else statements, logical operations, Call functions, arrays/vectors/matrices, plotting. Basics of MATLAB Simulink, Kinematic linkages in Simulink, Interfacing of Arduino/Raspberry Pi with MATLAB. Position analysis, Velocity and acceleration analysis of kinematic linkages.

References:

1. Amos Gilat, *MATLAB: An Introduction with Applications*,(5e), Wiley Publication, 2014.
2. Stormy Attaway, *MATLAB: A Practical Introduction to Programming and Problem Solving*, (4e), Butterworth-Heinemann Publication, 2016.
3. Harold Klee, *Simulation of Dynamic Systems with MATLAB and Simulink*, CRC Press, 2018.
4. Kevin Russell, Qiong Shen, Rajpal S. Sodhi, *Kinematics and Dynamics of Mechanical Systems, Second Edition: Implementation in MATLAB® and SimMechanics®*, (2e), CRC Press, 2018.
5. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, *Robotics: Modelling, Planning and Control*, Springer Science & Business Media, 2010.

MC 2131: SENSOR AND INSTRUMENTATION LAB [0 0 2 1]

Behavior of capacitive sensor, inductive sensor, magnetic sensor, light sensor and ultrasonic sensor. Switching frequency and switching distance and hysteresis of NBN, CJ, MB, OJ. Calculation of maximum admissible velocity of an object using ultrasonic sensor. Accelerometer sensor. Characteristics of Temperature sensor, Strain Measurement, Displacement measurement using LVDT. Sensor data analysis using Raspberry Pi /Arduino.

References:

1. A.K. Sawhney, *A course in Electrical and Electronic Measurements and Instrumentation*, (19e), Dhanpat Rai & Co. Publishers, 2012.
2. Bela G. Liptak, *Process Measurement and Analysis*, (4e), CRC press, 2003.
3. John G. Webster, *The Measurement, Instrumentation, and Sensors: Handbook*, Springer Science & Business Media, 1999.
4. Clarence W. de Silva, *Sensors and Actuators: Engineering System Instrumentation*, (2e), CRC

Press, 2015.

MC 2170: SEMINAR [0 0 2 1]

Each student has to present a seminar on any technical topic. The presentation time is a minimum of 30 minutes followed by a 10 minutes session for discussion/ question & answers; The seminar topic selected by the student must be approved by the authorized faculty of the department at least two weeks in advance; Each student has to submit to the department a seminar report at least three days before the day of seminar; Each student has to make the power point presentation (ppt).

EO 2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR, AR, MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, *Macroeconomics Theory and Policy*, (20e), S. Chand Publication.
2. H.C. Peterson, *Managerial Economics*, (9e), 2012.
3. P.L. Mehta, *Managerial Economics*, Sultan Chand & Sons.
4. G.J. Tuesen, H.G. Tuesen, *Engineering Economics*, PHI.
5. J.L. Riggs, D.D. Bedworth, Sabah U Randhawa, *Engineering Economics*, Tata McGraw Hill.

MA 2204: ENGINEERING MATHEMATICS IV [2 1 0 3]

Probability: Introduction, finite sample spaces, conditional probability and independence, Baye's theorem, one dimensional random variable, mean, variance. Two and higher dimensional random variables: mean, variance, correlation coefficient. Distributions: Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential distributions, simple problems. Moment generating function, Functions of one dimensional and two dimensional random variables, Sampling theory, Central limit theorem and applications. Finite difference expressions for first and second order derivatives (ordinary and partial): Solution of boundary value problems, Numerical solutions of Laplace and Poisson equations by standard five point formula and heat and wave equations by explicit methods. Difference equations: Difference equations representing physical systems, difference operator, the z transforms, properties of z transforms, initial and final value theorems, solution of difference equations by the method of z transforms.

References:

1. Dean G. Duffy, *Advanced Engineering Mathematics with MATLAB*, CRC Press, 2016.
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
3. Alan Jeffrey, *Advanced Engineering Mathematics*, Academic Press, 2001.
4. P. L. Meyer, *Introduction to Probability and Statistical Applications*, (2e), Oxford and IBH Publishing, Delhi, 1980.

MC2201: 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 For Static And Fatigue Load, 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. 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. Sensing and measurement of mechanical motion, computer programs to calculate stresses and deflection in simple machine members.

References:

1. V B Bhandari, *Design of Machine Elements*, (4e), Tata McGraw Hill, 2017
2. Ferdinand Beer, E. Russell Johnston Jr., *Mechanics of Materials*, (7e), McGraw Hill, 2014
3. Jospeh E. Shigley, *Mechanical Engineering Design*, (5e), McGraw Hill Inc, New York. 2004
4. Stephen Timoshenko, *Elements of Strength of Materials* (5e), Tata McGraw Hill, 2003.
5. Egor P. Popov, *Engineering Mechanics of Solids* (2e), Prentice Hall India, 2001.

MC 2202: DIGITAL SYSTEM DESIGN [3 0 0 3]

Concept of K-Maps reduction, Design of combinational circuits: Adder, Subtractor, Encoder, Decoder, Multiplexer, Demultiplexer. Design sequential circuits by using memory elements like latches , flip-flops, Counters, Registers, Synchronous Counters , Asynchronous counters, Logic families, Analysis and Design of Finite State Machines, Sequence Generator and Sequence Detector-Lock out condition, Design examples, Introduction to ASM charts. Basics of FPGA Architecture.

References:

1. Morris Mano, *Digital Design*, Prentice Hall Publishers, (5e), 2013
2. A. Anand Kumar, *Switching Theory and Logic Design*, (2e), Prentice
3. David J Comer, *Digital Logic State Machine Design*, (3e), Oxford University Press, 2012.
4. Samir Palnitkar, Verilog *HDL: A Guide to Digital Design and Synthesis*, (2e), Prentice Hall PTR, 2003.

MC 2203: FLUID MECHANICS [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 center of Pressure on vertical and inclined plane surfaces, Buoyancy, center 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.

References:

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
3. Victor Lyle Streeter, E. Benjamin Wylie, *Fluid mechanics*, McGraw Hill, 7th edition, 2007

MC 2230: PROGRAMMABLE LOGIC CONTROLLER LAB [0 0 3 1]

Introduction of PLC, study basic components, networking and different programming technique of PLC. Study NO, NC and holding circuit programs, Implementation of Ladder program for timers, counters, math, logical and program control instructions. Study different applications using ladder logic. Analog

PLC operations – Accessing Analog inputs, Process and control analog outputs, Conveyor control Systems, Stepper Motor Control, Traffic light Control, Lift Control, Bottling Plant, HMI, Mini project.

References:

1. F. D. Petruzella, *Programmable Logic Controllers*, 4th edition, McGraw- Hills Publications, 2010.
2. *Siemens PLC Handbook*, Siemens
3. John W. Webb and Ronald A. Reiss, *Programmable logic controllers-Principle and applications*, 5th edition, PHI, 2003.

MC 2231: INTEGRATED ELECTRONICS LAB [0 0 2 1]

Analog circuit designs using 741 IC, linear applications of Op-amps: design of rectifiers, DACs and ADCs, filters, multivibrators & Schmitt trigger using 555 IC, regulators. Digital circuit designs-combinational circuit's, implementation of Boolean functions and arithmetic circuits, multiplexers, encoders, decoders, code converters, design of sequential circuits- ripple counters, shift registers and ring counters, synchronous counters, sequence detectors.

References:

1. Franco Sergio, *Design with Op amps & Analog Integrated Circuits*, McGraw Hill, 3rd Edition, 2001
2. M. Morris, and M. D. Ciletti, *Digital design- with an introduction to the Verilog HDL*, Pearson, 5th edition, 2013.

MC 2270: PROJECT BASED LEARNING-I [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

BB 0026: ORGANIZATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower. Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit. Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

References:

1. Koontz, Harold, Cyril O'Donnell, and Heinz Weihrich, *Essentials of Management*,(1e)

Tata McGraw-Hill, New Delhi, 1978.
2. Robbins, Stephen P, and Mary Coulter, *Management, Prentice Hall*, (2e) New Delhi, 1997.
3. E. S. Buffa and R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987
4. H. J. Arnold and D. C. Feldman, *Organizational Behavior*, McGraw – Hill, 1986.
5. Aswathappa K, *Human Resource and Personnel Management*, Tata McGraw Hill, 2005.
6. William Wether & Keith Davis, *Human Resource and Personnel Management*, McGraw Hill, 1986.

MC 2080: 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 control, trajectory planning, mobile robotics, features of future robots, robot programming, 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.

References:

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
3. John J. Craig, *Introduction to Robotics - Mechanics and Control*, Pearson Education International, 2004.
4. FU, *Robotics Control Sensing Vision And Intelligence*,1st Edition, McGraw Hill Education,2010

MC 2081: MECHATRONICS SYSTEM [3 0 0 3]

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, Temperature sensor DRIVES AND ACTUATORS: relays, DC and BLDC Motor, Servo motor, stepper motors, Data Acquisition and Translation: Signal conditioning, amplifiers, filters, ADC, DAC Data Presentation System: LED, LCD, Controllers and Algorithms.

