I Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **17EPMC701** Course Title: **Manufacturing Systems and Automation**

L-T-P**: 3-0-0** Credits: **3** Contact Hrs: **3 hrs/week**

ISA Marks: **50** ESA Marks: **50** Total Marks: **100**

Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

Introduction: Production system facilities, Manufacturing support systems, Automation in production system, Automation principles and strategies, Manufacturing operations, Basic elements of an automated system, Advanced automation functions, Levels of automation.

Material handling and identification technology: Considerations in material handling system design, 10 principles of material handling, Automated guided vehicle systems, Conveyor systems, Analysis of material transport system, Automated storage systems, Engineering analysis of storage system. Components of manufacturing systems, Single station automated cells, Applications and analysis of single station cells.

Flexible manufacturing systems: FMS components, FMS application and benefits, Quantitative analysis of flexible manufacturing systems.

Industrial control systems: Sensors, Actuators, Drives and other control system components. Electro-hydraulic and Electro-pneumatics in manufacturing automations

Machine vision systems: Importance of machine vision system in manufacturing automation.

Role of microcontrollers in manufacturing automation system: Microcontroller architecture, interfacing sensors and actuators with microcontroller for industrial automation, Microcontroller programming.

PLCs in manufacturing automation: Application of programmable logic controllers in manufacturing automation, PLC basic and advanced ladder logic programming using RsLogix and CoDeSys format, Usage of timers, counters, sequencing, and interlocking, latching, master control relay for developing programs for manufacturing automation. Temperature control, valve sequencing, conveyor belt control, control of a process etc

SCADA for Automation: Elements of SCADA, Benefits of SCADA, Applications, Types of SCADA systems, Features and functions of SCADA, Building applications using SCADA for manufacturing automation.

References:

1. Grover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education Asia.
2. Grover M.P., Weiss M. M., Nagel R.N. and Odrey N.G., "Industrial Robotics, Technology, Programming and Applications", Mc Graw Hill Book Publications.
3. Krishna Kant, "Computer Based Industrial Control" PHI.
4. W. Bolton , "Programmable Logic Controllers" Fifth Edition, Elsevier
5. Vijay R. Jadhav, "Programmable Logic Controller", Second Edition, Khanna Publishers.

I Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **17EPMC702** Course Title: **CNC Machining Technology and Additive Manufacturing**

L-T-P**: 4-0-0** Credits: **4** Contact Hrs: **4 hrs/week**

ISA Marks: **50** ESA Marks: **50** Total Marks: **100**

Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Structure of CNC Machine Tools: Evolution of CNC Technology, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre-features and applications, Automatic tool changers and Multiple pallet system, types of control systems, CNC controllers, characteristics, interpolators. CNC Machine building, structural details, configuration and design, guide ways –Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion – Screw and nut, recirculating ball screw, rack and pinion, spindle assembly, torque transmission elements – gears, timing belts, flexible couplings, Bearings. Swarf removal and safety considerations

Drives and Tooling Systems: Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives – stepper motor, servo principle, DC and AC servomotors, Open loop and closed loop control, Tooling requirements for turning and machining centres, Qualified, semi qualified and preset tooling, coolant fed tooling system, work holding devices for rotating and fixed work parts, modular fixtures.

Feedback systems and Adaptive Control: Axis measuring system, Adaptive control with constraints (ACC), Adaptive control with optimization (ACO), Geometric adaptive control (GAC), Variable gain AC systems-stability problem, estimator algorithm, variable gain algorithm,

CNC Programming: G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre, generation of CNC codes from CAM packages. Basics of APT

Additive manufacturing (AM) processes: AM based rapid prototyping (RP) Systems like Stereo-lithography, Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Laminated Object Manufacturing (LOM), 3-D Printing, and LENS etc.

Role of additive manufacturing and rapid prototyping in product design and development: Solid modeling techniques for additive manufacturing with comparison, advantages and disadvantages, Process planning for rapid prototyping, STL file generation, Slicing and various slicing, procedures.

Accuracy issues in additive manufacturing: Properties of metallic and nonmetallic additive manufactured surfaces, Stress induced in additive manufacturing (AM) processes. Surface roughness problem in rapid prototyping, Part deposition orientation and issues like accuracy, surface finish, build time, support structure, cost etc.

