VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

Scheme of Teaching and Examinations and Common Syllabus

M.Tech in Computer Integrated Manufacturing

(Effective from Academic year 2020 - 21)

Corrected for typographical error 20.06.2021

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21

M.Tech in Computer Integrated Manufacturing

(Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20MCM11	Numerical Methods for Engineers	03	--	02	03	40	60	100	4
2	PCC	20MCM12	Mechatronics and Applications	03	--	02	03	40	60	100	4
3	PCC	20MCM13	Computer Integrated Manufacturing System	03	--	02	03	40	60	100	4
4	PCC	20MCM14	Control System Engineering	03	--	02	03	40	60	100	4
5	PCC	20MCM15	Operation Management	03	--	02	03	40	60	100	4
6	PCC	20MCML16	Computer Integrated Manufacturing Laboratory	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology & IPR	01	--	02	03	40	60	100	2
			TOTAL	**17**	**04**	**12**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Skill development activities:

Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.

The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.

The students shall

(1) Gain confidence in modelling of systems and algorithms.

(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.

(3) Handle advanced instruments to enhance technical talent.

(4) Involve in case studies and field visits/ field work.

(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.
(iii) Two credit courses are designed for 25 hours Teaching – Learning process.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech in Computer Integrated Manufacturing
(Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20MCM21	Design of Robotic Systems	03	--	02	03	40	60	100	4
2	PCC	20MCM22	Programmable Logic Controller	03	--	02	03	40	60	100	4
3	PCC	20MCM23	Pneumatic and Hydraulic Control	03	--	02	03	40	60	100	4
4	PEC	20MCM24X	Professional elective 1	04	--	--	03	40	60	100	4
5	PEC	20MCM25X	Professional elective 2	04	--	--	03	40	60	100	4
6	PCC	20MCML26	Robotics and AutomationLaboratory	--	04	--	03	40	60	100	2
7	PCC	20MCM27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				**17**	**06**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 20MCM24X	**Course title**	**Course Code under 20MCM25X**	**Course title**
20MCM241	Advanced Computer Concepts for Automation	20MCM251	Networking and IoT
20MCM242	Tooling for Manufacture In Automation	20MCM252	Drives and Control Systems for Automation
20MCM243	Metrology and Computer Aided Inspection	20MCM253	Virtual Reality & Augmented Reality
20MCM244	Machine Learning	20MCM254	Work Systems Engineering

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech in Computer Integrated Manufacturing
(Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini–Project/ Internship	Skill Development activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20MCM31	Artificial Intelligence and Expert System in Automation	03	--	02	03	40	60	100	4
2	PEC	20MCM32X	Professional elective 3	03	--	--	03	40	60	100	3
3	PEC	20MCM33X	Professional elective 4	03	--	--	03	40	60	100	3
4	Project	20MCM34	Project Work phase -1	--	02	--	--	100	--	100	2
5	PCC	20MCM35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20MCMI36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				**09**	**04**	**02**	**12**	**360**	**240**	**600**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		**Professional Elective 4**	
Course Code under 20MCM32X	**Course title**	**Course Code under 20MCM33X**	**Course title**
20MCM321	Logistics and Supply Chain Management	20MCM331	Cyber Security for physical system an Introduction
20MCM322	3D Printing and Rapid Manufacturing	20MCM332	Digital Image Processing & Machine Vision
20MCM323	Reliability and Maintenance Engineering	20MCM333	Virtual Instrumentation
20MCM324	Product Design	20MCM334	Operations Research

Note:
1. Project Work Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.
CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.
SEE (University examination) shall be as per the University norms.
2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech in Computer Integrated Manufacturing
(Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva Voce	Total Marks	
				L	P					
1	Project	20MCM41	Project Work Phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Work Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

NUMERICAL METHODS FOR ENGINEERS			
Course Code	20MCM11	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model.
Roots of Equations: Bracketing methods-Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed point iteration. MATLAB or Sci Lab session for solving equations using Graphical method, Bisection method, False position method and Newton Raphson method.

Module-2

Roots of Polynomial-Polynomials in Engineering and Science, Muller's method, Numerical Differentiation and Numerical Integration: Newton – Cotes and Guass Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae. MATLAB or Sci Lab session for Numerical differentiation and Numerical Integration**.**

Module-3

System of Linear Algebraic Equations and Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, Iteration Methods. MATLAB or Sci Lab session for solving system of equations using Cramer's Rule, Gauss elimination method and Gauss-Jordan method.

Module-4

Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method. MATLAB or Sci Lab session for finding eigen values and eigen vectors of a square matrix.

Module-5

Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering. Orthogonality and Least Squares: Inner product, length and orthogonality, orthogonal sets. Model some simple mathematical models of physical Applications and Find the roots of polynomials in Science and Engineering problems

Course outcomes:
At the end of the course the student will be able to:

- Use the numerical methods for solving algebraic and transcendental equations which comes in mechanical engineering courses
- Demonstrate common numerical methods and how they are used to obtain approximate solutions
- Analyze and evaluate the accuracy of common numerical methods.
- Apply modern tools numerical methods to solve problems
- Write efficient code and present numerical results in an informative way.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbook/ Textbooks

(1) S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.

(2) Steven C. Chapra, Raymond P.Canale, Numerical Methods for Engineers, Tata Mcgraw Hill, 4 th Ed, 2002.

(3) M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.

Reference Books

(1) Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010

(2) David. C. Lay, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002.

(3) (3) Brian R Hunt, Ronald L Lipsman, Jonathan M Rosenberg, A Guide to MATLAB for Beginners and Experienced Users. Cambridge University Press.

MECHATRONICS AND APPLICATIONS			
Course Code	20MCM12	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, temperature and light sensors.

Module-2

Introduction to Micro Controllers: Introduction, Comparing Microprocessors and Micro Controllers, Z-80, 8051, PIC Micro Controllers, PIC Development Tools. The Micro Controller Survey, 4Bit, 8Bit, 16Bit and 32 Bit Micro Controllers. Develop Systems for Micro Controllers.

Micro Controllers Architecture: 8051 Architecture, PIC Architecture, 8051 Micro Controller Hardware, Input/ Output Pins, Ports and Circuits, External Memory, Counter and Timers, Serial Data Input/Output, (SLE: Interrupts).

Module-3

Basic Assembly Language Programming Concepts in Micro Controllers: The Mechanics of Programming, the Assembly Language Programming Process, PAL Instructions, Programming Tools and Techniques. Addressing Modes, Data Exchanges, Code Memory Read-Only Data Moves, Push Pop Op Codes, Logical Operators, Arithmetic Operators, Jump and Call Instructions. (SLE: Programming Concepts for 8051 and PIC.)

Micro Controller Applications: Introduction, Key Boards, Displays, Pulse Measurement, D/A and A/D Conversions, Multiple Interrupts. (SLE: Programming the 8255).

Module-4

Input/output Systems: Interfacing, Input/output Addressing, Interface Requirements.

Communication Systems: Digital Communications, Centralised, Hierarchical and Distributed Control, Networks, Protocols, Open System Interconnection Communication Model, Serial Communication Interfaces, Parallel Communication Interfaces, Wireless Protocols.

Module-5

Mechatronics Systems: Mechatronics Designs, Timed Switch, Windscreen-wiper Motion, **Case Studies:** Car Park Barriers, Digital Camera, Car Engine Management, Bar Code Reader, Hard Disk Drive.

Course Outcomes:

At the end of the course the student will be able to:

- Identify and explain the architectures of 8085 and 8086 microprocessors. Describe the concept of segmentation.
- Interfacing with respect to memory and I/O. Discuss the application examples of stepper motor.
- Understand the concept of Microcontroller and microprocessor and PIC architectures and core concepts.
- Discuss about various assembly programming mechanics and explain various instructions used for Microcontroller assembly programing.
- Integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.
- Design, building, interfacing and actuation of a mechatronic system for a set of specifications.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Advanced Microprocessors and IBM PC- K. Udaya Kumar & B.S. Umashankar , TMH, 1st edition, 1996.

(2) Design with PIC and Micro controllers- John B Peatman, Pearson Education, I edition, 2001.

(3) Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.

Reference Books

(1) Mechatronics, 4th edition, W Bolton, Pearson.

(2) Microprocessors and Interfacing- Douglas V.Hall, McGraw Hill, 3rd edition,2012

COMPUTER INTEGRATED MANUFACTURING SYSTEM			
Course Code	20MCM13	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Computer integrated Manufacturing Systems: Manufacturing Systems, Types of Manufacturing Systems, , Machine Tools and related equipment's, Material Handling Systems, Computer monitoring and control, Manufacturing support systems, The Product Cycle and CAD/CAM, Functions of computers in CIMS: CIMS Data Files, System Reports, Benefits of Computer integrated Manufacturing Systems.