References:

1. D. Shetty & R. Kolk, *Mechatronics System Design*, PWS Publishers
2. *Mechatronics – HMT*, Tata McGraw Hill Publishing Company Ltd, 1998.
3. C. R. Venkataramana, *Mechatronics*, Sapna Book house, Bangalore, 2001.
4. Robert H. Bishop, *Mechatronics: An Introduction*, Taylor & Francis Group

MC 2082: AUTOMATION IN INDUSTRIAL SYSTEM [3 0 0 3]

Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines. Material handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods. Automated Manufacturing Systems: Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation. Quality Control Technologies in Automation.

References:

1. Krishna Kant, *Computer Based Industrial Control*, EEE-PHI,2nd edition,2010
2. Viswanandham, *Performance Modeling of Automated Manufacturing Systems*, PHI, 1st edition, 2009.
3. M. P. Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, Pearson Education.5th edition, 2009.

MC 2083: ARM ARCHITECTURE BASED SYSTEM DESIGN [3 0 0 3]

Introduction to ARM embedded systems, RISC and ARM design philosophy, Embedded system hardware and software, ARM processor fundamentals, ARM processor families, Architecture revisions, Pipeline, Registers and Exceptions, Interrupts and vector table. Introduction to ARM instruction set, Data Processing Instructions, Branch Instructions, Load and Store instructions, Software Interrupt instructions and Conditional execution. Optimizing ARM Assembly Code, Profiling and cycle counting, instruction scheduling, Exception and Interrupt Handling, Interrupts, Memory Management Units, Moving from an MPU to an MMU, How Virtual Memory Works, Case studies.

References:

1. Steve Furber, *ARM System-on-Chip Architecture*, Addison Wesley,(2e), 2000.
2. Andrew N Sloss, Dominic Symes, Chris Wright, *ARM system developers guide: Designing and optimizing system software*, Elsevier, 2004
3. Marilyn Wolf, *Computers as Components: Principles of Embedded Computing System Design*, Morgan Kaufmann Publishers(4e), 2016
4. Joseph Yiu, *The definitive guide to ARM Cortex M3 and Cortex M4 Processors*, Elsevier(3e), 2013
5. Peter Marwedel, *Embedded System Design*, Springer(2e),2011

MC 3101: SIGNAL AND SYSTEMS [3 0 0 3]

Introduction: 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. S-domain transformation using Laplace transform. Filter design. Signal processing in MATLAB.

References:

1. Ramesh Babu, *Signals & Systems*, 4th edition, Scitech Publications (Ind, 2011)
2. S. Haykin & B. V. Veen, *Signals and Systems*, John Wiley &Sons, New Delhi, 2nd edition, 2002.
3. J.G. Proakis, D.G. Manolakis, D. Mimitris, *Introduction to Digital Signal Processing*, Prentice Hall, India, 4th Edition, 2006.

MC 3102: MICROCONTROLLER BASED SYSTEM DESIGN [3 1 0 4]

Introduction to 8085, Comparison between 8085 and 8051, Introduction to 8051: Introduction to embedded controllers, Harvard vs. Von Neumann architecture, commercial microcontroller devices. Architecture of 8051: Registers, Register Banks, PSW, CPU, PC, DPTR, SFRs, RAM, ROM, Stack); Programming model of 8051, Pin diagram & details, I/O Ports & details. 8051 Assembly Language Programming: Assembler Directives, Addressing Modes of 8051, Instruction set, calculation of delay, delay programs. Timers, Counters, Serial Communication, Interrupts, Programming examples. 8051 Programming in Embedded C: Data types in embedded C, arithmetic & logic operators, control

statements and loops in embedded C, functions & arrays, I/O port programming, programming timers & counters, Interrupts & Serial communication program. Hardware Interfacing: Programmable I/O (8255); Memory Interfacing, Stepper Motor, DAC, ADC, Seven Segment Display, LCD, Relays & Optoisolators. Design of Microcontroller based systems: Introduction to other Microcontroller families (PIC, AVR and ARM).

References:

1. Muhammad Ali Mazidi, Janice Gillipse Mazidi, Rolin D. Mckinlay, *8051 Microcontroller and Embedded Systems Using Assembly and C*, Pearson Education, 2010.
2. Myke Predko, *Programming and Customizing the 8051 Microcontroller*, Tata McGraw Hill, 2007.
3. Kenneth J. Ayala, 8051 *Microcontroller and Embedded Systems using Assembly and C*, Cengage Learning, 2010.
4. Ajay V. Deshmukh, *Micro controllers- Theory and Applications*, TMH, New Delhi, 2008.

MC 3103: PNEUMATIC & HYDRAULIC SYSTEMS [3 1 0 4]

Introduction to Fluid Power: Hydraulics and Pneumatics, Fluid power and fluid transport system, advantages, disadvantages and applications. Components: functions and properties of Hydraulic fluid, Pascal's law application, hydraulic power, siphon effect. 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, cylinder load due to moving weight and cylinder loadings. Motors: types, torque, power and flow rate, performance. Valves: DC valves, check, pilot, 3-way, 4-way, manually, mechanically and solenoid actuated valves, shuttle valve, Twin pressure valves, Shuttle valves ,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, electrical controls in pneumatic circuits. Electro pneumatics and design of electro pneumatic circuits, timers, counters.

References:

1. E. Anthony, *Fluid power with applications*, Pearson Education, 2003.
2. P. A. Andrew*, Hydraulics and Pneumatics*, Elsevier Science &Technology Books, (3e) 2011.
3. D. Scholz., *Proportional Hydraulics*, Festo Didactic GMBH & Co, Germany, 2002.
4. S. R Majumdar, *Pneumatic Systems - Principles and Maintenance*, Tata McGraw Hill, 2000.

MC 3104: LINEAR CONTROL THEORY [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.

References:

1. Norman S. Nise, *Control Systems Engineering*, (6e), Wiley India.
2. R.C Dorf, R. H. Bishop, *Modern Control Systems*, (8e), Wesley Longman Inc.
3. B.C. Kuo, F. Golnaraghi, *Automatic Control Systems*, (8e), Wiley India.
4. K. Ogata, *Modern Control Engineering*, (5e), PHI.

5. M. Gopal, *Control System: Principles and Practices*, (4e), TMH.

MC 3130: MICROCONTROLLER LAB [0 0 2 1]

Microcontroller: Introduction to 8051, arithmetic instructions, array handling and code conversions, bit manipulations and logic instructions, timer/counter programming, serial communication and interrupts, interfacing ADC with 8051, interfacing stepper motor with 8051, interfacing DAC with 8051, interfacing logic controller with 8051, interfacing seven segment display with 8051, interfacing LCD with 8051, implementing a traffic light controller using 8051.

References:

1. Muhammad Ali Mazidi, Janice Gillipse Mazidi, Rolin D. Mckinlay, *8051 Microcontroller and Embedded Systems Using Assembly and C*, Pearson Education, 2010.
2. Myke Predko, *Programming and Customizing the 8051 Microcontroller*, Tata McGraw Hill, 2007.
3. Kenneth J. Ayala, *8051 Microcontroller and Embedded Systems Using Assembly and C*, Cengage Learning, 2010.
4. Ajay V. Deshmukh, *Microcontrollers- Theory and Applications*, Tata McGraw Hill, 2008.
5. Krishna Kant, *Microprocessors and Microcontrollers*, PHI, 2007

MC 3131: CAD AND KINEMATICS LAB [0 0 2 1]

2D and 3D design modelling using Auto CAD and CREO. Assembly and animation of mechanical linkages. Design of machine elements like shaft, cotter joint, springs, linkages, couplings, etc.

References:

1. I. Zeid, *CAD/CAM Theory and Practice* (2e), McGraw Hill Education, 2012

MC 3132: PNEUMATICS & HYDRAULICS LAB [0 0 2 1]

Operations of various valves like directional control valves, flow control, valves, pressure control valves and switches like pressure switches, proximity switches. Operations of timers and counters. Rigging of manual pneumatic and electro-pneumatic circuits using above valves and switches. Working principles of hydraulic pumps, hydraulic motors, throttle valves, direction control valves. Manual and electro hydraulic circuits using above components. Manual and electro hydraulic circuits using above components.

References:

1. E. Anthony, *Fluid power with applications*, Pearson Education, 2003.
2. S. R Majumdar, *Pneumatic Systems - Principles and Maintenance*, Tata McGraw Hill, 2000.

MC 3170: PROJECT BASED LEARNING-II [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

MC 3201: ROBOTICS [3 1 0 4]

Introduction of robots and its types, degrees of Freedom of robot, Robot Configuration, Specification of a robot; Manipulator Kinematics: Homogeneous Transformations, Forward and Inverse Kinematics, Differential motions and velocity: Differential motions of joints and robot, Jacobians, Dynamics: Euler-Lagrange Equations of Motion, Properties of Robot Dynamics, Robot statics, Trajectory planning: Joint space trajectory planning, Cartesian space trajectory planning. Kinematics of wheeled mobile robots.