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References:

1. Radhakrishnan P "Computer Numerical Control Machines", New Central Book Agency.
2. Rao P.N., "CAD/CAM", Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Pabla, B.S. & Adithan, M. "CNC Machines", New Age Publishers, New Delhi.
4. Warren. S. Seames, "Computer Numerical Control: Concepts and Programming", 4th edition, Delmar Thomson Learning Inc.
5. James Madison, "CNC Machining Hand Book", Industrial Press Inc.
6. Peter Smid, "CNC Programming Hand book", Industrial Press Inc., 2000
7. Chua, C.K., Leong, K.F., "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley and Sons Inc.
8. Hopkinson, N., Hague, R.J.M. and Dickens, P.M., "Rapid Manufacturing and Industrial Revolution for the Digital Age", John Wiley and Sons Ltd, Chichester.
9. Gebhardt, A., "Rapid Prototyping", Hanser Gardner Publications, Inc., Cincinnati.
10. Noorani, R., "Rapid Prototyping: Principles and Applications", John Wiley & Sons, Inc., New Jersey.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPMC703**		Course Title: **Operations Management**
L-T-P**: 3-1-0**	Credits: **4**	Contact Hrs: **5 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**	Tutorial Hrs: **24 hrs**	Exam Duration: **3 hrs**

Overview of Operations Management: Functional sub systems of organizations, Systems concept of production, Types of production systems, Productivity, Strategic management.

Product Design and Analysis: New product development, Process Planning and Design, Value analysis and Value Engineering, Standardization, Simplification, Make or Buy decisions, Ergonomic considerations in Product design.

Capacity Planning and Investment Decisions: Capacity planning and strategies, Investment formulas and comparisons of alternatives.

Forecasting: Nature and use of forecasting, Measures of Forecasting, Factors affecting forecasting, Types and models of forecasting

Facility Location and Layout: Factors influencing plant location, location evaluation methods, Different types of lay outs for operations and production, arrangement of facilities within the department, CRAFT, ALDEP, CORELAP etc.

Aggregate Planning and Master Production Scheduling: Nature of aggregate planning, Methods of aggregate planning, Approaches to aggregate planning –graphical, empirical and optimization, Development of MPS, MRP-I and MRP-II.

Inventory Analysis and Control: ABC inventory systems, Inventory models, EOQ models for purchased and manufactured parts, lot sizing techniques.

Scheduling and Controlling: Objectives in scheduling, Major steps involved, Information systems linkages in production planning and control , Production control in repetitive, batch / flow shop and job shop scheduling environment - SPT, EDD, WMFT.

Project Planning and Management: Phases of project planning, Evolution of network planning techniques - Critical Path Method (CPM) and Project Evolution and Review Technique (PERT), Crashing of project network, Project scheduling with constrained resources –Graphical Evolution and Review Technique (GERT), Project monitoring, Line balance.

References

1. Vollman.T.E., “Manufacturing Planning & Control Systems”, McGraw-Hill.
2. Dilworth. B. James., “Operations Management – Design, Planning and Control for Manufacturing and services”, McGraw Hill Inc., New Delhi.
3. Bedworth D.D., “Integrated production control systems: management, analysis,design”, John Wiley & sons, New York
4. Panneerselvam. R., “Production and Operations Management”, Prentice Hall. gement

Tutorial Exercises:

Forecasting, Facility location and layout, Aggregate Planning and MPS, Inventory Control, Scheduling and Controlling, Project Planning and Management

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPMC704**		Course Title: **World Class Manufacturing**
L-T-P**: 4-0-0**	Credits: **4**	Contact Hrs: **4 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50 hrs**		Exam Duration: **3 hrs**

World-Class Manufacturing (WCM): Manufacturing Excellence and Competitiveness, Meaning of World-class, Competing in World markets, WCM Techniques, Review of frameworks for WCM, Justification of WCM, Case studies.

Lean Manufacturing: Elements of Lean manufacturing: Stability, Standardized work, Just in time, Jidoka, Hoshin Planning, The culture of lean, Implementation of Lean manufacturing: Implementation framework for the Lean manufacturing, DEMAIC process, Case studies.

Total Productive Maintenance (TPM): An overview of various maintenance systems, Evolution of TPM, Productivity and TP, OEE, TPM and TQC, Small Group Activities, Pillars of TQM, Kobsu-Kaizen (Continuous Improvement), Jishu-Hozen (Autonomous maintenance), Planned Maintenance System, Skill upgrade training, Initial control (Equipment Life cycle management), Hinshitsu-Hozen (Quality Maintenance), Office TPM, Total safety management, Implementation, 5s,Case studies,

Total Quality Management (TQM): Understanding quality, Evolution of TQM, Framework for TQM, Commitment and leadership, Customer satisfaction, Employee involvement, Continuous process improvement, Supplier partnership, Performance, measures, Formulation and implementation of TQM