Fundamentals of Numerical Control: Basic concepts of NC, Classification of NC- Point to Point and contouring, Incremental and absolute system, Open loop and closed loop system, Advantages of NC.

Module-2

NC/ CNC Machine Tools: General architecture of CNC Machine, Components of the CNC Systems: Machine Control Unit, CNC Driving system components: Hydraulic, Servo Motors, Stepper Motors, Feedback Devices: Encoder, Resolver, Inductosyn, Tachometers, Counting devices.

Module-3

Constructional Features of CNC Machines: Design considerations of CNC machines for improving machining accuracy, Structural Members, Slide ways, bearings, Re-circulating ball Screws, Spindle drives, Work holding devices and tool holding devices, Automatic tool changers.

Module-4

N.C Part Programming: Introduction, NC/ CNC programming methods: Manual part programming for turning and milling centers, G codes, M codes, canned cycles, Programming with CAD/CAM integration, CAM packages for CNC part program generation, Practical Exercises on CNC part programming.

Computer Controls in NC: CNC Technology: Functions of CNC Control in Machine Tools, Advantages of CNC, Direct Numerical Control (DNC Systems): Configuration of DNC system, Functions of DNC, Communication between DNC computer & MCU, Advantages of DNC.

Module-5

Adaptive Control: machining systems. Adaptive control optimization system, adaptive control constraint system, applications to machining processes, Benefits of Adaptive control Machining.

Computerized Manufacturing Planning and Control Systems: Computer aided process planning, Variant and Generative approaches, Computer integrated production planning and control systems,

Typical production planning and control system, Material planning systems, Capacity planning, Shop Floor Control, Automatic identification, Automated data collection systems

Course Outcomes:

At the end of the course the student will be able to:

- Apply the concepts of machining for the purpose of selection of appropriate machining centers, machining parameters,
- Create and demonstrate the technical documentation for design/ selection of suitable drive technologies, precision components and an overall CNC machine tool system for automation of machining operations
- Part model/ part drawings using Computer Aided Manufacturing technology through programming, setup, and ensuring safe operation of Computer Numerical Control (CNC) machine tools.
- Create and validate NC part program data using manual data input (MDI) and automatically using standard commercial CAM package for manufacturing of required component.
- Design automated material handling and storage systems for a typical production system and control the process

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Groover, M. P. and Zimmers, E. W., CAD/CAM:Computer Aided Design & Manufacturing, 2006, Pearson Education India

(2) Mikell P. Groover and Emory W. Zimmer, Jr., CAD/CAM Computer Aided Design and Manufacturing, Prentice Hall India (P) Ltd, 1992.

(3) M. Koren—Computer Controls of Manufacturing Systems, McGrawHill, 1983

Reference Books

(1) Martin J. ―Numerical control of machine tools".
(2) P.N. Rao – CAD/CAM Principles and Applications McGrawhill 2002
(3) Y. Koren&J.Benuri -"Numerical control of machine to ols -Khanna, 1992
(4) Hood-Daniel P., and Kelly J.F., Build Your Own CNC Machine, 2009, Springer-Verlag New York

CONTROL SYSTEM ENGINEERING			
Course Code	20MCM14	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Motivation for control. Review of differential equations, impulse response and Laplace transformations, Introduction to state equations and transfer functions.

Module-2

Interpretation of poles and zeros of transfer functions. Time domain response of second order system. Command tracking and system type. Rough/Hurwitz test.

Module-3

Frequency response and frequency domain methods. Nyquist stability test. Bode plots. Phase and gain margins. Bode phase formula.
Robustness, Uncertainty and performance weights, Robust stability test, Robust performance test, Loop shaping necessary and sufficient conditions. Bode integral formula.

Module-4

Applications of Root locus, Sensitivity of roots of characteristics equation, Tool for design and analysis of control systems, Case studies using mat lab on Bode, Nyquist and Root locus.

Module-5

State variable analysis and design, Introduction, Concepts of state variables for linear discrete time systems, Diagonalization solutions of state equations, Concepts of controllability and observability, Pole placement by state feedback, Observer systems, problems.

Course Outcomes:

At the end of the course the student will be able to:

- Categorize different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form
- Characterize any system in Laplace domain to illustrate different specification of the system using transfer function concept
- Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions and determine the (absolute) stability of a closed-loop control system
- Formulate different types of analysis in frequency domain to explain the nature of stability of the system.
- Apply root Locus technique to analyze and design control systems.
- Solve system equations in state-variable form (state variable models)

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbook/ Textbooks

(1) Feedback Control of Dynamical Systems, 5th Edition, Franklin, Powell, and Enami-Naeini, Addison-Wesley, 2006

(2) Control Systems Engineering – I. J.Nagrath, M.Gopal, 5th Edition; New Age International (P) Ltd, Publishers.

Reference Books

(1)Nagrath, I.J. and Gopal, M., Control System Engineering, New Age International (P) Limited, Publishers (2003).

(2)Bandyopadhyan M. N. "Control Engineering: Theory & Practices", PHI, 4th Ed., Printing 2006.

(3)Nise N. S "Control System Engineering" Pub: John willey& sons, 4/E, 2004.

OPERATION MANAGEMENT			
Course Code	20MCM15	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Management of production systems: Production system and its management, Classical, Behavioral& quantitative management, Introduction to CAP-OM. (SLE: Tasks of a Production Manager)

Module-2

Linear & Dynamic programming: Introduction, Canonical form of LP problems, Standard form of LP problems, Basic feasible Solution, The Simplex method of solution, Tabular method, Dynamic optimization models and programming.

Module-3

Forecasting and Capacity planning: Forecasting and analysis, spreadsheet models, time series analysis, simple moving average, weighted moving average, simple exponential smoothing, exponential smoothing and correction, linear regression, regression analysis and Delphi method. Capacity analysis basics, introduction to capacity planning methods, linear programming for aggregate planning, basics of facility layout methods. Introduction to Line Balancing, precedence requirements of operations, methods of solution, real life problem.

Module-4

Inventory systems: Basic inventory systems, parameters of an inventory policy, costs associated with inventory policy, deterministic inventory models, simple EOQ model.

Module-5

MRP system: Master Production Schedule, Production scheduling and sequencing, MRP System, Computation in a MRP system, Information provided by the MRP system, ERP system.

Just in time manufacturing: Kanban system, Dual card Kanban, Number of Kanbans Implementation of a JIT system**,** Quality circle**.**

Course outcomes:

At the end of the course the student will be able to:

- Identify the elements of operations management and various transformation processes to enhance productivity and competitiveness.
- Identify the roles and responsibilities of operations managers in different organizational contexts
- Apply and analyze and evaluate various Linear & Dynamic programming models to various real time problems
- Solve and analyze problems using different forecasting techniques and develop aggregate capacity plans in different operation environments.
- Describe Inventory types and its objectives and calculate EOQ using various models.
- Develop a balanced line of production & scheduling and sequencing techniques in operation environments and Describe MRP & JIT concepts,

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Operations Management: A Quantitative Approach, P. B. Mahapatra, Published 2010 by PHI Learning

(2) Production Planning and Inventory Control, Narasimhan, McLeavey and Billington, PHI, 2nd edition, 2009.

Reference Books

(1) Production/Operations Management- Elwood S Buffa, Wiley Eastern, 8th edition, 1987 publication.

(2) Production and Operations Management- Concepts, Models and Behavior, Adam & Ebert, PHI, 5th edition, 2009.

CIM LABORATORY			
Course Code	20MCML16	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl. NO	Experiments
	PART A (Any SIX)*
1	Modeling and Simulation of Computer Integrated Manufacturing System
2	Modelling, Offline Manual Part Programming and Simulation of the operation of a 3 axis CNC Milling Machine
3	Programming and operation of a 3 axis CNC Miling Machine
4	CAD/CAM based Part Programming and operation of a 3 axis CNC Milling Machine
5	Modelling, offline programming and simulation of a 5-Axis Robot manipulator
6	Programming and operation of a 5-Axis Robot manipulator
7	Machine vision based quality control
8	Remote Monitoring and Operation of a Computer Integrated Manufacturing System
	PART B (Any FOUR)
1	Generation of CNC program by optimising tool path movement using CAM software for lathe and mill.
2	Exercises in tool pre-setting and workpiece referencing on CNC machine tools, manual part programming for CNC turning and milling centres,
3	Use of software for simulation of turned and milled parts and simple surfaces, Automatic Cutter location data generation from CAD Models in APT format and post-processing for machining on CNC machines using standard CAD/CAM software.
4	Simulation inspection planning for automated inspection for an automotive component
5	Simulation of Product layout using plant simulation software
6	Factory floor simulation using suitable simulation software
7	Each student will submit a research assignment in terms of a short report and a small presentation on topic related to either design/selection criteria for critical CNC machine elements, CNC interpolation algorithms, need and design of special control features in CNC controller, or design of CNC toolpath algorithms

Course outcomes:

At the end of the course the student will be able to:

- Write part programs for NC machining
- Simulate manufacturing processes before being put to actual machining
- Apply/develop solutions or to do research in the areas of Design and simulation in Mechanical Engineering.
- Developing and applying computer software and hardware to mechanical design and manufacturing fields.
- Formulate relevant research problems; conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.