Reference:

1. Y Kozyhev, *Industrial Robots Handbook, MIR Publications*, 2nd edition, 1999.
2. S.B. Niku, *Introduction to Robotics Analysis, Control Applications*, Wiley Publications,2nd edition,2011.
3. Tzafestas, Spyros G. *Introduction to mobile robot control*. Elsevier, 2013.
4. Spong, Vidyasagar, *Robot Dynamics and Control,* Wiley Publications, 2nd edition2009
5. K. Yoram, *Robotics*, McGraw Hill Publications, 1992.

MC 3202: COMPUTER INTEGRATED MANUFACTURING [3 1 0 4]

Numerical Control Production Systems: Components of NC Machine, CNC Machine, Classification, Advantages and disadvantages, Control loop of point to point systems, Control loop of contouring systems. CNC Tooling, CNC programming: Co-ordinate systems, CNC programming for Turning Center and Machining center by Manual method (word address format only), Manual data input, Distributed Numerical Control, Group Technology , FMS and CIM: Part families – Part classification and coding, production flow analysis, machine cell design, benefits of GT, Computer Integrated Manufacturing System, Types of Manufacturing System, Material Handling System, Analysis of storage systems, Single station manufacturing cells, Flexible Manufacturing System, FMS work station, Types of FMS Layouts, fundamentals of CIM and Benefits of CIM, Single Station Manned /Automated Workstations: Parts Storage Subsystem and Automatic Parts Transfer, Analysis of Single Station Cells. Analysis Of Automated Flow Line & Line Balancing: General terminology and analysis, Analysis of Transfer Line, Partial automation-with numerical problems. Computerized Manufacturing Planning Systems: Computer aided Process planning, Computer integrated planning systems.

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. P.N Rao, *CAD/CAM*, Tata McGraw Hill, New Delhi, 2005.
5. Smid Peter, *CNC programming Hand book*, Industrial Press Inc., New York, 2000.

MC 3203: POWER ELECTRONICS AND ELECTRICAL DRIVES [3 1 0 4]

Semiconductor devices: Power diode, SCR, GTO, BJT, MOSFET, IGBT. Power converters: ac to ac, ac to dc, dc to ac, dc to dc. DC Motors: construction, speed-torque characteristics, starting methods, speed control. AC Motors: Induction Motors, construction, starting methods, speed control. Servo motors, BLDC motors, Stepper motors. 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, equivalent moment of inertia, steady state stability, load equalization, motor power rating, motor duty cycles, Electric braking.

References:

1. G. K. Dubbey, Fundamentals of Electric Drives, (2e), Narosa Publishers, 2010

2. J. Nagrath and D. P. Kothari, Electric machines, (3e), Tata McGraw Hill, 2011
3. P.S. Bimbra , Power electronics, (3e), Khanna Publishers, 2010
4. R. Krishnan, Electric Motor Drives Modeling, Analysis, and Control, (2e), Prentice Hall, 2012
5. M.H. Rashid, Power Electronics: Circuits, Devices & Applications, (4e), Pearson, 2014

MC 3230: INDUSTRIAL AUTOMATION LAB [0 0 2 1]

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. Manual & electro Hydraulics.

References:

1. Bosch Rexroth AG, *Project Manual Industrial Hydraulics*, RE 00845/04.07.
2. Rexroth AG, *Trainer's Manual Electro Hydraulics*, R900071655.
3. E. Anthony, *Fluid power with applications*, Pearson Education, 2003.
4. S. R Majumdar., *Pneumatic Systems - Principles and Maintenance*, Tata McGraw Hill, 2000

MC 3231: ROBOTICS LAB [0 0 2 1]

Forward and inverse kinematics of a Robot, velocity analysis, Mobile robot, Dynamics of Robot Manipulators, Control of Robot Manipulators: PID control, Adaptive Control, Robot Path-Planning.

Reference:

1. Y Kozyhev, *Industrial Robots Handbook, MIR Publications*, 2nd edition, 1999.
2. S.B. Niku, *Introduction to Robotics Analysis, Control Applications*, Wiley Publications,2nd edition,2011.
3. Tzafestas, Spyros G. *Introduction to mobile robot control*. Elsevier, 2013.
4. Spong, Vidyasagar, *Robot Dynamics and Control,* Wiley Publications, 2nd edition2009
5. K. Yoram, *Robotics*, McGraw Hill Publications, 1992.
6. Craig, John J., *Introduction to Robotics: Mechanics and Control*, 2nd Edition, Addison Wesley, 1989

MC 3232: DRIVES, CONTROL AND SIMULATION LAB [0 0 2 1]

Characteristics of SCR, IGBT MOSFET. Power converters, Control of DC Motors, induction Motors, BLDC Motor, Stepper Motor, Servo Motor.

References:

1. G. K. Dubbey, *Fundamentals of Electric Drives*, (2e), Narosa Publishers, 2010
2. I. J. Nagrath and D. P. Kothari , *Electric machines*, (3e), Tata McGraw Hill, 2011
3. P.S. Bimbra , *Power electronics*, (3e), Khanna Publishers, 2010
4. R. Krishnan, *Electric Motor Drives Modeling, Analysis, and Control*, (2e), Prentice Hall, 2012
5. M.H. Rashid, *Power Electronics: Circuits, Devices & Applications*, (4e), Pearson, 2014

MC 3270: PROJECT BASED LEARNING-III [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from

experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

MC 3240: BIG DATA ANALYTICS [3 0 0 3]

Big Data, Characteristics of Big Data, Data in a warehouse and data in Hadoop, Importance of Big Data, Big data use cases, Map Reduce, Distributed File System, Algorithms using Map Reduce, Communication Cost model, Complexity Theory, Meet Hadoop, Comparison with other systems, The Hadoop Distributed File System, Hadoop I/O, File Based Data structures, Developing a Map Reduce Application, Inverted Index for Text Retrieval, Graph Algorithms, Page Rank, Stream Data Model: A DataStream Management system, Sampling Data in a Stream, Filtering Streams, Distinct Elements in a Stream, NOSQL Models, Understanding Storage Architecture, Performing CURD operations, Querying NOSQL Stores.

References:

1. Anand Rajaraman and Jeffrey David Ullman, *Mining of Massive Datasets*, (1e) Cambridge University Press, 2011.
2. Tom White, Hadoop: *The definitive guide*, (3e), O'reilly, Yahoo Press, 2012.
3. Shashank Tiwari, *Professional NOSQL*, (2e), Wiley India Pvt. Ltd., 2012.
4. Jimmy Line, Chris Dyer, *Data Intensive Text Processing with MapReducee*, (1e), Mprgan and Claypool Publishers, 2010.
5. Paul C Zikopoulous, Chris Eaton, Dirk Deroos, Thomas Deutch, George Lapis, *Understanding Big Data*, (1e) McGraw Hill, 2012.

MC 3241: COMPUTER ARCHITECTURE AND REAL-TIME SYSTEMS [3 0 0 3]

Organization and Architecture, Processor Organization, The Instruction Cycle, Introduction to Parallel processing, Parallel Computer Structures, Architectural Classification schemes, Pipelining, Instruction Level Parallelism, SIMD Computer Organizations, SIMD Interconnection networks, Parallel Algorithms for Array processors, symmetric Multiprocessor Organization, Cache Coherence and the MESI protocol, Multithreading and Chip Multiprocessors, Synchronization, Models of Memory Consistency, Clusters, Operation System Design Issues, Cluster Computer Architecture, Blade servers, Clusters compared to SMP, Multicore computers, Hardware Performance issues: Increase in Parallelism, Power consumption, Software performance issues: Software on multicore, Multicore organization, Intel x86 Multicore organization: Intel Core Duo, Intel Core i7.

References:

1. William Stalling, *Computer Organization and Architecture: Designing for Performance*, (8e), Pearson Prentice Hall, 2010.
2. Kai Hwan and Faye A. Briggs, *Computer Architecture and Parallel Processing*, TMH Private Ltd., 2012.
3. John L. Hennessy and David A. Patterson, *Computer Architecture, A Quantitative Approach*, (5e), Morgan Kaufmann, 2014.
4. Rajiv Chopra, *Advanced Computer Architecture (A Practical Approach)*, S. Chand and Company Ltd. 2011

MC 3242: DESIGN OF MECHANICAL DRIVES [3 0 0 3]

Introduction, bevel gear and worm gear, beam strength, dynamic load and wear load, heat dissipation and efficiency of worm gear, sliding contact bearings, lubricants, viscosity, bearing modulus, Somerfield number, coefficient of friction, mechanism of film lubrication, eccentricity and minimum oil film thickness. Belt drives, power transmission, flat and V belts, power rating, V-flat drives, selection of belts and pulleys. Wire and rope drives - types & construction of wire ropes, loads & stresses in ropes, selection

of wire ropes. Chain drives, chordal action, sprocket size and teeth, chain speed, selection of roller chains. Mechanical brakes - block brakes, band brakes, pivoted Shoe brakes, disc brake, torque capacity, heat dissipation, clutches, friction clutches, disc clutch, cone clutch, design projects.