Concurrent engineering, Design Failure Mode Effects Analysis (DFMEA) and Process Failure Mode Effects Analysis (PFMEA), Manufacturing Quality in Supply Chain Management, Manufacturing Quality and its importance in Product Life Cycle, Case studies

References:

1. Todd J., "World Class Manufacturing", McGraw Hill, London.
2. Schonberger R.J., "World Class Manufacturing - The Lesson of Simplicity", Free Press.
3. Marcus, A. A., “Management Strategy: Achieving Sustained Competitive Advantage”, New York: McGraw-Hill/Irwin.
4. Voss C.A., "Manufacturing Strategy: Process and Content", Chapman & Hall, London.
5. Pascal D., "Lean production simplified", 2nd Edition, Productivity Press.
6. Nakajima S., "Introduction to Total Productive Maintenance", Productivity Press.
7. Besterfield D. H., et al., "Total Quality Management", Pearson Education.
8. Mohanty R.P. and Deshmukh S: G., "Advanced Operations Management", Pearson Education.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME701** Course Title: **Intelligent Manufacturing Systems**
L-T-P**: 4-0-0** Credits: **4** Contact Hrs: **4 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Introduction: Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, -CAD, CAPP, CAM, CAQC, ASRS,Manufacturing Communication Systems -MAP/TOP, OSI Model, Data Redundancy, Top-down and Bottom-up Approach, Volume of Information, Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

Components of Knowledge Based Systems: Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

Machine Learning: Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks -Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing

Automated Process Planning: Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process Planning. Knowledge Based System for Equipment Selection (KBSES), Manufacturing System Design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving Approach in KBSES, Structure of the KRSES

Group Technology: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology, Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) —Data Base, Knowledge Base, Clustering Algorithm.

References:

1. Andrew Kusiak, “Intelligent Manufacturing Systems”, Prentice Hall.
2. Yagna Narayana , “Artificial Neural Networks”, PHI.
3. Groover M.P, “Automation, Production Systems and CIM”, PHI.
4. Simon Hhaykin, “Neural networks: A comprehensive foundation”, PHI.
5. James A Freeman & David M S Kapura, “Neural Networks”, Pearson Education.
6. Jacek M. Zurada, “Introduction to Artificial Neural Systems”, JAICO Publishing House.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME702** Course Title: **Design for Manufacture and Assembly**
L-T-P**: 4-0-0** Credits: **4** Contact Hrs: **4 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Tolerance Analysis: Introduction – Concepts, definitions and relationships of tolerancing – Matching design tolerances with appropriate manufacturing process – manufacturing process capability metrics – Worst care, statistical tolerance Analysis – Linear and Non-Linear Analysis – Sensitivity Analysis – Taguchi's Approach to tolerance design.

Tolerance Allocation: Tolerance synthesis – Computer Aided tolerancing – Traditional cost based analysis – Taguchi's quality loss function – Application of the Quadratic loss function to Tolerancing – Principles of selective Assembly.

GD&T: Fundamentals of geometric dimensioning and tolerancing – Rules and concepts of GD&T – Form controls – Datum systems – Orientation controls – Tolerance of position – Concentricity and symmetry controls – Run out controls – Profile controls.

Tolerance Charting: Nature of the tolerance buildup – structure and setup of the tolerance chart – piece part sketches for tolerance charts – Arithmetic ground rules for tolerance charts – Determination of Required balance dimensions – Determination of Mean working Dimensions – Automatic tolerance charting – Tolerance charting of Angular surfaces.

Manufacturing Guidelines: DFM guidelines for casting, weldment design – Formed metal components – Turned parts – Milled, Drilled parts – Non metallic parts – Computer Aided DFM software – Boothroyd and Dewhurst method of DFMA – DCS – Vis/VSA – 3D Dimensional control – Statistical tolerance Analysis Software –Applications.

References:

1. M. Creveling, "Tolerance Design – A handbook for Developing Optimal Specifications", Addison Wesley.
2. James D. Meadows, "Geometric Dimensioning and Tolerancing., Marcel Dekker Inc..
3. Alex Krulikowski, "Fundamentals GD&T.", Delmar Thomson Learning.
4. James G. Bralla"Handbook of Product Design for Manufacturing", McGraw Hill.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME703** Course Title: **Design and Analysis of Experiments**
L-T-P**: 4-0-0** Credits: **4** Contact Hrs: **4 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Overview: Taguchi's approach to quality and quality loss function, noise factors and average quality loss, exploiting non linearity, classification of parameters

Analysis of variance: No-Way ANOVA, One-Way ANOVA, Two-Way ANOVA and Three-Way ANOVA

Two Level Experiments: Two factor factorial design, model adequacy checking and estimating model parameters, 2^2 full factorial design, 2^3 full factorial design, 2^k full factorial design and Two level fractional factorial design, General 2^{k-p} fractional factorial design.