Reference

1) Remote (virtual) Experiments 'Computer Integrated Manufacturing (CIM)' from IIT Kharagpur (http://vlabs.iitkgp.ac.in/cim/#).
2) M.P. Groover, Automation Production systems and Computer Integrated manufacturing, Pearson Education, 2015.
3) Xun Xu, Integrating advanced Computer Aided Design, Manufacturing and Numerical Control, IGI Global, 2009
4) T.C. Chang, R. Wysk and H.P. Wang, Computer aided Manufacturing, Pearson Education, 2009

RESEARCH METHODOLOGY AND IPR			
Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:0:2	SEE Marks	60
Credits	02	Exam Hours	03

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.

Course outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR. ■

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbooks

(1) Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.

(2) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module

(3) RanjitKumar,SAGE Publications,3rd Edition, 2011

(4) Study Material (For the topic Intellectual Property under module 5),

(5) Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013

Reference Books

(1) Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.

(2) Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

*** END OF I SEMESTER ***

DESIGN OF ROBOTIC SYSTEMS			
Course Code	20MCM21	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Automation and Robotics, Historical Development, Definitions, Basic Structure of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, the Wrist & Gripper Subassemblies. Concepts about Basic Control System, Control Loops of Robotic Systems, Different Types of Controllers-Proportional, Integral, Differential, PID controllers

Module-2

Kinematics of Robot Manipulator: Introduction, General Mathematical Preliminaries on Vectors& Matrices, Direct Kinematics problem, Geometry Based Direct kinematics problem, Co-ordinate and vector transformation using matrices, Rotation matrix, Inverse Transformations, Problems, Composite Rotation matrix, Homogenous Transformations,, Robotic Manipulator Joint Co-Ordinate System, Euler Angle & Euler Transformations, Roll-Pitch-Yaw(RPY) Transformation. D H Representation & Displacement Matrices for Standard Configurations, Jacobian Transformation in Robotic Manipulation. Introduction, Trajectory Interpolators.

Module-3

Dynamics of Robotic Manipulators: Introduction,. Preliminary Definitions, Generalized Robotic Coordinates, Jacobian for a two link Manipulator, Euler Equations, and The Lagrangian Equations of motion. Application of Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Velocity of Joints, Kinetic Energy T of Arm, Potential Energy V of Robotic Arm, The Lagrange L, Two Link Robotic Dynamics with Distributed Mass.

Module-4

Robot Teaching: Introduction, Various Teaching Methods, Task Programming, Survey of Robot Level Programming Languages, A Robot Program as a Path in Space, Motion Interpolation, WAIT, SIGNAL & DELAY Commands, Branching, Robot Language Structure, various Textual Robot Languages Such as VAL II, RAIL and their Features, Typical Programming Examples such as Palletizing, Loading a Machine Etc.

Module-5

Robot Sensing & Vision: Various Sensors and their Classification, Use of Sensors and Sensor Based System in Robotics, Machine Vision System, Description, Sensing, Digitizing, Image Processing and Analysis and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors.
Industrial Applications: Objectives, Automation in Manufacturing, Robot Application in Industry, Task Programming, Robot Intelligence and Task Planning, Modern Robots.

Course outcomes:
At the end of the course the student will be able to:

- Demonstrate the relationship between mechanical structures of industrial robots and their operational workspace characteristics.
- Apply the concepts of coordinate transformations for development of arm equation and subsequently the inverse kinematics model for given serial manipulator.
- Develop and analyze the mathematical model for trajectory planning, resolved motion rate control and dynamics model for a given serial robotic manipulator
- Develop the algorithms for design of robotic work cell controller and its programming
- Design and analyze the workcell environment for given robotic manipulator configuration and workcell devices for required integrated industrial application.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Robotics, control vision and intelligence-Fu, Lee and Gonzalez. McGraw Hill International, 2nd edition, 2007

(2) Introduction to Robotics- John J. Craig, Addison Wesley Publishing, 3rd edition, 2010.

Reference Books

(1) Robotics for Engineers -YoramKoren, McGraw Hill International, 1st edition, 1985.

(2) Industrial Robotics-Groover, Weiss, Nagel, McGraw Hill International, 2nd edition, 2012.

(3) Robotic Engineering - An Integrated approach, Klafter, Chmielewski and Negin, PHI, 1st edition, 2009.

PROGRAMMABLE LOGIC CONTROLLER

Course Code	20MCM22	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Technical Definition: PLC, advantages, characteristic functions L1, of A PLC, chronological evolution of PLC, types of PLC, unitary PLC, modular small PLC, medium PLC, large PLC block diagram Of PLC : input / output (I/O) se processor section, power supply, memory. Central processing, processor soft executive software, multitasking, languages, ladder language. Input and output contact program symbols, numbering system of inputs and outputs, program form.

Module-2

Introduction To Logic: Equivalent ladder diagram of AND gate, equivalent ladder diagram of OR gate, equivalent ladder diagram of NOT gate, equivalent ladder diagram of XOR gate, equivalent ladder diagram of NAND gate, equivalent ladder diagram of NOR gate, equivalent ladder diagram to demonstrate de-morgan theorem, ladder design. Timer and its classification: characteristics of PLC timer, functions in timer, resetting retentive and non-retentive, classification of PLC timer, or delay and off delay timers timer-on delay, timer off delay, retentive and non-retentive timers, format of a timer instruction.

Module-3

PLC Counter: operation of PLC counter, counter parameters, Counter Instructions Overview Count up (CTU) Count Down (CTD).Introduction to comparison instructions, discussions on comparison instructions, "EQUAL." Or "EQU" instruction, "NOT EQUAL" or "NEQ" instruction, "LESS THAN" or "LES" instruction, "LESS THAN OR EQUAL" or "LEQ" Instruction, GREATER THAN" or "GRT" instruction, "GREATER THAN OR EQUAL TO″ or "GRQ" Instruction, "MASKED COMPARISON FOREQUAL" or "MEQ" instruction, "LIMIT TEST" or "LIM" instruction.

Module-4

Data Movement Instructions, logical instructions, mathematical instructions. Special mathematical instructions, data handling instructions, program flow control instructions, Proportional Integral Derivative (PID) Instruction. introduction to classification of I/O, I/O system overview, practical I/O system and its mapping addressing local and expansion I/O, input-output systems, direct I/O, Parallel I/O systems serial I/O systems. Sinking and sourcing, discrete input module, rectifier with filter, threshold detection, isolation, logic section specifications of discrete input module and output modules. Specifications of analog input module, types of analog input module special input modules, analog output module, I/O modules in hazardous locations power supply requirements, power supply configuration, filter.

Module-5

Industrial Communication and Networking : Evolution of industrial control process, types of communication interface types of networking channels, parallel communication interface, IEEE- 488 bus, devices useable with IEEE - 488, Handshaking process, interface management lines, serial communication interface. communication mode, synchronization and timing in communication, synchronous and asynchronous transmissions compared, different recommended standards compared software protocol, industrial network, network topology, media access methods, open system interconnection (OSI) network model, network components, advantage of standardized industrial network, industrial network, controller area network (CAN), AS-I Interface.

Course outcomes:

At the end of the course the student will be able to:

- Describe and analyze working principles of various types of motors, differences, characteristics and selection criteria, control methods, SCADA.
- Apply the knowledge in selection of motors, heating effects and braking concepts in various industrial applications.
- Construct a program using PLC to problems pertaining to automation industries.
- Demonstrate self-learning capability

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) 'PLC and Industrail Applications", MadhuchhandanGupts and Samarjxit Sen Gupta,Pernram International Pub. (India) Pvt.Ltd., 2011

(2) Programmable Logic Controllers, 5th Edition W. Bolton John W. Webb PHI learning , New Delhi

Reference Books

(1) 'Basic PLC Course (Programmable Logic Controller)'MohdShafiekYaacob, Pearson, 2006.