References:

1. Shigley J. E. and Mischke C. R., *Mechanical Engineering Design*, (5e), McGraw Hill Inc, New York, 2004.
2. Bhandari V. B., *Design of Machine Elements*, (2e), Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.
3. Norton R. L., *Machine Design - An Integrated Approach*, (2e), Prentice Hall Inc. New Jersy, 2004.
4. Juvenile R. C. and Marshek K. M., *Fundamentals of Machine Component Design*, (3e), John Wiley and Sons, Inc, New York, 2000.
5. Mahadevan K. and Balaveera Reddy K., *Machine Design Data Hand Book*, (4e), CBS Publishers and Distributors, New Delhi, 2014.

MC 3243: DIGITAL SIGNAL PROCESSING [3 0 0 3]

Introduction to Signal Processing, Sampling, Aliasing, Transform domain analysis of discrete-time systems: Z Transform and application of Z transforms to discrete time systems, Computation of DFT, Fast Fourier Transform. Digital Filter Characteristics and structures, IIR Filter Design using Butterworth and Chebyshev approximations, Impulse invariant and bilinear transformation methods. FIR Filter Design using Window method and Frequency sampling method. Architectural features of Digital signal processors and Case study: Sensing, measurement and analysis of mechanical motion, fault analysis.

References:

1. Oppenheim A.V, Willsky A.S, *Signals and Systems*, (2e), PHI, 2011
2. Proakis J.G. and D.G. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, (3e), PHI, 2007.
3. Rabiner L.R and Gold D.J, *Theory and Applications of Digital Signal Processing*, (2e), Prentice Hall, 2007.

MC 3244: EMBEDDED SYSTEM DESIGN [3 0 0 3]

Introduction to embedded system, attributes and major application areas of ES, Processor and memory organization, Communication networks, ARM processor introduction, architectural inheritance, Architectural features of ARM Processor, instruction set, Pipelined architecture in ARM, THUMB instruction format, memory mapped peripherals, architectural features of ARM Cortex M3 and programming examples. Introduction To Real-Time Operating Systems, Tasks and Task states, Semaphores, Message queues, Mail boxes and pipes, Hard and Soft real time systems, scheduling considerations, Multicore real time systems.

References:

1. Steve Furber, *ARM System-on-Chip Architecture*, Addison Wesley,(2e), 2000.
2. Marilyn Wolf, *Computers as Components: Principles of Embedded Computing System Design*, Morgan Kaufmann Publishers(4e), 2016
3. Joseph Yiu, *The definitive guide to ARM Cortex M3 and Cortex M4 Processors*, Elsevier(3e), 2013
4. Peter Marwedel, *Embedded System Design*, Springer(2e),2011

MC 3245: ENGINEERING MATERIALS [3 0 0 3]

Crystal structures, Miller indices, crystal imperfections, mechanism of solidification, nucleation and crystal growth, phases in solids, equilibrium diagrams, iron-Carbon systems, principle and objectives of

heat treatment, TTT diagrams, electronic materials, deposition of thin films, insulators and dielectric properties, polarization in dielectrics, electrostriction, piezoelectricity, ferroelectricity, magnetic materials, magnetic dipole and moments, magnetization, super paramagnetic materials, applications of magnetic materials, photonic materials, refraction, reflection, absorption, emission phenomena.

References:

1. Donald R. Askeland and Pradeep P. Fulayl, *The Science and Engineering of Materials*, (6e), Cengage Learning Publishers, 2011.
2. Avner S. H., Introduction to Physical Metallurgy, McGraw Hill. Delhi, 2004.
3. R. Balasubramaniam, Callister's Materials Science and Engineering, (2e), Wiley, 2010

MC 3246: ADVANCE ROBOTICS [3 0 0 3]

Robot dynamics, Lagrange-Euler dynamics, Newton's equations of motion, state variable representation and robot control problems, tracking problems, PD, PID compensation, closed loop control, set point tracking control, actuator saturation, integrator anti-windup compensation, quadratic optimal control problem, Non-linear dynamics and control, Lyapunov stability theorem, robust control, feedback linearization controllers, variable-structure controllers, saturation type controllers, inverse dynamics controllers, force control, stiffness control, impedance control, hybrid position/force control, reduced state modelling and control.

References:

1. Mark W. Spong, *Robot dynamics and control, (2e)*, John Wiley and sons, 2009.
2. John J. Craig, *Introduction to Robotics – Mechanics and control*, (3e), Pearson education International, 2004.
3. Fahimi, Farbod. *Autonomous robots: modeling, path planning, and control*. Vol. 107. Springer Science & Business Media, 2008

MC 3247: HYBRID VEHICLE TECHNOLOGY [3 0 0 3]

Vehicle dynamics-vehicle resistance, dynamic equation, tire ground adhesion, maximum tractive effort, vehicle speed, transmission characteristics, vehicle performance, hybrid and electric drive trains-configurations of electric vehicles, traction motor characteristics, basic concept of hybrid traction, hybrid drive train architecture – series, parallel torque and speed coupling, electric propulsion unit, different motors, configuration and control of dc motor drives, introduction to power modulators, control and regenerative breaking, classification of different energy management strategies, fundamentals of regenerative braking, sizing the drive system- propulsion motor, sizing the power electronics, selecting the energy storage technology, communications, supporting subsystems, design of series hybrid drive train.

References:

1. Mehrdad Ehsani, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles- Fundamentals, Theory and Desig*n, (2e), CRC Press, 2010.
2. Iqbal Hussein, *Electric and Hybrid Vehicles-Design Fundamentals*, (2e), CRC Press, 2010.

MC 3248: MECHANICAL VIBRATIONS [3 0 0 3]

Introduction to mechanical vibration, vibration system and types, vibration analysis - degrees of freedom, mathematical modeling, equations of motion, SHM, natural frequency of single degree of freedom system 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.

References:

1. Groover G.K., *Mechanical Vibrations*, Nemchand and Bros, Roorkee, 2012.
2. Singirisu Rao S, *Mechanical Vibration*, Pearson Education, Delhi, 2004.
3. Dukkapatti Rao V., *Text Book of Mechanical Vibration*. Prentice Hall of India Ltd, 2004.
4. Daniel Imnan J. *Engineering Vibration*, Prentice Hall, New Delhi, 2001.
5. Thomson W.T., *Theory of Vibrations with Applications*, Chapman and Hall, 4th Edition, 1993.

MC 3249: 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,

Reference:

1. S. Kalpakjian, and S. R. Schmid, *Manufacturing Engineering and Technology*, Pearson Education, 6th Edition, 2009.
2. Ghosh, and A. K. 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.

MC 3250: AUTONOMOUS ROBOTS [3 0 0 3]

Locomotion, Legged Mobile Robots, Leg configurations and stability, Examples of legged robot locomotion, Wheeled Mobile Robots, Wheeled locomotion, Mobile Robot Kinematics: Kinematic Models and Constraints, Representing robot position, Forward kinematic models, Wheel kinematic, Robot kinematic constraints, Examples. Perception: Sensors for Mobile Robots, Sensor classification, Characterizing sensor performance, Wheel/motor sensors, Heading sensors, Ground-based beacons, Active ranging, Motion/speed sensors, Vision-based sensors. Mobile Robot Localization: The Challenge of Localization: Noise and Aliasing, Sensor noise, Sensor aliasing, To Localize or Not to Localize: Localization-Based Navigation versus Programmed Solutions, Map Representation, Continuous representations, Decomposition strategies, Probabilistic Map-Based Localization, Markov localization, Kalman filter localization. Planning and Navigation: Competences for Navigation: Planning and Reacting, Path planning, Obstacle avoidance.

References:

1. Roland Siegwart, Illah R. Nourbaksh, *Introduction to Autonomous Robots*, MIT Press, 2004.
2. Howie Choset, Kevin M Lynch, *Principles of Robot Motion*, MIT Press, 2005
3. Gonzalez, Robotics- *control, sensing, vision, and intelligence*, McGraw-Hill, 1987.

MC 3251: ROBOT PATH PLANNING AND MOBILE ROBOTS [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.

Reference:

1. Farbod Fahimi, *Autonomous Robots- Modeling, Path Planning, and Control* (1e) Springer, 2009.
2. Yasmina Bestaoui Sebbane, *Planning and Decision Making for Aerial Robots*, (1e), Springer, 2014.
3. Choset H., Lynch K. M., *Principles of Robot Motion: Theory "Algorithms, and Implementations* (1e), MIT Press, Boston, 2005.

MC 3252: WIRELESS SENSOR NETWORK [3 0 0 3]

Single-Node Architecture, Energy Consumption, Operating Systems and Execution, Optimization Goals and figures of merit, Gateway Concepts, Networking sensors, WSN protocols, Wakeup Radio Concepts, Address and Name Management, Routing Protocols, Time Synchronization, Localization and Positioning, Sensor Tasking and Control, Sensor Node Hardware, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

References:

1. Holger Karl & Andreas Willig, *Protocols and Architectures for Wireless Sensor Networks*, John Wiley, 2012.
2. Feng Zhao & Leonidas J. Guibas, *Wireless Sensor Networks- An Information Processing Approach*, Elsevier, 2007.
3. Kazem Sohraby, Daniel Minoli, & Taieb Znati, Wireless Sensor Networks - Technology, Protocols, And Applications, John Wiley, 2007.