Steps in Robust Design: Identification of process and its main function, Noise factors and testing conditions, Control factors and their levels, Matrix experiment and data analysis plan, Conducting the experiment and data analysis, Verifying experiment and future plan.

Signal to Noise Ratios: Comparison of the quality of two process conditions, Relationship between Signal to Noise Ratio and quality loss after adjustment, Identification of a scaling factor, Signal to Noise Ratios for static problems, Signal to Noise Ratios for dynamic problems, Analysis of ordered categorical data.

Taguchi inner and outer arrays, orthogonal arrays and fractional factorial designs, Parameter design and tolerance design, Analysis of inner/outer array experiment, Alternative inner/outer orthogonal array experiments.

Constructing orthogonal arrays, Dummy level technique, Compound factor method, Linear graphs and Interaction assignment, Modification of linear graphs, Column merging method, Branching design.

References:

1. Montgomery, D. C., "Design and Analysis of Experiments", John Wiley & Sons.
2. Khuri A. I. and Cornell J. A. "Response Surfaces: Designs and Analyses, Marcel Dekker, Inc., New York.
3. Myers R. H., Montogomery, D. C. and Anderson-Cook C. M. "Response Surface Methodology: Process and Product Optimization Using Designed Experiments", John Wiley & sons, Inc., New York.
4. Mason R. L., Gunst, R. F., Hess J. L., "Statistical design and Analysis of Experiments With Applications to Engineering and SISAnce", John Wiley & sons, Inc., New York.
5. Phadke M. S., "Quality Engineering using Robust Design", Prentice Hall PTR Englewood Cliffs, New Jersy.
6. Ross P. J., "Taguchi Techniques for Quality Engineering", McGraw -Hill International.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME704** Course Title: **Finite Element Analysis**
L-T-P**: 4-0-0** Credits: **4** Contact Hrs: **4 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Introduction: Introduction to FEA, General FEM procedure, Approximate solutions of differential equations: FDM method, W-R technique, collocation least square sub-domain and Galerkin method Numerical integration, Gauss Quadrature in 2-D and 3-D, Structure of FEA program, Pre and Post processor, commercially available, standard packages, and desirable features of FEA packages, Principal of minimum total potential, elements of variational calculus, minimization of functional, Rayleigh-Ritz method, Formulation of elemental matrix equation, and assembly concepts.

One Dimensional FEM: Coordinate system: Global, local, natural coordinate system, Shape functions: Polynomial shape functions, Natural co-ordinate and coordinate transformation, Linear quadratic and cubic elements, Shape functions using Lagrange polynomials. Convergence and compatibility requirement of shape functions, One dimensional field problems: structural analysis (step-bar, taper-bar), Structural analysis with temperature effect, Thermal analysis.

Two Dimensional FEM: Trusses, Thermal effects in truss members, Beams, Two dimensional finite elements formulations, Three noded triangular element, Four-noded rectangular element, Four-noded quadrilateral element, derivation of shape functions: natural coordinates, triangular elements, and quadrilateral elements, Six-noded triangular elements, Eight-noded quadrilateral elements, Nine noded quadrilateral element, Strain displacement matrix for CST element.

Three dimensional elements: Tetrahedron, Rectangular prism (brick), Arbitrary hexahedron, Three Dimensional polynomial shape functions, Natural co-ordinates in 3D, Three dimensional Truss(space trusses), Introduction to material models: Introduction to plasticity (Von-Mises Plasticity), Hyper –elasticity. Generating and using experimental data to model material behaviour, Errors in FEA, sources of errors, method of elimination, Patch test.

Applications of FEA in Manufacturing: FE analysis of Metal casting, Analysis of metal forming- Sheet metal stamping, Analysis of Machining using standard FE analysis packages

References:

1. Reddy J. N., “Introduction to Finite Element Method”, McGraw-Hill.
2. Rao S.S, “Finite Element Method in Engineering”, Academic Press, Elsevier.
3. Desai and Abel, “Introduction to the finite element method: A numerical method for engineering analysis”, CBS.
4. Chandrupatla R T and Belegundu A D, “Introduction to Finite Elements in Engineering”, PHI.
5. David Hutton, “Fundamentals of Finite Element Analysis”, McGraw-Hill.
6. Buchanan, G R., Finite Element Analysis, Adapted by: R Rudramoorthy, The McGraw-Hill, Indian Adapted Edition, Schaum’s Outlines.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPMP701** Course Title: **Automation Lab**
L-T-P**: 0-0-1** Credit: **1** Contact Hrs: **2hrs/week**
CIE Marks: **80** SEE Marks: **20** Total Marks: **100**
Practical Hrs: **24 hrs**