(2) A practical Handbook to PLC Alireza H. Fassih New Generation publication

PNEUMATIC AND HYDRAULIC CONTROL			
Course Code	20MCM23	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to control system, Types of control system and their utility.

Module-2

Hydraulic power generation and transmission, valve control pressure flow relationship for hydraulic valves, valve configurations and constructions, steady state operating forces, transient forces and valve instability. Circuit design.

Module-3

Pneumatic valves, Hydraulic and pneumatic drives.

Module-4

Fluidics: Introduction to fluidic devices and sensors lumped and distributed parameter fluid systems. Fluid mechanics of jets, wall attachment and vortex devices. Pure fluidic analog amplifiers. Analog signal control techniques. Design of pure fluid digital elements

Module-5

Electro-hydraulic and Electro-pneumatic Systems: Physical concepts of pneumatics and electrical. Electro-pneumatic components operation and application interpretation of electric ladder diagram. P.PI & PID – controllers & applications.

Course outcomes:

At the end of the course the student will be able to:

- Correlate the basics of hydraulics to the performance of fluid power systems.
- Describe the working principle of hydraulic systems including pumps and controllers.
- Correlate the basics of pneumatics to the performance of pneumatic systems.
- Design and analyse problems relating to Pneumatic and Hydraulic control systems and components.
- Design hydraulic and pneumatic power circuits.

Text Book

(1) K. Foster, G.P. Parker, Fluidic Components and Circuits, Wiley, 1970.

(2) A.B. Goodwin, Fluid Power Systems, Macmillan, 1976.

(3) Oil Hydraulic Systems by S.R. Majumdar, Tata Megraw Hill Pub. Co. Ltd. 2001

(5) Pneumatic Systems by S.R. Majumdar, Tata Megraw Hill Pub. Co. Ltd. 1995

(6) Hydraulic and Pneumatic Control by Srinivasan, Vijay Nikole, Imprints Pvt. Ltd. 2004

(8) Hydraulic Control of Machine Tools by Khaimovich, Pergamon Press Ltd.196

Reference Books

(1) Werner Deppert / Kurt Stoll, Pneumatic Application, Vogel verlag, 1986.

(2) John Pippenger, Tyler Hicks, Industrial Hydraulics, McGraw Hill International Edition, 1980.

(3) FESTO, Fundamentals of Pneumatics, Vol I, II and III.

(4) Thomson, Introduction to Fluid power, Prentice Hall, 2004.

(5) Hehn Anton, H., Fluid Power Trouble Shooting, Marcel Dekker Inc., NewYork, 1984.

(6) Majumdar S.R., “Oil Hydraulics”, Tata McGraw-Hill, 2000.

ADVANCED COMPUTER CONCEPTS FOR AUTOMATION			
Course Code	20MCM241	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Big Data: Big Data and its Importance – Four V's of Big Data – Drivers for Big Data –Introduction to Big Data Analytics – Big Data Analytics applications. Hadoop's Parallel World – Data discovery – Open source technology for Big Data Analytics – cloud and Big Data –Predictive Analytics – Mobile Business Intelligence and Big Data – Crowd Sourcing Analytics – Inter- and Trans-Firewall, Analytics - Information Management.

Module-2

Processing Big Data: Integrating disparate data stores - Mapping data to the programming framework Connecting and extracting data from storage - Transforming data for processing - Subdividing data in preparation for Hadoop Map Reduce.

Module-3

Hadoop Mapreduce: Employing Hadoop Map Reduce - Creating the components of Hadoop Map Reduce jobs - Distributing data processing across server farms -Executing Hadoop Map Reduce jobs - Monitoring the progress of job flows - The Building Blocks of Hadoop Map Reduce - Distinguishing Hadoop daemons - Investigating the Hadoop Distributed File System Selecting appropriate execution modes: local, pseudo-distributed, fully distributed.

Module-4

Database Management System: Comparison of File System, Database Management System, Characteristic Features of Database Management Systems, Relational Databases.
Data Base Models: DBMS Languages and Interfaces. Data Base Security and Authorization.

Module-5

Big Data Tools and Techniques: Installing and Running Pig – Comparison with Databases – Pig Latin – User-Define Functions – Data Processing Operators – Installing and Running Hive – Hive QL – Tables – Querying Data – User-Defined Functions – Oracle Big Data.

Course outcomes:
At the end of the course the student will be able to:

- Understand of big data and its importance and its applications in different sectors.
- Data identification and its extraction from various sources and transforming them for processing.
- apply Hadoop Map-Reduce techniques for data processing
- Describe about database, highlighting its characteristics and discuss key components of the database and providing security and authorization to the databases.
- Apply various tools and techniques of Big Data to solve the problems.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Fundamentals of DBMS – RamezElmasri and Navathe, Addison Wesley, 5th edition, 2009

(2) Michael Minelli, Michehe Chambers, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business", I Edition, Wiely 2013.

(3) Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", 1st Edition, IBM Corporation, 2012.

(4) Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", 1st Edition, Wiley and SAS Business Series, 2012.

(5) Tom White, "Hadoop: The Definitive Guide", 3rd Edition, O'reilly, 2012.

Reference Books

(1) Introduction to DBMS – Date C.J, Addison Wesley, 3rd edition, 1981.

(2) Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.

(3) Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013)

(4) Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R

(5) AnandRajaraman and Jefrey David Ulman, "Mining of Massive Datasets", Cambridge University Press, 2012

TOOLING FOR MANUFACTURE IN AUTOMATION			
Course Code	20MCM242	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Mechanics of Metal Cutting: Introduction, measurement of cutting forces and chip thickness, force components, chip formation and primary plastic deformation, shear plane and slip line theories for continuous chip formation.
Modern Cutting Tool Materials: Material properties, HSS related materials, sintered tungsten carbide, cermets, ceramics, polycrystalline tools, tool coatings.
Cutting tools: Basic types of cutting tools, turning tools, indexable inserts, groove geometry, edge preparation, wiper geometry, insert clamping methods, tool angles, threading tools, cutters.

Module-2

Optimization: Machining cost and production rate verses cutting speed, role of computerized optimization system, economic considerations, optimization of machining system.
Tooling Requirements for CNC Machines: Tool holding systems modular and quick change tool holding system, tool holder spindle connection, cutting tool clamping systems, milling cutter driver, side lock type chuck, collet chucks, hydraulic chucks, milling chucks. Tool magazines, Automatic tool changers.

Module-3

Location and Clamping Methods: Basic principles of locating, locating methods &devices, Basic principles of clamping, clamping methods.
Fixtures: Definitions, General considerations, Machine considerations, Process considerations, Product considerations, Types of fixtures, Vise fixtures, Milling fixtures.

Module-4

Fixtures for Automation: Work holders for CNC, Fixturing in FMS: Part holding on Pallets, standard fixtures, pallet changers, pallet pool, flexible fixturing – principles and methodologies, modular fixturing system: T slot based, dowel pin based, fixturing components.

Module-5

Plastics for Tooling Materials: Introduction, Commonly used plastics for tooling, Epoxy plastics tools, Construction methods, Urethane dies, Force calculation for Urethane pressure pads.

Course outcomes:
At the end of the course the student will be able to:

- Select the cutting tool according to requirements and component design.
- Design the tooling requirement and customize the same for developing complex geometry components.
- Explain basic principles of locating & clamping. Discuss General considerations in design of drill jigs.
- Design flexible fixture for automation preprocess.
- Demonstrate application of non-metal fixture.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Cyrol Donaldson, Tool Design -, Tata McGraw Hill, India.

(2) Edward G Hoffman, Fundamentals of Tool Design -, SME, USA.

(3) Joshi, P.H., Jigs & Fixtures, Second Edition, Tata McGraw-Hill, New, Delhi 2004

(4) Hiram E Grant, Jigs and Fixture Tata McGraw-Hill, New Delhi, 2003

Reference Books

(1) William E Boyes, Handbook of Jigs & Fixtures Design -, SME, USA

(2) G.R. Nagpal, Tool Engineering & Design -, Khanna publications

(3) David A.Stephenson, John S. Agapiou, Metal cutting theory and practice, Second edition CRC taylor and Francis publishers

(4) Dr. B.J. Ranganath, Metal cutting and tool design, Vikas publishing house

(5) ASTME; Die Design Hand book; McGraw Hill.