MC 3253: IoT SYSTEM [3 0 0 3]

Introduction to M2M communication and IoT, An emerging industrial structure for IoT, IoT system architecture, IoT reference model, IoT deployment and operational view, IoT physical devices and endpoints, Communication and networking protocols-MQTT and AMQP protocols, IoT enabling technologies-RFID, WSN,SCADA etc., Analytics for the IoT, Applying the geospatial analytics to IoT data, Real world design constraint, Technical design constraint, Future internet design for various IoT use cases such as smart cities, smart environments, smart homes, smart health etc.

References:

1. Holler J., Tsiatsis V., Mulligan C., Karnouskos., Boyle D., *From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence* (1e), Elsevier 2014.
2. Bahga A., Madisetti V., *Internet of Things-A Hands on Approach* (1e), Orient Blackswan Private Limited, 2015.
3. Roderick O., Marko N., Sanchez D. and Aryasomajula A., *Internet of Things and Data Analytics Handbook* (1e), Wiley-Blackwell, 2017.
4. Patil Y., *Azure IoT Development Cookbook* (1e), Packt publishing Ltd, 2017.

MC 3080: HYDRAULIC & PNEUMATIC SYSTEMS [3 0 0 3]

Pneumatic systems, structure and signal flow, compressors, actuators and control valves, single acting and double acting cylinders, manual pneumatics, single and multiple actuators, limit switches, proximity sensors, electro pneumatics and design of electro pneumatic circuits, direction control valves, relay control systems, timers, counters, pressure control valves, closed loop pneumatics and Flow control valves. Hydraulic systems, physical principles of oil hydraulics, hydraulic actuators, valves and accessories, hydraulic power pack, types of hydraulic pumps, accumulator, Filters, hydraulic circuits, regenerative, meter in, meter out, bleed off, sequencing, pressure reducing circuits, electro hydraulic circuits, proportional hydraulics and servo hydraulics.

References:

1. E. Anthony, *Fluid power with applications*, Pearson Education, 2003.
2. P. A. Andrew, *Hydraulics and Pneumatics*, Elsevier Science &Technology Books, (3e) 2011.
3. D. Scholz., *Proportional Hydraulics*, Festo Didactic GMBH & Co, Germany, 2002.
4. S. R Mujumdar, *Pneumatic Systems - Principles and Maintenance*, Tata McGraw Hill, 2000.

MC 3081: QUALITY CONTROL & 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, and 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.

References:

1. B. H. Dale, *Total Quality Management*, Pearson Education, 2018
2. E. L. Grant E, R. Levenworth , *Statistical Quality Control*, McGraw Hill Publications, 2005.
3. M. S. Mahajan , *Statistical Quality Control*, Dhanpat Rai, 2006

MC 3082: RELIABILITY AND MAINTENANCE ENGINEERING [3 0 0 3]

Introduction to Reliability Availability and Maintainability (RAM), Development of RAM Engineering, Reliability Availability and Maintainability utilization factors, down time consequences. Reliability engineering fundamentals and applications, Reliability functions, typical Hazard functions, Mean time to failure, Cumulative Hazard function, Application of Probability distribution function in Reliability evaluation combinational Aspects of Reliability, Markov models optimization of system Reliability, Heuristic Methods applied to optimal system Reliability. Maintainability: Definition and application of Maintainability Engineering, Factors affecting Maintainability. Maintainability design criteria, operating and down time categories, Maintainability and its quantification, Mean time to activity restore an equipment, Mean Maintenance man hours, Mean time for corrective and Preventive Maintenance, Replacement Policies. Availability, types of Availability, approaches to increase equipment Availability.

References:

1. C.E. Ebeling, *An Introduction to Reliability and Maintainability Engineering*, McGraw Hill Publication, 2005.
2. S.S. Rao, *Reliability Engineering*, Pearson Publication, 2016.
3. K.C. Kapoor and L.R. Lamberson, *Reliability in Engineering Design*, John Wiley Publication, 2015.
4. E. Balagurusamy, *Reliability Engineering*, McGraw Hill Publication, 2018.

MC 3083: BIOMEDICAL INSTRUMENTATION [3 0 0 3]

Fundamentals of Medical Instrumentation, Physiological Transducers, Half- cell potential, Types of electrodes, Electrode, Electrolyte model, Amplifiers for biomedical instrumentation; Physiological Signals & Measurements: Basics of ECG, EMG, EEG, blood pressure & blood flow and the instrumentation for measuring these signals; Cardiac Pacemakers: Types of pacemakers, Modes of triggering, Pacemaker power supplies, pacemaker codes; Defibrillators: AC and DC defibrillators, principles of tomography; Diathermy, MRI ,Electrical Hazards & Safety: Safety code standards, Micro and Macro shock and its physiological effects, Methods of electrical safety.

References:

1. John G Webster, *Medical Instrumentation Applications and Design*, John Wiley and Sons, New York, (3e), 2011.
2. R S Khandpur, *Handbook of Biomedical Instrumentation*, McGraw Hill, Delhi, (3e), 2014.
3. L A Geddes, L E Baker, *Principles of Applied Medical Instrumentation*, Wiley India, New Delhi, (3e), 2008.
4. Richard Aston, *Principles of Biomedical Instrumentation and Measurement*, Merrill, New York, 1991.
5. Joseph J Carr, John M Brown, *Introduction to Biomedical Equipment technology*, Prentice Hall, New Jersey, (4e), 2003.

MC 3084: SENSORS &TRANSDUCERS [3 0 0 3]

Functional elements of an Instrument, Types of transducers, Null and Deflection methods, Input/output configurations, characteristics, types of errors, Resistive, Capacitive, Inductive transducers, Hall Effect sensors, magneto elastic transducers, solid state sensors, eddy current transducers, Piezo Electric transducers, pH Measurement, Semiconductor sensors, photo electric transducers, CCD, shaft encoder and decoders, optical encoders, flow sensors, gas sensors, density, viscosity, moisture and humidity measurements.

References:

1. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.
2. DVS Murthy, Transducers & Instrumentation, PHI, (2e), 1999.
3. B.G. Liptak, Process Measurement & Analysis, Chilton Book Company, (4e), 2003.
4. A.K Sawhney, A course in Electrical and Electronic Instrumentation Measurements, (7e), Dhanpat Rai & Co, 2002.
5. Jon S Wilson, Sensor Technology Handbook, Newnes Elsevier Publication, 2005.

MC 4140: INDUSTRIAL INSTRUMENTATION [3 0 0 3]

Temperature measurement using RTD, Thermistors and thermocouple. Solid-state temperature sensors, radiation methods, Pressure Measurement - Manometers, Elastic types, Bell gauges, Electrical types, Differential Pressure transmitters, Dead weight Pressure gauges. Low Pressure Measurement, Flow Measurement, head type flow meters, variable area flow meters, anemometers, velocity based flow meters, Measurement of mass flow rate - Radiation, angular momentum, impeller, turbine, constant torque hysteresis clutch, twin turbine, target flow meters, V-cone flow meters, Multiphase flow measurement, Measurement of Speed, velocity and Acceleration, Level Measurement.

References:

1. Patranabis D, Principles of Industrial Instrumentation, TMH, (3e), 2005.
2. Gioia Falcone, Geoffrey Hewitt, C Alimonti, Multiphase Flow Metering- Principles and Applications, Elsevier Publication, 2009.
3. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.
4. A. K. Sawhney, A course in Mechanical Measurement and Instrumentation, (7e), Dhanpat Rai and Co, 2002

MC 4141: MICRO ELECTRO MECHANICAL SYSTEMS [3 0 0 3]

Introduction to MEMS and microsystems - products, evolution of microfabrication, microelectronics, miniaturization, applications in automotive and other industries, micro sensors, micro actuation, micro accelerometers, microfluidics. Scaling laws in miniaturization, scaling laws – geometry, electrostatic forces, electromagnetic forces, electricity, heat transfer and fluid mechanics. Materials for MEMS and microsystems. Microsystems fabrication processes, photo lithography, ion implantation, diffusion, oxidation, chemical vapor deposition, physical vapor deposition, deposition by epitaxy, etching, bulk manufacturing, surface micromachining, LIGA process. Microsystems – design and packaging, mechanical packaging of microelectronics, assembly of microsystems, packaging materials.

References:

1. Tai Ran Hsu, *MEMS and Microsystems - Design and Manufacturing*, Tata McGraw Hill, (1e), 2002.
2. Chang Liu, *Foundation of MEMS*, Pearson, (2e), 2012.
3. Marc J. Madou, *Fundamentals of Micro Fabrication-The Science of Miniaturization*, CRC Press, (2e), 2002
4. Wolfgang Menz, J. Mohr and Oliver Paul, *Microsystem Technology*, Wiley-VCH, 2008.

MC 4142: MICRO-MANUFACTURING SYSTEMS [3 0 0 3]

Introduction, working principles and process parameters, machine tools, applications of the micro manufacturing processes, challenges in meso, micro, and nano-manufacturing, industrial applications and future scope of micromanufacturing processes. Different instruments related to micro manufacturing such as microsensors, microactuators, microsystems. Working principles, machine construction, and applications of micromachining, nano-finishing, microjoining, microforming, micro-casting, micromolding, LIGA for micro/nano products and features, the diversified industrial applications of the micro-manufactured processes, and recent research trends in this area.