Laboratory Exercises:

- Non controller based applications
- Controller based applications
- Programming PLC system for small applications using CodeSys and RsLogix software
- Interfacing PLC system for analyzing industrial applications
- Building programs for manufacturing automation processes
- Building and analyzing circuits using electro hydraulics and electro pneumatics system.

I Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **17EPMP702** Course Title: **Machining Lab**
L-T-P**: 0-0-1** Credit: **1** Contact Hrs: **2hrs/week**
CIE Marks: **80** SEE Marks: **20** Total Marks: **100**
Practical Hrs: **24 hrs**

Laboratory Exercises:

- CNC programming practices on machining centers and WEDM.
- CAD/CAM integration with CNC machine tool.
- Practices in 3D printing**.**
- Machinability studies in turning, drilling, milling and non-traditional machining.
- Open ended experiments on
  - ✓ Parametric analysis in traditional/non-traditional machining for a work tool combination,
  - ✓ CNC Programming

I Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **17EPMW701** Course Title: **Mini Project I**
L-T-P**: 0-0-3** Credit: **1** Contact Hrs: **6hrs/week**
CIE Marks: **80** SEE Marks: **20** Total Marks: **100**
Practical Hrs: **72 hrs**

Mini Project I: The Guide shall define the problem statement for the Project work. The student shall execute the Project within during the 1st semester. The student who has opted Mini Project I shall opt automation theme to carry out their work.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **17EPMC705**		Course Title: **Data Analytics**
L-T-P**: 3-1-0**	Credits: **4**	Contact Hrs: **5 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**	Tutorial Hrs: **24 hrs**	Exam Duration: **3 hrs**

Statistical Data Analysis: Data and Statistics- Review of Basic Statistical Measures-Probability Distributions-Testing of Hypotheses-Non Parametric Tests

Data Analysis I: Introduction – Basic concepts – Uni-variate, Bi-variate and Multi-variate techniques – Types of multivariate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation – Approaches to multivariate model building.

Data Analysis II: Simple and Multiple Linear Regression Analysis – Introduction – Basic concepts – Multiple linear regression model – Least square estimation – Inferences from the estimated regression function – Validation of the model.

Factor Analysis: Definition – Objectives – Approaches to factor analysis – methods of estimation – Factor rotation – Factor scores - Sum of variance explained – interpretation of results. Canonical Correlation Analysis - Objectives – Canonical variates and canonical correlation – Interpretation of variates and correlations

Data Analysis III: Multiple Discriminant Analysis - Basic concepts – Separation and classification of two populations - Evaluating classification functions – Validation of the model. Cluster Analysis – Definitions – Objectives – Similarity of measures – Hierarchical and Non – Hierarchical clustering methods – Interpretation and validation of the model.

Data Analysis IV: Conjoint Analysis – Definitions – Basic concepts – Attributes – Preferences – Ranking of Preferences – Output of Conjoint measurements – Utility - Interpretation. Multi Dimensional Scaling – Definitions – Objectives – Basic concepts – Scaling techniques – Attribute and Non-Attributes based MDS Techniques – Interpretation and Validation of models. Advanced Techniques – Structural Equation modeling.

References:

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, “Multivariate Data Analysis”, Pearson Education, New Delhi.
2. Richard A Johnson and Dean W. Wichern, “Applied Multivariate Statistical Analysis”, Prentice Hall, New Delhi.
3. David R Anderson, Dennis J Sweeney and Thomas A Williams, “Statistics for Business and Economics”, Thompson, Singapore.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **17EPMC706**		Course Title: **Enterprise Resource Planning**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

ERP as Integrated Management Information System: Evolution of ERP, Benefits of ERP,ERP versus Traditional Information Systems, Business Process Reengineering, Need and challenges.

Management concerns about BPR: BPR to build business Model for ERP, ERP & Competitive advantage, Basic Constituents of ERP, Selection criteria for ERP Packages.