METROLOGY AND COMPUTER AIDED INSPECTION

Course Code	20MCM243	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Metrology and Techniques: Standards in metrology, definitions, Traceability, Characteristics Length & Angular measurements-Review of standard instruments, GD and tolerance procedure-Review of dimension & form tolerance and methods of measurement, Tolerance analysis, Surface metrology Instruments, Methods and new approaches.

Module-2

Laser Applications in Metrology: LASER light source, LASER interferometer, LASER alignment telescope, LASER micrometer, On-line and in-process measurements of diameter, Roundness and surface roughness using LASER, Micro holes and topography measurements.

Module-3

Special Measuring Instruments and Techniques: Optoelectronic devices, contact and non-contact types, Applications in on-line and in-process monitoring systems, Tool wear measurement, Surface measurement, Machine vision, shape identification, Edge detection techniques, Normalisation, gray scale correlation, Template Techniques, Surface roughness using vision system, Interfacing robot and image processing system.

Module-4

Co-ordinate Measuring Machine: Types of CMM, Probes used, Applications, Non-contact CMM using electro optical sensors for dimensional metrology, Non-contact sensors for surface finish measurements, statistical evaluation of data using computer, Data integration of CMM and data logging in computers.

Module-5

Sensors in Inspection: Manufacturing applications of photo detectors, deflection methods-beam detection, Reflex detection, & Proximity detection, Applications of Inductive and Capacitive proximity sensors, Understanding microwave sensing applications laser sensors and limit switches. Advanced sensor technology-Bar code systems, Principles and applications of Colour sensors, electro-magnetic identifier, Tactile sensors, Ultrasonic sensors, Odour sensors

Course outcomes:

At the end of the course the student will be able to:

- Acquire the basic knowledge and practice regarding Quality Assurance through different Computer Aided Inspection and Newest Metrology Precision Instruments.
- Basic information and real time applications of LASER technology in the field.
- Get knowledge of modern measuring technics their application for Digitizing the Production Time.
- Get knowledge applications and principal of CMM mechanics
- Apply various sensors for process control and product quality monitoring

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Fundamentals of dimensional Metrology T. Busch and R. Harlow Delmar, 3e

(2) Engineering Metrology G. Thomas and G. Butter Worth PUB

(3) Sensors and Control systems in Manufacturing SabneSoloman McGraw Hill Book

(4) Measurement systems: Applications & Design Doebelin International Student Edition

Reference Books

(1) Optoelectronics for Technology and Engineering Robert G. Seippel Prentice Hall India

(2) Interface Technology for Computer Controlled Manufacturing processes Ulrich-Rembold, Armbruster and Ulzmann Marcel Dekker Publications, NY 7

(3) Optoelectronics J. Watson Van Nostrand Rein Hold (UK) Company

(4) ASME, Hand book of Industrial Metrology,1998

MACHINE LEARNING			
Course Code	20MCM244	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction, Concept Learning and Decision Trees
Learning Problems – Designing Learning systems, Perspectives and Issues – Concept Learning – Version Spaces and Candidate Elimination Algorithm – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search

Module-2

Neural Networks and Genetic Algorithms: Neural Network Representation – Problems – Perceptron's – Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evolution and Learning.

Module-3

Bayesian and Computational Learning Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier– Bayesian Belief Network – EM Algorithm – Probably Learning – Sample Complexity for Finite and Infinite Hypothesis Spaces – Mistake Bound Model.

Module-4

Instant Based Learning and Learning Set of Rules: K- Nearest Neighbor Learning – Locally Weighted Regression – Radial Basis Functions – Case-Based Reasoning – Sequential Covering Algorithms – Learning Rule Sets – Learning First Order Rules – Learning Sets of First Order Rules – Induction.

Module-5

Analytical Learning and Reinforced Learning: Perfect Domain Theories – Explanation Based Learning – Inductive-Analytical Approaches - FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning.

Course outcomes:
At the end of the course the student will be able to:

- Design the learning system for learning problem with this basic knowledge.
- Apply effectively neural networks and genetic algorithms for appropriate applications.
- Apply bayesian techniques for classification problems
- Derive effectively learning rules for appropriate learning systems.
- Choose and differentiate reinforcement and analytical learning techniques

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- Understand the concept of learning, and various issues related to designing a learning system. Explain the Candidate Elimination algorithm. Discuss about Version spaces and explain Heuristic Search Spaces.
- Understand the concept of neural networks and various relevant issues. Discuss the concept of perceptions and explain back propagation algorithm. Explain the genetic algorithm concept and discuss about hypothesis space search. Understand various evolution and learning models.
- Learn about concept learning and explain various algorithms associated with concept learning. Discuss about various types of classifiers and complexities for hypothesis spaces.
- Explain the concept of k nearest neighbour learning technique and weighted regression. Understand how to apply learning techniques for a set of rules.
- Discuss about various techniques used for analytical and reinforced learning..■

Textbook/ Textbooks

(1) Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013.

(2)EthemAlpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013.

Reference Books

(1) Stephen Marsland, Machine Learning: An Algorithmic Perspective

(2) T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer; 1st Edition, 2001

(3) Tom Mitchell, Machine Learning,

NETWORKING AND IoT

Course Code	20MCM251	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to IoT Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models &APIs.
IoT& M2M Machine to Machine, Difference between IoT and M2M, Softwaredefine Network

Module-2

Network & Communication aspects Wireless medium access issues, MAC protocol survey, Surveyrouting protocols, Sensor deployment & Node discovery, Dataaggregation & dissemination.

Module-3

Challenges in IoT Design challenges, Development challenges, Security challenges,Other challenges.

Module-4

Domain specific applications of IoT Home automation, Industry applications, Surveillance applications,Other IoT applications.

Module-5

Developing IoTs Introduction to Python, Introduction to different IoT tools,Developing applications through IoT tools, Developing sensor basedapplication through embedded system platform, Implementing IoTconcepts with python.

Course outcomes:
At the end of the course the student will be able to:

- Interpret the design aspects and communication models of IoT.
- Examine the design, development, security and deployment challenges pertaining to IoT.
- Analyze the media access control protocols, routing protocols and node discovery strategies used in IOT.
- Explain the data dissemination and aggregation techniques used by IoT sensors.
- Examine the domain specific IoT applications.
- Apply python programming to and develop simple IoT applications

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things.by David Hanes,Cisco Press,2007

(2) Vijay Madisetti, ArshdeepBahga, “Internet of Things: A Hands-On Approach”

Reference Books

(1) Computer Networks; By: Tanenbaum, Andrew S; Pearson Education Pte. Ltd., Delhi, 4th Edition 6

(2) WaltenegusDargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice

(3) Data and Computer Communications; By: Stallings, William; Pearson Education Pte. Ltd., Delhi, 6th Edition

DRIVES AND CONTROL SYSTEMS FOR AUTOMATION			
Course Code	20MCM252	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Working principle of synchronous, Asynchronous & stepper motors, Difference between Induction and servo motors, Torque v/s speed characteristics, Power v/s. Speed characteristics, Vector duty induction motors, Concepts of linear and frameless motors, Selection of feedback system, Duty cycle.

Module-2

Industrials Drives: DC and AC motors operation and selection, method of control and application of brushless DC motor, PMSM, stepper motor, A.C servomotor, selection criteria for servo motor and servo amplifier, universal motor, electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects.

Module-3

Motion Laws For Rotary And Linear Systems: converting rotary to linear system, concepts and principles of ball screws, rack and pinion, belt and pulley, chain drives, gear drives, Selection of converting systems, Dynamic response gearing, and control approaches of Robots, Control loops using Current amplifier

Module-4

Introduction to Programmable Logic Controllers: Definitions of PLC, basic structure of PLC, working principles, data storage methods, inputs / outputs flag processing's, types of variables, definition of firmware, software.

Module-5

Logic, Instructions & Application of PLC: What is logic, Conventional Ladder v/s PLC ladder, series and parallel function of OR, AND, NOT logic, Ex Or logic, Analysis of rung. Timer and Counter Instructions; on delay and Off delay and retentive timer instructions, PLC counter up and down instructions, combining counters and timers, Comparison and data handling instructions, Sequencer instruction, Visualization Systems.