References:

1. Jain V. K., *Introduction to Micromachining*, Narosa Publishing house Pvt. Ltd., 2010.
2. Jain V. K., *Micromanufacturing*, CRC Press, 2012.
3. Jain V. K., *Advanced Machining Processes*, Allied Publishers Pvt. Ltd., 2014.
4. Mahalik N. P., *Micromanufacturing & Nanotechnology*, Springer Berlin Heidelberg, 2006.
5. Jackson J. M., *Microfacbrication & Nanomanufacturing*, CRC Press, 2005.

MC 4143: NANOTECHNOLOGY [3 0 0 3]

Introduction to nanotechnology, bottom-up and top-down approaches, physical and chemical properties, methods of preparation of nanoparticles, carbon nanostructures and their applications, physical chemistry of nanosystems, micro electro mechanical devices and technologies - microsensors, MEMS fabrication processes and applications, microscale and nanoscale heat conduction, nanofluids preparation and characterization, nanomaterials used in energy and environmental applications and their properties, future development of micro actuators, nano-lithograghy, photoresist patterning, photolithography, electron beam lithography, production of polygon mirrors, optic fibers, future trends in nanotechnology.

References:

1. Charles P. Poole, *Introduction to Nanotechnology*, Wiley-Interscience, 2003.
2. Guozhong Cao, *Nanostructures & Nanomaterials*, Imperial College Press, 2004.
3. C B Sobhan, *Microscale and Nanoscale Heat Transfer*, Taylor and Francis, 2008.
4. Norio Taniguchi, *Nanotechnology*, Oxford University Press, 2008.
5. James J Allen, *MEMS Design*, Taylor and Francis, 2005.

MC 4144 NON-LINEAR CONTROL SYSTEM [3 0 0 3]

Common Nonlinearities in Control Systems, State-space representation of nonlinear systems, Phase plane analysis, Lyapunov's Direct Method, Lyapunov Analysis of Non-Autonomous Systems, describing function analysis, Input-State Linearization of SISO, Input-Output Linearization, Stability Circle criterions, Sliding mode Control, Basic Concepts in Adaptive Control, Trajectory Control, back stepping.

References:

1. Khalil H.K., *Nonlinear Systems* (3e), Pearson Education India, 2014.
2. Marino R. and Tomei P., *Nonlinear Control Design - Geometric, Adaptive and Robust*, Prentice Hall, 1995.
3. Slotine J.J. and Li. W., *Applied Nonlinear control*, Pearson, 1991.
4. Isidori A., *Non-linear Control Systems*, Springer Verlag, 1999.

MC 4145 PRODUCTION AND OPERATION MANGEMENT [3 0 0 3]

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, Queuing Model: Introduction, Markov Chains and Markov Processes, Birth-Death Processes, Simple Queueing Models M/M/-/- Queues. Supply chain management: performance measures, centralized vs. decentralized systems, Outsourcing: Distribution and logistics in supply chains, Direct shipment/intermediate storage policies, Vehicle routing models, Third-party logistics, Service oriented architecture (SOA).

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.

MC 4146 STATISTICAL QUALITY CONTROL METHODS [3 0 0 3]

Definitions of the term quality, Causes of variation, Patterns of variation, Frequency distribution, Measures of central tendency and dispersion, The Normal distribution curve, Inequality theorems, Shewhart's bowl drawing experiments, Control charts for variables (X, R and s charts), Type I and Type II Errors, Process capability analysis, Process capability indexes, Control charts for attributes (p ,np, c

and u charts), Acceptance sampling by attributes, Single and Double sampling plans, Operating characteristic curve, Acceptable quality level, Lot tolerance percent defective, Average outgoing quality, Average total Inspection, Average fraction inspected, Producers risk, Consumers risk, Acceptance sampling tables, Conventional and Statistical tolerance, Precision, Accuracy and Reproducibility of method of measurements, Quality costs.

References:

1. E. l. Grant, R. Levenworth, *Statistical Quality Control*, McGraw Hill Publications, 2005.
2. D.C. Montgomery, *Introduction to Statistical Quality Control*, John Wieley and Sons, 2005.
3. .M. S. Mahajan, *Statistical Quality Control*, Dhanpat Rai and Co. Pvt. Ltd., 2012.
4. J. M. Juran, F. M Gryna, *Quality Planning and Analysis*, Tata McGraw Hill Publications, 1995.
5. L. Bertrand, Hansen, *Quality Control- Theory and Applications*, Prentice Hall India, 1987.

MC 4147 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.

References:

1. P. O'Connor, *Practical Reliability Engineering*, John Wiley & Sons Inc. 2002.
2. G. K. Hobbs, *Accelerated Reliability Engineering: HALT and HASS*, Wiley, 2000.
3. C. Ebeling, *An Introduction to Reliability and Maintainability Engineering*, Waveland Pr. Inc., 2nd edition, 2009.
4. I. Bazovsky, *Reliability Theory and Practice*, Dover Publications, 2004.

MC 4148 SYSTEM MODELLING AND SIMULATION [3 0 0 3]

Principles of modeling and simulation, modeling and simulation of mixed systems, transfer function, block diagram, state space representation of SISO, MIMO, modeling of dynamic systems, construction, analysis, practical applications, linear systems, methods of model order determination, impulse and frequency response methods, system identification, algorithms for parameter estimation, gradient algorithm, least square algorithm, ARX, ARMAX applications of LS and ARMA methods, regression methods, introduction to nonlinear modeling, identification NARMAX model, case studies UAV quad-rotor, hard discs, maglev systems, ball and beam systems.

References:

1. George Pelz, *Mechatronic Systems Modeling and Simulation with HDLs*, Wiley, 2003.
2. Devdas Shetty, Richard Kolk, *Mechatronics System Design*, (2e), Cengage Learning, 2010.
3. Benjamin C. Kuo, Farid Golnarghi, *Automatic Control Systems*, (8e), Wiley, 2009.
4. Jack W. Lewis, *Modeling of Engineering Systems PC-Based Techniques and Design Tools*, High Text Publications, 2000.
5. Ioan D. Landau, Gianluca Zito, *Digital Control Systems Design, Identification and Implementation*, Springer, 2006.

MC 4149 VIRTUAL INSTRUMENTATION [3 0 0 3]

Architecture of a virtual instrument, Virtual instruments V/s Traditional instruments, Advantages of VI, Graphical programming, Creating Virtual Instruments using Lab VIEW-Loops, Arrays, Clusters, String and file I/O, Graphs, Case/Sequence Structures, Formula nodes, Local &Global Variables Data Acquisition, Common Instrument Interfaces, Current loop, System buses, Interface buses, VISA, Image acquisition and processing, Design of ON/OFF controller for a mathematically described processes using VI software.

References:

1. Jovitha Jerome, *Virtual Instrumentation Using LabVIEW*, PHI
2. Gary Johnson, *LabVIEW Graphical Programming*, (2e), MGH, 1997.
3. Jeffrey Travis, Jim Kring, *LabVIEW for Everyone: Graphical Programming Made Easy and Fun* (3e), Prentice Hall Professional.
4. S. Sumathi, P Surekha, *LabVIEW based Advanced Instrumentation systems*, Springer, 2007.
5. Rick Bitter, Taqi Mohiuddin, Matt Nawrocki, *LabVIEW Advanced Programming Techniques*, CRC Press, 2007

MC 4150 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, 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.

References:

1. S. Kalpakjian, and Steven R. Schmid, *Manufacturing Engineering and Technology*, Pearson Education, 6th Edition, 2009.
2. Ghosh, and 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.

MC 4151 INDUSTRIAL ERGONOMICS [3 0 0 3]

Definitions of Ergonomics, Role of human factors engineer, Types of systems, Elements of man-machine system, System approach to human engineering, Information input and processing, Information theory, Sources and pathways of stimuli, Human sensorimotor system, Biases in decision making. Visual Displays, Quantitative and qualitative displays, Auditory displays, Biomechanics of motion, Functions of controls, Factors influencing design of control, Design of hand and foot controls, Use of Anthropometric data, Work surface, Location of component and general work place arrangement, Industrial fatigue, Causes and elimination of fatigue, Productivity and its improvement, Worker and working environment, Effect of light, colour, noise and vibration on performance.

References:

1. S. Mark, Sanders, J.C. Ernest, *Human Factors in Engineering and Design*, (7e), McGraw-Hill and Co, Singapore 1992.
2. R. S. Bridger, *Introduction to Ergonomics*, Taylor & Francis, (3e), 2008.
3. B. Pulat, Mustafa, *Fundamentals of Industrial Ergonomics*, (2e), Waveland Press Inc., Illinois, 1997.
4. M. I. Khan, *Industrial Ergonomics*, PHI Learning Pvt. Ltd., New Delhi, 2010.
5. S. Gavriel., *Handbook of Human Factors and Ergonomics*, (3e), Wiley, Hoboken, New Jersey, 2006.