Procurement process for ERP Package, ERP packages – PEOPLE SOFT, SAP-R/3, BAAN IV, MFG/PRO, IFS/AVALON, ORACLE-FINANCIAL, Survey of Indian ERP Packages regarding their Coverage, performance and cost

ERP Implementation: Issues, Role of Consultants, Vendors, Users, Need for training, customization. ERP implementation methodology and post implementation issues and options,

Supply Chain Management: Types of SCM, Potential benefits of SCM, Possible obstacles, Application systems supporting SCM – engineering, Product Data Management, Sales, Procurement, Production, MRP, Distribution, ERP case studies in HRM, finance, production, product database, materials, sales & distribution.

References:

1. Leon Alexis, “Enterprise Resource Planning”, Tata McGraw Hill, New Delhi.
2. Garg V. K. and Venkatakrishna N. K., “Enterprise Resource Planning: Concepts and Practices”, PHI, New Delhi.
3. Sadagopan S., “Enterprise Resource Planning: A Managerial Perspective”, Tata McGraw Hill, New Delhi.
4. Brady, “Enterprise Resource Planning”, Thomson Learning.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **17EPMC707** Course Title: **Manufacturing Systems Simulation**

L-T-P**: 3-0-0** Credits: **4** Contact Hrs: **3 hrs/week**

ISA Marks: **50** ESA Marks: **50** Total Marks: **100**

Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

Principles of Modeling & Simulation: Basic Simulation Modeling, Systems – discrete and continuous systems, general systems theory, models of systems- variety of modeling approach, concept of simulation, simulation as a decision making tool, types of simulation, Principle of computer modeling- Monte Carlo simulation, Nature of computer modeling, limitations of simulation, area of application.

Random Number Generation: Random variables and their properties, Properties of random numbers, generation of Pseudo random numbers, techniques for generating random numbers, Various tests for random numbers-frequency test and test for Autocorrelation,

Random Variate Generation: Different techniques to generate random Variate: Inverse transform technique,-exponential, Normal, uniform, Weibull, direct transformation technique for normal and log normal distribution, convolution method and acceptance rejection techniques-Poisson distribution, **Statistical Techniques:** Comparison of two system designs, Comparison of several system designs – Bonferroni approaches to multiple comparisons for selecting best fit, for screening

Design and Evaluation of Simulation Experiments: Problem formulation, data collection and reduction , time flow mechanism, key variables, logic flow charts, starting condition, run size, experimental design consideration, output analysis, verification and validation of simulation models. **Simulation Languages:** Comparison and selection of simulation languages, study of any one simulation language.

Discrete Event Simulation: Concepts in discrete –event simulation, development of simulation models for queuing systems, production systems, inventory systems, maintenance and replacement systems, investment analysis and network, Programming for discrete event simulation, Case studies.

References:

1. Jerry Banks and John S Carson, Barry L Nelson, David M Nicol, “Discrete event system simulation”, Prentice Hall, India.
2. Khoshnevi. B., “Discrete system simulation”, McGraw Hill International.
3. Ronald G Askin and Charles R Standridge , “Modeling and analysis of manufacturing systems”, John Wiley & Sons.
4. Gordon G , “System Simulation”, Prentice Hall, India..
5. Thomas J Schriber., “Simulation using GPSS”, John Wiley & Sons.
6. Shannon, R.E., “System Simulation – The art and science”, Prentice Hall, India.
7. Averill Law & David M.Kelton , “Simulation, Modeling and Analysis”, TMH.

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME705** Course Title: **Flexible Manufacturing Systems**
L-T-P**: 4-0-0** Credits: **4** Contact Hrs: **4 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Overview of FMS: Definition of an FMS-need for FMS, types and configuration, types of flexibilities and performance measures, Economic justification of FMS. Development and implementation of FMS- planning phases, integration, system configuration, FMS Layouts, Simulation

Automated Material Handling and Storage: Functions – types - analysis of material handling systems, primary and secondary material handling systems-conveyors, Automated Guided Vehicles-working principle, types, traffic control of AGVs. Role of robots in material handling, Automated storage systems- storage system performance – AS/RS-carousel storage system, WIP storage systems, interfacing handling and storage with manufacturing.

Computer control of FMS: Planning, scheduling and computer control of FMS, Hierarchy of computer control, supervisory computer. DNC system- communication between DNC computer and machine control unit features of DNC systems.

Computer Software, Simulation and Data base: System issues, types of software – specification and selection- trends-application of simulation and its software, Manufacturing Data systems- planning FMS data base, Modeling of FMS- analytical, heuristics, queuing, simulation and petrinets modeling techniques.

Scheduling of FMS: Scheduling of operations on a single machine- two machine flow shop scheduling, two machine job shop scheduling, - three machine flow shop scheduling-scheduling, 'n' operations on 'n' machines, knowledge based scheduling, scheduling rules, tool management of FMS, material handling system schedule.