Course outcomes:

At the end of the course the student will be able to:

- Understand the basics of Electric drives
- Explain industrial processes and selection of drives
- Differentiate various control systems
- Develop motor control circuits
- Illustrate computer based industrial control
- Describe Electric traction

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Process Control Instrumentation Technology, Johnson Curties, Prentice hall of India, 8th edition Andrew Parr, Industrial drives, Butterworth – Heineamann

(2) Andrew Parr, Industrial drives, Butterworth – Heineamann

(3) G.K. Dubey. Fundamentals of electrical drives

(4) Programmable Logic Controllers by W.Bolton

Reference Books

(1) Introduction to Programmable Logic Controllers by Garry Dunning, 2nd edition, Thomson, ISBN:981-240-625-5

(2) Instrumentation Engineers Hand Book - Process Control, Bela G Liptak, Chilton book company, Pennsylvania

(3) A.E. Fitzerald , C. Kingsley and S.D Umans, Electric Machinery - McGraw Hill Int. Student edition

(4) S.K. Pillai. A First course on electric drives –Wiley Eastern 1990

(5) Programmable Logic Controllers by Hugh Jack.

VIRTUAL REALITY & AUGMENTED REALITY			
Course Code	20MCM253	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Virtual Reality Fundamental Concept and Components of Virtual Reality, Primary Features and Present Development on Virtual Reality, Multiple Modals of Input and Output Interface in Virtual Reality, Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based 3D Menus & 3DScanner etc; Output -- Visual /Auditory / Haptic Devices.

Module-2

Visual Computation in Virtual Reality (1) Fundamentals of Computer Graphics; Real time rendering technology; Principles of Stereoscopic Display; Software and Hardware Technology on Stereoscopic Display

Module-3

Environment Modeling in Virtual Reality Geometric Modeling; behaviour Simulation; Physically Based Simulation, Haptic & Force Interaction in Virtual Reality Concept of haptic interaction; Principles of touch feedback and force feedback; Typical structure and principles of touch/force feedback facilities in application

Module-4

Augmented Reality System Structure of Augmented Reality; Key Technology in AR; General solution for calculating geometric & illumination consistency in the augmented environment.

Module-5

VR Development Tools Frameworks of Software Development Tools in VR; Modeling Tools for VR; X3D Standard; Vega, MultiGen, Virtools.

Course outcomes:

At the end of the course the student will be able to:

- Describe Virtual Reality concepts and its implication.
- Illustrate the Input-Output interactions in Virtual Reality
- Interpret the need of Visual Computation and role of Computer Graphics in Virtual reality
- Illustrate the role of modeling and simulation in Virtual Reality
- Describe the Architecture of Augmented Reality
- Demonstrate the tools aiding Virtual Reality Frameworks

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.

(2) Edward Angel, "Interactive Computer Graphics: A Top-Down Approach Using OpenGL", Addison-Wesley,

(3) Donald Hearn and Pauline Baker, "Computer Graphics C Version", Pearson Education, 2002.

Reference Book

(1) Sherman, William R. and Alan B. Craig. Understanding Virtual Reality – Interface, Application, and Design, Morgan Kaufmann, 2002.

(2) Fei GAO. Design and Development of Virtual Reality Application System, Tsinghua Press, March 2012.

(3) Guangran LIU. Virtual Reality Technology, Tsinghua Press, Jan. 2011.

WORK SYSTEMS ENGINEERING			
Course Code	20MCM254	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Productivity and Work Study: Productivity concepts and definitions, productivity Vs standard of living, Techniques for productivity improvement, Measuring productivity of an enterprise, materials, land, building, machines and man power.

Methods Study: Selection of job, record - examine - develop, movement of workers, materials, tools for recording the movement of workers.

Module-2

Principles of Motion Economy: Classification of movements, two handed process charts, Micro motion study (therbligs), memo motion study, simo chart, chronocycle graph, recording techniques, define-install-maintain

Module-3

Work Measurement: Definition, basic procedure, techniques, work sampling, determination of sample size, conducting work sampling study, performance rating systems, various types of allowances.

Module-4

Time Study: Equipment, forms, selecting the job and worker, basic steps, classification of elements, breaking the job into elements, determination of sample size.

Techniques for Work Measurements: Stop watch time study, work sampling, PMTS, MTM, analytical estimation.

Module-5

Influence of Working Conditions in Work Study: Layout and housekeeping, lighting, noise, vibration, ergonomics, fire prevention and protection, OSHA.

Course outcomes:

At the end of the course the student will be able to:

- Measure the work flow and use the tools and technics to improve the productivity
- Carryout the micro motion study and optimize the movements.
- Design the sample size to analyses the work study
- Classified the various elements to time study
- Design the pant to more ergonomic way by considering all specified industry norms

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) ILO, "Introduction to Work Study: Indian Adaptation", Oxford and IBH Publishing Company Private Limited, 2008.

(2) Ralph M Barnes, "Motion and Time: Study Design and Measurement of Works", John Wiley & Sons Inc., 2002.

(3) Benjamin W Niebel, "Motion and Time Study - An Introduction to Methods, Time Study and Wage Payment", Richard Dirwin, Illinois, 1958.

Reference Books

(1) Barnes, Raeph.m., "Motion and Time Study – Design and Measurement of Work ", John Wiley &sons, New York, 1990

(2) Mc.Cormick, E.J., "Human Factors in Engineering and Design", Mc.Graw Hill.

ROBOTICS AND AUTOMATION LABORATORY			
Course Code	20MCML26	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl.NO	Experiments
	PART A (Minimum Five)
1	Experimental study on direct operation of Single acting and Double acting cylinder
2	Design a circuit for Speed Control of Double acting cylinder meter-in by employing 4/2 DC solenoid valve Design a circuit for Speed Control of Double acting cylinder meter-out by employing 4/3 DC solenoid valve
3	Design a circuit for Speed Control of hydraulic motor meter-in circuit by employing 4/2 DC valve Design a circuit for Speed Control of hydraulic motor meter-out circuit by employing 4/3 DC valve
4	Study of power steering apparatus
5	Study of Shock single acting and double acting and double acting shock absorber
6	Study of air suspension
	PART B (Minimum Five)
7	PLC programing on Automatic Bottle filling system
8	Application of PLC for Traffic Light Control
9	Develop the PLC Program to control level of water level controller
10	Develop the PLC Program to control batch process reactor
11	lift control system using PLC
12	Starting Three Phase induction Motors via Star-Delta Starter using PLC
13	Pressure Control Using PLC
14	Temperature Control Using PLC
	PART C (Optional)
15	Substation Automation with SCADA
16	Robotic Programming for various functions Fanuc/Simons controller

Course outcomes:

At the end of the course the student will be able to:

- Write part programs for NC machining
- Program and control robot path for industrial applications.
- Simulate manufacturing processes before being put to actual machining

TECHNICAL SEMINAR			
Course Code	20MCM27	CIE Marks	100
Number of contact Hours/week (L:P:SDA)	0:2:0	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.

Marks distribution for CIE of the course 20XXX27 seminar:

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks

*** END OF II SEMESTER***

ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEM IN AUTOMATION			
Course Code	20MCM31	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: artificial intelligence in cad, applications of artificial intelligence in design. Scope and history of AI. Structure of an expert system, building an expert system. Strategies for knowledge acquisition, components of knowledge. Knowledge representation, production systems, decision tables, frame systems.

Module-2

Knowledge Representations: knowledge representations process, purposes, contexts and agents, knowledge soup, knowledge acquisition and sharing. Knowledge representation languages, issues in knowledge representation. A network representation language. LISP: Introduction to LISP. Search strategies in LISP, a recursive unification function. Interpreters and embedded languages. Logic programming in LISP. An expert system shell in LISP.

Module-3

Decision Support Systems: introduction. Basis of decision making. Typical progressive models. Intelligent models, life-cycle values. Total life-cycle cost. Compatibility analysis. Sensitivity analysis. Life-cycle ranking or rating scheme.

Module-4

Learning Processes and AI Algorithms: the general problem solver and difference tables. Resolution theorem proving. Machine learning, perceptron learning, back propagation learning, and competitive learning. The genetic algorithm: the genetic programming. Artificial life and society based learning. Methods of inference, inexact reasoning.

Module-5

Knowledge Based Design Aids: inference process, backward chaining, forward chaining, hybrid chaining. Expert system shells, feature based modeling, feature recognition, design by features, and application of feature based models.
Design of expert systems and applications: benefits and examples of expert systems. Design of expert systems, introduction to clips, pattern matching, modular design and execution control fuzzy logic, typical expert system MYCIN, DENDRAL, PROSPECTOR.

Course outcomes:

At the end of the course the student will be able to:

- Understand problem solving methods, state space problems and search methods.
- Understand knowledge acquisition and representation methods.
- Apply knowledge on decision making.
- Assess critically the techniques presented and apply them to real world problems.
- Develop knowledge of decision making and learning methods.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

Textbook/ Textbooks

(1) A guide to Expert Systems – Donald A Waterman, Addison Wesley, 1st edition, 2002.