MC 4152: PROJECT MANAGEMENT [3 0 0 3]

Concept of project, Importance of project management, Project life cycle, Project management as an integrated approach, organizing projects within the functional organization, organizing projects as dedicated teams, Organizing projects within a matrix arrangement, Project manager and their attributes. Feasibility study: Pre-feasibility study, Technical feasibility, Managerial feasibility, Economic feasibility, financial feasibility, Cultural feasibility, Political feasibility, Environmental feasibility, Market feasibility, Steps of feasibility study. Estimating project times and costs: Factors influencing the quality of estimates, Costs associated with projects, estimating guidelines for times, costs and resources, Top-down approaches of estimation, Bottom-up approaches of estimation, and Hybrid approach of estimation. Risk management process: Risk identification, Risk Assessment - probability analysis, mitigating risk, avoiding risk, transferring risk, sharing risk, retaining risk, Contingency planning, Contingency funding and time buffers, Risk response control – change control management, Decision tree analysis, Numerical. Project scheduling: Bar charts and Milestone charts, Elements of network, Development of networks, Work Breakdown Structure (WBS), Critical Path Method, Program Evaluation and Review Technique, Network crashing, CPM updating, Numerical. Project audit and closure: Guidelines for conducting a project audit, Initiating and staffing, Data collection and Analysis, Audit reporting, Conditions for project closure, Evaluation of project team and members.

References:

1. C. Gary, E Larson, G. Desai, *Project Management – The Managerial Process*, Tata McGraw Hill Pvt. Ltd., New Delhi, 2013.
2. R. Paneerselvam, P. Senthilkumar, *Project Management*, PHI Learning Pvt. Ltd., New Delhi, 2010.
3. J. Meredith, S. Mantel, *Project Management - A Managerial Approach*, John Wiley & Sons, USA, 2012.
4. N. D. Vohra, *Quantitative Techniques in Management*, New Delhi, 2007.

MC 4153 INFORMATION SYSTEM IN MANUFACTURING [3 0 0 3]

Manufacturing organizations and networked enterprises, Globalization challenges and opportunities, Dimensions of Information systems, Approaches to study information system, Technical and Behavioral approach. Global e-business: Use of information systems in manufacturing functions, information system, organizations, and strategies Information Technology Infrastructure: IT Infrastructure and Emerging Technologies, Securing Information Systems, shop floor communications. Smart manufacturing and connected enterprise, ISA 95, Functional and physical sub-divisions, Global connected supply chain, mass customization, customer co-creation. Case studies of information systems for key manufacturing functions: Life cycle, supply chain, enterprise, quality, maintenance, materials, energy and sustainability information systems.

References:

1. T. O. Boucher and A. Yalçin, *Design of Industrial Information Systems*, 1st edition, Elsevier, 2006.

2. K. E. Kurbel, *Enterprise Resource Planning and Supply Chain Management: Functions, Business Processes and Software for Manufacturing Companies*, 1st edition, Springer, 2013.
3. R. Zurawski, *Integration Technologies for Industrial Automated Systems*, 1st edition, CRC Press, 2006.

MC 4154 ARTIFICIAL INTELLIGENCE [3 0 0 3]

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.

References:

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 3rd edition 2012.
3. Dan W. Patterson, *Introduction to AI and ES*, Pearson Education, 2007.
4. George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, Pearson Education Asia (2009).

MC 4155 BUILDING AUTOMATION [3 0 0 3]

Overview of Digital Controller: Data Form used in computers, Microcomputer, Input / Output Unit, Processor Operation and Software, Sensors, Actuator, I/O devices, Field Controllers. Network and Communication protocols: Networking basics, Types of Networks- Serial and Parallel Communication, RS232 and RS 485 Interfaces, MODBUS protocol overview, BACnet protocol overview. Introduction to Building Management Systems: Buildings and Energy Management, Different systems in a building. Introduction to HVAC, StruxureWare for Building Operation. General BMS architecture: Introduction to HVAC and Optimal control methods for HVAC Systems: Important components of HVAC, HVAC Control systems and Direct Digital Control, AHU, Chillers, Zones, Air Distribution Systems, Field Devices, Schneider Controllers (PLC's). Lighting control systems: Strategies for energy management and lighting. Security and Safety Control Systems: Access Control-Introduction, Basic Components, Controller / Panel, Credentials, Reader, Locking Device, How it works / Operations, Type of Card/Readers, Anti-Pass back, Power Requirements, Videos (Digital Video Recorder), Types of Camera, Fire Alarm Systems - Sprinklers. System integration and convergence: Need for integration, interoperability and protocols, BMS integration case studies, iBMs, Compatibility of different internet Technologies and its application in BMS. Application of internet for Automation and Management: Web Based Automation, General Architecture, Web Enablement, Data Communication Energy Management: Overview on EMS, Energy Analysis/Audit. Green Buildings (LEED): Green Buildings Approach, Benefits of Green Buildings, Elements of Green Building Design, Leadership in Energy and Environmental Design (LEED), LEED Case Study.

References:

1. V. K. Jain, *Automation Systems in Smart and Green Buildings*, published by Khanna Publishers, 2009.
2. Reinhold A, *Understanding Building Automation Systems: Direct Digital Control, Energy Management, Life Safety, Security/access Control, Lighting, Building Management Programs*, 2009.
3. Ronnie J. Auvil, *HVAC Control Systems*, (2e), 2007.
4. Thomas L. Norman, *Integrated Security Systems Design: Concepts, Specifications, and Implementation* (1e) by CPP PSP CSC 2007.

5. Benantar, Messaoud, *Access Control Systems: Security, Identity Management and Trust Models*, Springer publication, 2005.

MC 4156: ENERGY CONSERVATION, AUDIT AND MANAGEMENT [3 0 0 3]

Energy Conservation: Energy Scenario, Thermodynamic basis of energy conservation, Energy Conservation Act and policies, Energy conservation in HVAC systems and thermal power plants, Energy conservation in buildings and star ratings. Energy Audit: Definition, Energy audit-need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy audit instruments. Energy Management: Definition and Objective of Energy Management, General Principles of Energy Management. Energy Management Skills, Energy Management Strategy; Financial Analysis: Simple Payback, IRR, NPV, Discounted Cash flow.

References:

1. C.B. Smith, K.E. Parmenter, *Energy Management Principles*, (2e), Elsevier, 2015.
2. Albert Thumann, William J. Younger, *Handbook of Energy Audits*, (6e), The Fairmont Press Inc., 2003.
3. Frank Krieth, D. Yogi Goswami, *Energy Management and Conservation Handbook*, CRC Press, 2008.
4. Barney L. Capehart, Wayne C. Turner, *Guide to Energy Management*, (6e), Fairmont Press, 2008.
5. Barun Kumar De, *Energy Management, Audit and Conservation*, (2e),Vrinda Publications P Ltd. 2014.

MC 4157 MACHINE TOOL TECHNOLOGY [3 0 0 3]

Types of motion in cutting, cutting speed, feed, depths of cut in machining, cutting tools classification, nomenclature of single point cutting tool, difference between orthogonal and oblique cutting, mechanism of metal cutting, types of chips, chip breakers, forces acting on a tool, merchant circle diagram, velocity relations, specific energy in cutting, tool wear, tool life factors, Taylor's tool life equation, tool wear mechanisms, heat distribution in metal cutting, measurement of temperature in metal cutting, lathe tool dynamometer, cutting fluids selection and applications, cutting tool materials, specifications for inserts and tool holders. CNC tooling, tool presetting, automated tool & pallet changing, work holding, cutting process parameter selection, jigs and fixtures, types of clamping devices, principles of clamping.

References:

1. Milton C.Shaw, *Metal Cutting Principles*, (2e), Oxford University Press, 2000.
2. Kempster, *Jigs and Fixtures*, (3e), Mark Howard Publications, 2004.
3. Steve Krar, Arthur Gill and Peter Smid, *MachineTool Technology Basics*, (2e), Industrial Press Inc., U.S, 2012.
4. Sharma. P. C, *A Text Book of Production Engineering*, (7e), S. Chand Publishers, New Delhi, 2008.

MC 4158 MACHINE VISION AND IMAGE PROCESSING [3 0 0 3]

Image Acquisition and Analysis: Vision system components, Image acquisition and analysis, Image digitization, Image enhancement, restoration, Segmentation, Morphological Operations, image representation and analysis, color image processing. 3D Vision: Camera and optics, Perspective Projection Geometry Rotation and translation matrix, Pinhole camera model, Calibration methods, Intrinsic and Extrinsic Camera Parameters, Stereovision, Stereo correspondence Algorithms, Epipolar Geometry, Essential and fundamental matrix, 3D Reconstruction. Motion Estimation and Tracking:

Optical □ow estimation, Object tracking with Kalman filtering. Basic idea of localization employing passive markers. Case Studies/Application: Basic color detection, Face recognition, Vehicle tracking, applications using computer vision toolbox and image processing toolbox of MATLAB.