References:

1. Jha. N.K., "Hand Book of Flexible Manufacturing Systems", Academic Press Inc.
2. Raouf, A. and Ben-Daya, M., Editors, "Flexible manufacturing systems: recent development", Elsevier Science.
3. Parish.D.J., "Flexible Manufacturing", Butter worth-Heinemann Ltd.
4. Groover. M. P., "Automation production systems and computer integrated manufacturing", PHI.
5. Taiichi Ohno, "Toyota production system: beyond large-scale production", Productivity Press (India) Pvt. Ltd.
6. Parrish D. J., "Flexible Manufacturing", Butter worth, Heinemann, Ltd., Oxford.
7. Luggen W. W., "Flexible Manufacturing Cells & Systems", Prentice Hall, Englewood Cliffs.
8. Shivanand H K., "Flexible Manufacturing System", Dhanpat Rai Publications, New Delhi.

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME706** Course Title: **Sensors for Intelligent Manufacturing and Condition Monitoring**

L-T-P**: 4-0-0** Credits: **4** Contact Hrs: **4 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Introduction: Role of sensors in manufacturing automation – operation principles of different sensors - electrical, optical, acoustic, pneumatic, magnetic, photo -electric, electro-optical, vision, proximity.

Sensors in Manufacturing: Industrial sensors - Temperature sensors- Semiconductor absorption sensors, Non-contact sensors, Pyrometers, Pressure sensors-piezoelectric circuit, strain gauges, fiber optic pressure sensors, displacement sensors for robotic applications, Manufacturing of industrial sensors – Semiconductors, Fiber optics sensors and their principles and applications.

Sensors in CNC machine tools: Linear and Angular position sensors, Velocity sensors, Principles and applications. Sensors in Robots-Position sensors, encoder and revolvers, potentiometers, range proximity touch – torque sensors, Machine vision, Smart sensors

Condition monitoring of manufacturing systems: Principles, Sensors for monitoring force, Vibration and Noise, selection of sensors and monitoring techniques.

Acoustic Emission: Principles of Acoustic emission sensors, Concepts of pattern recognition, applications of Acoustic emission, on line monitoring of tool wear using Acoustic emission.

Automatic identification techniques for shop floor control, optical character and machine vision sensors, smart / intelligent sensors, integrated sensors, Robot sensors, Micro sensors, Nano sensors

References:

1. Jacob Fraden “Handbook of Modern Sensors physics, designs and applications” Springer-Verlag New York.
2. Sabrie Salomon, “Sensors and control systems in manufacturing”, McGraw Hill Int. Edition.
3. Julian W. Gardner, “Micro sensor MEMS and Smart Devices”, John Wiley & Sons.
4. Randy Frank, “Understanding smart sensors”, Artech House, USA, 2011.
5. Julian W. Gardner, “Micro sensor principles and applications”, John Wiley & sons.

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPME707** Course Title: **Advanced Precision Engineering**
L-T-P**: 4-0-0** Credits: **4** Contact Hrs: **4 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Concept of Measurement methods, Experimental Test plan, Calibration, Static and Dynamic characteristics of signals, Measurement system behavior, Probability and Statistics, Density functions, Infinite and finite statistics, Chi-squared distribution, Regression analysis, Data outlier detection, Uncertainty Analysis, Measurement errors, Design-stage uncertainty analysis, error sources, Bias and precision errors, error propagation, single and multiple measurement, uncertainty analysis, Surface roughness measurement, Stylus instruments (Mechanical and Electrical), Sources of error, Optical instruments (Profiling and Parametric techniques), Data acquisition and filtering, Amplitude and texture parameters, Coordinate Measuring Machines: Coordinate metrology, Configuration of CMM, Hardware components, Control system for CMM, Operating sequence, Measurement program,Automated inspection, Principles, Methods of online, offline, distributed and flexible inspections, Machine vision, Image Acquisition & digitization, Image processing & Analysis, interpretation, applications

References:

1. Figliola R. S. and Beasley, D. E., "Theory and Design for Mechanical Measurements", Third edition, John Wiley & Sons Inc.
2. Thomas Tom R., "Rough Surfaces 2nd ed", Imperial College Press, London.
3. Hooken Rabert and Pereira P. H., "Coordinate Measuring Machines and Systems", CRC press.
4. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", PHI.

Reference Books:

Ambrose, S., Bridges, M., DiPietro, M., Lovett, M., & Norman, M. (2010) How learning works: 7 Research-Based principles for smart teaching. San Francisco: Jossey-Bass.