(2) Principles of Artificial Intelligence – Springer-Verlag, Berlin, 1982.

(3) Introduction to Artificial Intelligence and Expert Systems – DAN.W.Patterson, PHI, 2nd edition, 2009.

Reference Books

(1) Understanding Decision Support System and Expert Systems-McGraw Hill, 2nd edition, 1993.

(2) Artificial Intelligence – Elain Rich, McGraw Hill, 3rd edition, 2010.

(3) Artificial Intelligence- George.F.Luger, Pearson Education, Asia, 3rd Edition,2009.

LOGISTICS AND SUPPLY CHAIN MANAGEMENT			
Course Code	20MCM321	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Definition of logistics and supply chain management, decision phases in a supply chain, objectives of SCM, examples of supply chains, supply chain drivers, supply chain integration, supply chain performance measures.
Logistics Network Design: Role of distribution in supply chain, distribution network design, factors influencing distribution network design, distribution networks in practice, network design in the supply chain, factors influencing the network design, framework for network design, models for facility location and capacity allocation, Impact of uncertainty on network design.

Module-2

Coordinated Product And Supply Chain Design: General framework - design for logistics - standardization - push-pull boundary - supplier integration into new product development - keys to effective supplier integration - mass customization - meaning - mass customization and supply chain management.

Module-3

Strategic Alliances: Framework for strategic alliances - Third Party Logistics - 3PL issues and requirements - retailer - supplier partnerships - issues in retailer - supplier partnerships - distributor integration - types and issues of distributor integration.

Module-4

Inventory Management: Cycle inventory, economies of scale to exploit fixed costs, quantity discounts, example problems, multi-echelon inventory, safety inventory in supply chain, safety level estimation, supply uncertainty, data aggregation, replenishment policies, managing safety inventory in practice, product availability, optimal level, affecting factors, supply chain contracts - Bull whip effect.

Module-5

Technologies For SCM: Information Technology (IT) - Infrastructure - Interface devices - System architecture - Electronic commerce - IT for supply chain excellence - Service oriented architecture - Radio Frequency Identification (RFID) - Impact of internet.

Course outcomes:
At the end of the course the student will be able to:

- Demonstrate a clear understanding of the key concepts applied in logistics and supply chain management.
- To highlight the importance of all activities of the supply chain and an understanding of concepts like inbound and outbound logistics, offshore and inshore logistics.
- To develop skills for planning, designing the operational facilities of supply chain with the analytical and critical understanding
- Apply various tools and technics to plan and maintain the inventory
- Demonstrate application information technology in SCM.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Simchi - Levi Davi, Kaminsky Philip and Simchi-Levi Edith, “Designing and Managing the Supply Chain”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2012.

(2) Sunil Chopra and Peter Meindl, “Supply Chain Management”, Prentice Hall, New Jersey, 2010.

(3) Sadler I, “Logistics and Supply Chain Integration”, Sage Publishers, 2007.

(4) David J.Bloomberg , Stephen Lemay and Joe B.Hanna, “Logistics” PHI

Reference Books

(1) Jeremy F.Shapiro, “Modeling the Supply Chain”, Thomson Duxbury

(2) Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management", PHI,

(3) James B.Ayers, “Handbook of Supply Chain Management”, St.Lucle press

3D PRINTING AND RAPID MANUFACTURING

Course Code	20MCM322	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems

Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details,

Module-2

Selective Laser Sintering and Fusion Deposition Modeling: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modeling, Process parameter.

Module-3

Solid Ground Curing: Principle of operation, Machine details, Applications. **Laminated Object Manufacturing:** Principle of operation. Process details, application.

Module-4

Concepts Modelers: Principle, Thermal jet printer, Sander's model market. GenisysXs printer HP system 5, object Quadra systems.

Module-5

Rapid Tooling:. Indirect Rapid tooling -Silicone rubber tooling –Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, etc Direct Rapid Tooling., AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling.

RP Process Optimization: Factors influencing accuracy. Data preparation errors, Partbuilding errors, Error in finishing.

Course outcomes:

At the end of the course the student will be able to:

- Analyse, design and evaluate engineering products using the knowledge of mathematics, science, engineering and IT tools.
- Solve complex manufacturing problems for significant technological and societal development
- Apply additive manufacturing concepts to all possible fields of human life.
- Engage in lifelong learning to adapt to changing needs for professional advancement.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Stereo lithography and other RP & M Technologies- Paul F. Jacobs, SME, NY 1996.

(2) Rapid Manufacturing- Flham D.T &DinjoyS. S, Verlog London 2001.

(3) Rapid automated- Lament wood, Indus press New York, 1st edition, 1993

Reference Books

(1) D.T. Pham and S.S. Dimov, "Rapid Manufacturing", Springer, 2001

(2) Chua C.K., Leong K.F. and LIM C.S Rapid prototyping: Principles an Applications, World Scientific publications, 3rdEd., 2010

(3) Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer, 2nd Ed, 2014

RELIABILITY AND MAINTENANCE ENGINEERING

Course Code	20MCM323	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Reliability Engineering: System reliability - series, parallel and mixed configuration, Block diagram, r-out-of-n structure, Solving problems using mathematical models. Reliability improvement and allocation-Difficulty in achieving reliability, Method of improving reliability during design, different techniques available to improve reliability, Reliability – Cost trade off, Prediction and analysis, Problems.

Module-2

Maintainability, Availability & Failure Analysis: Introduction, Techniques available to improve maintainability & availability, trade off among reliability, maintainability & availability and analysis. Defect generation – Types of failures, defects reporting and recording, Defect analysis, Failure analysis, Equipment down time analysis, Breakdown analysis, TA, FMEA, FMECA.

Module-3

Maintenance Planning and Replacement: Maintenance planning – Overhaul and repair; Meaning and difference, Optimal overhaul/Repair/Replace maintenance policy for equipment subject to breakdown, Replacement decisions – Optimal interval between preventive replacements of equipment subject to breakdown, group replacement.

Module-4

Maintenance Systems: Fixed time maintenance, Opportunity maintenance, design out maintenance, Total productive maintenance, Inspection decision – Optimal inspection frequency, non-destructive inspection, PERT & CPM in maintenance, Concept of terotechnology.

Module-5

Mechanical Fault Diagnosis by Condition Monitoring Techniques: Thermography, Radiography, Ferrography, Acoustic emission monitoring, Noise monitoring. On line monitoring and diagnostic systems. Condition monitoring in power plants, chemical plants and petrochemical plants.

Course outcomes:

At the end of the course the student will be able to:

- Describe various methods of reliability to predict maintenance requirements and cost effectiveness.
- Predict and analyze the failure and maintenance requirement using various techniques
- Plan the schedule the maintenance with minimum breakdown time
- Apply various tool and techniques monitor the condition of the equipment
- Describe case studies related to condition monitoring of various manufacturing and process engineering systems.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Optimization theory & Applications/ S.S Rao/ New Age International

(2) Introductory to operation research/Kasan& Kumar/Springar

(3) Optimization Techniques theory & practice/M.C Joshi, K.M.Moudgalya/Narosa Publications.

(4) Operation Research/H.A. Taha/TMH

Reference Books

(1) Optimization in operations research/R.L Rardin.

(2) Optimization Techniques/Benugundu&Chandraputla/Person Asia.

(3) Optimization Techniques /Benugundu&Chandraputla / Pearson Asia.

PRODUCT DESIGN			
Course Code	20MCM324	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.

Development Processes and Organizations: A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

Module-2

Product Planning: The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications**.**

Module-3

Concept Generation: The activity of concept generation clarify the problem, search externally, search internally, explore systematically, and reflect on the results and the process.

Concept Selection: Overview of methodology, concept screening, and concept scoring,

Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

Module-4

Product Architecture: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

Industrial design: Assessing the need for industrial design, the impact of industrial design, industrial design, process, managing the industrial design process, assessing the quality of industrial design

Module-5

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes.

Product Development Economics**:** Elements of economic analysis, base case financial mode. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.

Managing Projects: Understanding and representing task, baseline project planning, accelerating projects, project execution, cost-mortem project evaluation.

Course outcomes:

At the end of the course the student will be able to:

- Design and develop the product using various development process
- Analyze the data and develop the process with in a stipulated time
- Describe concept generation, selection and testing process
- Develop the product architecture and industrial design process
- Analyze the economical aspect of product development project planning

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Product Design and Development- Karl. T.Ulrich, Steven D Eppinger**,** Irwin McGrawHill, 5th edition, 2011

(2) Product Design and Manufacturing- A C Chitale and R C Gupta, PHI 3rd Edition, 2003.