References:

1. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, (3e), Pearson Education, 2008.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis and Machine Vision*, (2e), 1998.
3. Boguslaw Cyganek & J. Paul Siebert, *An Introduction to 3D Computer Vision Techniques and Algorithms*, (1e), Wiley, 2009
4. David A. Forsyth Jean Ponce, *Computer vision: A modern approach*, Pearson Education Limited.
5. E.R. Davies, Royal Holloway, *Machine Vision: Theory, Algorithms and Practicalities*, (3e), University of London, 2004.

MC 4159 DYNAMICS AND CONTROLS OF MECHATRONICS SYSTEMS [3 0 0 3]

Industrial feedback controllers, PID controllers, tuning methods, frequency response approach, computational optimization, modified PID scheme. Introduction to state space analysis - state space representations, Eigen vectors and Eigen values, transfer functions, state space modeling. Control system design in state space, solution of LTI state equation, controllability and observability, state feedback controllers, state observers Lyapunov stability analysis, quadratic optimal control. Types of nonlinearity, describing functions phase plane method, linearization techniques, MATLAB simulation, state space modeling, feedback controllers, observers, regulator problems.

References:

1. Ogata K., *Modern Control Engineering*, (5e), Pearson Prentice Hall, 2005.
2. Karl J. Astrom, *Feedback systems- An Introduction for Scientists and Engineers*, Princeton University Press, 2008.
3. Norman S. Nise, *Control Systems Engineering*, (6e), John Wiley & Sons, Inc, 2011.
4. Stanley M. Shinners, *Modern Control Systems, Theory and Design*, John Wiley & Sons, Inc, 2009.
5. Gopal M., *Modern Control System Theory*, (2e), New Age International Ltd, 2005.

MC 4160 ELECTRIC VEHICLE MACHINES AND DRIVES [3 0 03]

Overview of EV Technologies-Motor Drive Technology, Energy Source Technology, Battery Charging Technology, Vehicle-to-Grid Technology, Pure Electric Vehicle, Hybrid Electric Vehicle, Gridable Hybrid Electric Vehicle, Fuel-Cell Electric Vehicle. DC Motor Drives – System Configurations, DC Machines, DC–DC Converters, Soft-Switching DC–DC Converter Topologies, DC Motor Control, Regenerative Braking, Design Criteria of DC Motor Drives for EVs. Induction Motor Drives-System Configurations, Induction Machines, Inverters for Induction Motors, Induction Motor Control, Design Criteria of Induction Motor Drives for EVs. Permanent Magnet Brushless Motor Drives- System Configurations, PM Brushless Machines, PM Brushless Motor Control, Design Criteria of PM Brushless Motor Drives for EVs, Switched Reluctance Motor Drives- SRM Machines, SR Converters, Comparison of SR Converters for EVs, SR Motor Control, Design Criteria of SR Motor Drives for EVs, Machine Initialization, Planetary-Geared SR Motor Drive, Outer-Rotor In-Wheel SR Motor Drive. Integrated-Starter-Generator Systems -System Configurations, ISG Machines, ISG Operations, Cranking, Electricity Generation, Idle Stop-Start, Power Assistance. Planetary-Geared Electric Variable Transmission Systems: Input-Split PG EVT Systems, Compound-Split PG EVT Systems, Design

Criteria of PG EVT Systems, PM Synchronous PG EVT System Configuration. Double-Rotor Electric Variable Transmission Systems- Double-Rotor Machines, Basic Double-Rotor EVT Systems, Advanced Double-Rotor EVT Systems, Axial-Flux DR EVT System, Magnetless DR EVT System, Design Criteria of DR EVT Systems, Design Example of DR EVT Systems. Potential Applications of DR EVT Systems in HEVs.

References:

1) K T Chau, Electric Vehicle Machines and Drives- Design, Analysis and Application, (1e) John Wiley & Sons, 2015.

MC 4161 COMPUTER NETWORKS AND COMMUNICATION PROTOCOLS [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.

References:

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

MC 4162: MACHINE LEARNING [3 0 0 3]

Introduction: Basic concepts-Supervised Learning, Discriminative Algorithms. Supervised learning: Supervised learning setup, Linear Algebra, Weighted Least Squares, Logistic Regression, Newton's Method, Perceptron, Exponential Family, Generalized Linear Models, Gaussian Discriminant Analysis, Naive Bayes, and Laplace Smoothing. Support Vector Machines, Support Vector Machines, Kernels, Bias-Variance tradeoff. Regularization and model/feature selection, Tree Ensembles, Neural Networks: Basics, Evaluation Metrics, K-means. Mixture of Gaussians. Expectation Maximization, Factor Analysis, Principal Component Analysis. Independent Component Analysis, MDPs. Bellman Equations, and Reinforcement learning and control: MDPs. Bellman equations, Value iteration and policy iteration, linear quadratic regulation (LQR), LQG, Q-learning. Value function approximation.

References:

1. Ethem Alpaydin, *Introduction to Machine Learning*, (3e), MIT Press, 2014
2. Christopher Bishop, *Pattern Recognition and Machine Learning (Information Science and Statistics)*, Springer; (1e). 2006. Corr. 2nd Print, 2011.
3. Stephen Marsland, *Machine Learning: An Algorithmic Perspective*, Chapman and Hall/CRC, (2e), 2014.
4. Tom M. Mitchell, *Machine Learning*, McGraw Hill Education 2013.
5. Andreas C. Muller & Sarah Guido, *Introduction to Machine Learning with python: A guide for Data Scientists*, O'Reilly (3e), 2017.

MC 4163: INDUSTRIAL AUTOMATION [3 0 0 3]

Data loggers, Data Acquisition Systems, Direct Digital Control, SCADA, Programmable Logic Controller, Ladder logic Programming, PID functions, analog PLC operation, Alternate Programming Languages, PLC Maintenance, Interface and Backplane Bus Standards, Field bus, HART protocol, Smart transmitters, Valves and Smart actuators, MODBUS, Profibus, IEC 1158-2 Transmission Technology, Distributed Control Systems, Local Control Unit, Communications for DCS, Displays Engineering interfaces.

References:

1. John. W. Webb Ronald A Reis, Programmable Logic Controllers - Principles and Applications, PHI, (4e). 1998.
2. Lukcas M.P, Distributed Control Systems, Van Nostrand Reinhold Co., 1986.
3. Frank D. Petruzella, Programmable Logic Controllers, MGH, (2e), 1997.

MC 4164: AUTOMATED MANUFACTURING SYSTEM [3 0 0 3]

Overview of Manufacturing and Automation: Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Additive Manufacturing : Process Chain for Additive Manufacturing Processes, Rapid Prototyping Data Formats, Liquid Based Process, Rapid Freeze Prototyping, Solid Based Process, Powder Based Process, Rapid Tooling Application in design, engineering, analysis and planning, Applications. Subtractive Manufacturing: Computer numerically controlled machining, Numerical control in Non-Traditional Machining, Adoptive control Machining system. Basics of CNC programming (Simulation). Flexible Manufacturing System: Group Technology, Cellular Manufacturing, Quantitative Analysis of Cellular Manufacturing (Rank order Clustering), Flexible Manufacturing system (FMS), Quantitative analysis of FMS (Bottleneck model), Computer Aided Process Planning (CAPP). Product Life Cycle and Data Management (PLDM): Components of PLM, phases of PLM, PLM feasibility study, PLM visioning. PLM Strategies, Strategies for recovery at end of life, recycling. Product Data Management systems and importance, barriers to PDM implementation.

References:

1. C.K. Chua, K.F. Leong, C.S. Lim, *Rapid Prototyping: Principles and Applications*, (3e), 2010.
2. Gibson, I, Rosen, D W., and Stucker, B., *Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing*, Springer, 2014.
3. Groover Mikell P, Automation, *Production Systems, and Computer Integrated manufacturing*, (4e), Prentice Hall of India. New Delhi, 2016.
4. Kalpakajain, *Manufacturing Engineering and Technology*, (4e), Addison Wesley, New York, 2014.
5. Saaksvuori, Antti, Immonen, Anselmi, *Product Lifecycle Management*, (2e), Springer-Verlag Berlin Heidelberg, 2005.

MC 4170: MINOR PROJECT [0 0 2 1]

The project work may be carried out in institute laboratory. The duration of the project work shall be 16 weeks. The final evaluation and viva-voce will be conducted after submission of the final project report in the prescribed form. Students have to make a presentation on the work carried out, as part of project evaluation.

MC 4171: INDUSTRIAL TRAINING [0 0 2 1]

Each student has to undergo industrial training for a minimum period of 45 days/ 6 weeks. This may be taken in a phased manner during the vacation starting from the end of six semester. Student has to

submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

MC 4270: MAJOR PROJECT [0 0 0 12]

Project work should be carried out for a minimum duration of 16 weeks at the institution/ industry/ research laboratory or any other institution where facilities exist, with approval of the parent Department. The grade awarded to the student will be on the basis of the total marks obtained by him/ her out of 400 marks. There will be a mid-semester evaluation of the work done on the project after 8-10 weeks. In case of external projects, the qualitative feedback of the external guide shall be taken. The final evaluation and viva voce will be conducted after the completion of the project work and submission of the project report, by a panel of examiners including the internal guide.