Reference Books

(1) New Product Development- Timjones. Butterworth Heinmann, Oxford. UCI. 1997

(2) Product Design for Manufacture and Assembly-GeofferyBoothroyd, Peter Dewhurst and Winston Knight**,** 3rd

CYBER SECURITY FOR PHYSICAL SYSTEM AN INTRODUCTION

Course Code	20MCM331	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Software and System Security : Control hijacking attacks – buffer overflow, integer overflow, bypassing browser memory protection; Sandboxing and Isolation; and techniques for writing robust application software; Security vulnerability detection tools, and techniques – program analysis (static, concolic and dynamic analysis); Privilege, access control, and Operating System Security; Exploitation techniques, and Fuzzing.

Module-2

Network Security & Web Security: Security Issues in TCP/IP – TCP, DNS, Routing (Topics such as basic problems of security in TCP/IP, IPsec, BGP Security, DNS Cache poisoning etc); Network Defense tools – Firewalls, Intrusion Detection, Filtering; DNS Sec, NSec3, distributed firewalls, intrusion detection tools: Threat Models, Denial of Service Attacks, DOS-proof network architecture; Security architecture of World Wide Web, security architecture of web servers, and Web Clients: Web Application Security – cross site scripting attacks, cross site request forgery, SQL Injection Attacks: Content Security Policies (CSP) in web: Session management and user authentication, session integrity: Https, SSL/TLS: Threat Modeling, Attack surfaces, and other comprehensive approaches to network design for security.

Module-3

Security in Mobile Platforms: Android vs. IoS security model, threat models, information tracking, rootkits: Threats in mobile applications, analyser for mobile apps to discover security vulnerabilities; Viruses, spywares, and key loggers and malware detection.

Module-4

Introduction to Hardware Security, Supply Chain Security: Threats of Hardware Trojans and Supply Chain Security; Side Channel Analysis based Threats, and attacks.

Module-5

Issues in Critical Infrastructure and SCADA Security: Security issues in SCADA; IP Convergence Cyber Physical System Security threats: Threat models in SCADA and various protection approaches; Machine learning and SCADA Security.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate physical system security from the cyber attack
- Demonstrate network and web security threat models and corrective modules
- Demonstrate various mobile platforms discover security vulnerabilities
- Understand and analyse the hardware security requirement
- Describe the application of SCADA protection approaches

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Cybersecurity: Understanding cybercrime, phenomenon, challenges, and legal response ITU Report, November' 2014 *www.itu.int/ITU-D/cyb/cybersecurity/legislation.html*

(2) Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, By Nina Godbole and SunitBelapure , Wiley India

Reference Books

(1) Network Security Through Data Analysis: From Data to Action (2nd Edition)

(2) Best Practices for Securing Infrastructure (1st Edition)

DIGITAL IMAGE PROCESSING & MACHINE VISION

Course Code	20MCM332	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Fundamentals of Image formation, components of image processing system, image sampling and quantization

Image Enhancement in the spatial domain: Basic gray-level transformation, histogram processing, arithmetic and logic operators, basic spatial filtering, smoothing and sharpening spatial filters.

Module-2

Image Restoration: A model of the image degradation/restoration process, noise models, restoration in the presence of noise–only spatial filtering, Weiner filtering, constrained least squares filtering, geometric transforms; Introduction to the image enhance in frequency domain.

Module-3

Morphological Image Processing: Preliminaries, dilation, erosion, open and closing, basic morphologic algorithms, The Hit-or-Miss Transformation

Module-4

Image Segmentation: Detection of discontinuous, edge linking and boundary detection, thresholding, Hough Transform Line Detection and Linking, region–based segmentation.

Module-5

Machine vision: Introduction, definition, Active vision system, Machine vision components, hardware's and algorithms, image function and characteristics, segmentation, data reduction, feature extraction, edge detection, image recognition and decisions, m/c learning, application of machine vision such as in inspection of parts, identification, industrial robot control, mobile robot application, Competing technologies, CCD line scan and area scan sensor, Videcon and other cameras, Triangulation geometry, resolution passive and active stereo imaging, laser scanner, data processing.

Course outcomes:

At the end of the course the student will be able to:

- Explain the fundamentals of digital image and its processing
- Perform image enhancement techniques in spatial and frequency domain.
- Elucidate the mathematical modelling of image restoration and compression
- Apply the concept of image segmentation.
- Understand and document needs for specific machine vision system
- Develop machine vision system based on requirement

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) Computer Vision: Algorithms and Applications , Richard Szeliski , 2010 Springer

(2) Digital Image Processing, RafealC.Gonzalez, Richard E.Woods, Second Edition, Pearson Education/PHI

(3) Digital Image Processing using Matlab, RafealC.Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson

Reference Books

(1) Computer Vision - A modern approach by D. Forsyth and J. Ponce, Prentice Hall 2. Robot Vision by B. K. P. Horn, McGraw-Hill.

(2) Image Processing, Analysis, and Machine Vision, Milan Sonka, Vaclav Hlavac and Roger Boyle, Second Edition, Thomson Learning.

(3) Introduction to Digital Image Processing with Matlab, Alasdair McAndrew, Thomson Course Technology

(4) Computer Vision and Image Processing, Adrian Low, Second Edition, B.S.Publications

VIRTUAL INSTRUMENTATION			
Course Code	20MCM333	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Virtual Instrumentation: An introduction

Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, and comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems.

Module-2

VI programming techniques:

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

Module-3

Data acquisition basics:

Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

Module-4

VI Interface requirements:

Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

Module-5

VI toolsets:

Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control

Course outcomes:

At the end of the course the student will be able to:

- Explain virtual instrument concepts.
- Select proper data acquisition hardware and Configure data acquisition.
- Familiarize the basics and interfacing of VI
- Discuss operating systems required for virtual instrumentation.
- Create virtual instruments for practical works

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) LabVIEW Graphical Programming, Gary Johnson, Second edition, McGraw Hill, Newyork, 1997.

(2) LabVIEW based Advanced Instrumentation Systems, S. Sumathi and P. Surekha, Spinger.

(3) PC Interfacing for Data Acquisition and Process ControlGupta S.and Gupta J.P Instrument society of America, 1994

Reference Books

(1) PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Kevin James, Newnes, 2000.

(2) WEB RESOURCES: www.ni.com

(3) LabVIEW for everyone, Lisa K. wells & Jeffrey Travis Prentice Hall, New Jersey, 1997.

OPERATIONS RESEARCH			
Course Code	20MCM334	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

Module-2

Formulation of a LPP - Graphical solution revised simplex method – duality theory - dual simplex method - sensitivity analysis - parametric programming.

Module-3

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.

Module-4

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models – Geometric Programming

Module-5

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

Course outcomes:

At the end of the course the student will be able to:

- Understand the meaning, definitions, scope, need, phases and techniques of operations research.
- Formulate as L.P.P and derive optimal solutions to linear programming problems by graphical method, Simplex method, Big-M method and Dual Simplex method.
- Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks.
- Determine minimum processing times for sequencing
- Solve problems on game theory for pure and mixed strategy under competitive environment.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) H.A. Taha, Operations Research, an Introduction, PHI, 2008

(2) HM. Wagner, Principles of Operations Research, PHI, Delhi, 1982.

(3) JC. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008

(4) Hitler Libermann Operations Research: McGraw Hill Pub. 2009

Reference Books

(1) Pannerselvam, Operations Research: Prentice Hall of India 2010

(2) Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

PROJECT WORK PHASE – 1			
Course Code	20MCM34	CIE Marks	100
Number of contact Hours/Week	2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

MINI PROJECT			
Course Code	20MCM35	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	02	Exam Hours/Batch	03

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

At the end of the course the student will be able to:

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Mini - Project:

The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination

SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.

INTERNSHIP / PROFESSIONAL PRACTICE			
Course Code	20MCMI36	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	06	Exam Hours	03

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

To put theory into practice.

To expand thinking and broaden the knowledge and skills acquired through course work in the field.

To relate to, interact with, and learn from current professionals in the field.

To gain a greater understanding of the duties and responsibilities of a professional.

To understand and adhere to professional standards in the field.

To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.

To identify personal strengths and weaknesses.

To develop the initiative and motivation to be a self-starter and work independently.■

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Course outcomes:

At the end of the course the student will be able to:

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Semester End Examination

SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.

PROJECT WORK PHASE -2			
Course Code	20MCM41	CIE Marks	40
Number of contact Hours/Week	4	SEE Marks	60
Credits	20	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism. ■

Course outcomes:

At the end of the course the student will be able to:

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it. ■

Continuous Internal Evaluation:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■