Suggested Web Resources:

https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/
http://educationaltechnology.net/instructional-design/
https://www.nwea.org/blog/2014/33-digital-tools-advancing-formative-assessment-classroom/
http://oedb.org/ilibrarian/101-web-20-teaching-tools/

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPMP703** Course Title: **ERP Lab**
L-T-P**: 0-0-1** Credit: **1** Contact Hrs: **2hrs/week**
CIE Marks: **80** SEE Marks: **20** Total Marks: **100**
Practical Hrs: **24 hrs**

- Introduction and selection criteria for ERP Packages, Survey of Indian ERP Packages
- Production Planning and Execution Module: - Exercises on production planning, machine scheduling, Material Requirement Planning, track daily production progress, production forecasting & actual production reporting with case studies.
- Supply Chain Management Module: - Exercises on Management of flow of products from manufacturer to consumer & consumer to manufacturer, demand & supply management, sales returns & replacing process, shipping & transportation tracking with case studies.
- Finance & Accounting module: - Exercises on Track of all account related transactions like expenditures, Balance sheet, account ledgers, budgeting, bank statements, payment receipts, tax management with case studies.
- Human Resource Module:- Exercises on Efficient management of human resources, employee information, track employee records like performance reviews, designations, job descriptions, skill matrix, time & attendance tracking. Payroll System, payment repots, travel Expenses & Reimbursement tracking. with case studies.

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **17EPMP704** Course Title: **Simulation Lab**
L-T-P**: 0-0-1** Credit: **1** Contact Hrs: **2hrs/week**
CIE Marks: **80** SEE Marks: **20** Total Marks: **100**
Practical Hrs: **24 hrs**

Laboratory Exercises:

Development of simulation models for the following systems

- Queuing and Inventory systems, manufacturing system and service operations.
- Maintenance and replacement systems
- Job shop with material handling and FMS
- Exercises on real life problems using discrete event systems simulation software on product, process and FMS layouts.

II Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **17EPMW702** Course Title: **Mini Project II**
L-T-P**: 0-0-3** Credit: **1** Contact Hrs: **6hrs/week**
CIE Marks: **80** SEE Marks: **20** Total Marks: **100**
Practical Hrs: **72 hrs**

Mini Project II: The Guide shall define the problem statement for the Project work. The student shall execute the Project within during the 2nd semester. The student who has opted Mini Project II shall opt automation theme to carry out their work.

I Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMC701** Course Title: **PLM Fundamentals**
L-T-P**: 2-0-0** Credits: **2** Contact Hrs: **2 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **30 hrs** Exam Duration: **3 hrs**

Introduction to Product Lifecycle Management (PLM): PLM Overview, Background for PLM, Scope, Components/Elements of PLM, PLM Grid, PLM Paradigm - Concepts, Consequences and Corollaries, Strategic Benefits, Operational Benefits, Spread of PLM, Overcoming Problems, Enabling Opportunities, Challenges.

The PLM Environment: Issues in the Traditional Environment, Product Data Issues, A Complex Changing Environment-Change, Interconnections, Changes Driving PLM, Product Pains-Aerospace, Automotive and Other Products, Product Opportunities - Globalization Opportunity, Technology Opportunity, Social/Environmental Opportunity, Human Resource Opportunity.

Product Lifecycle Management System: Product Data or Product Information, System Architecture, Information Models and Product Structure, Information Model, Product Information Data Model, Product Model, Reasons for the Deployment of PLM Systems.

PLM in Different Verticals: Functionality of the Systems, Use of PLM Systems in Different Organizational Verticals, Product Development and Engineering, Production, After Sales, Sales and Marketing, Sub-Contracting, Sourcing and Procurement, Different Ways to Integrate PLM Systems, System Roles - ERP, CAD.

Project/Program Management in PLM Environment: Characteristics of Projects, People in Projects, Project Phases, Project Management Knowledge Area, Project Management Tools and Templates, The Importance of Project Management in PLM, Project reality in a Typical Company, Project Management Activities in PLM Initiatives, Pitfalls of Project Management, Top Management Role with Project Management.

References:

1. Stark John, "Product Lifecycle Management: 21st Century Paradigm for Product Realization", Springer, Third Edition, 2015
2. Antti Saakasvuori, Anselmi Immonen, "Product Lifecycle Management" - Springer, 1st Edition, 2003.
3. Grieves Michael, "Product Lifecycle Management - Driving the Next generation of LeanThinking" , McGraw-Hill, 2006.

I Sem M. Tech. (Production Management)
Curriculum Content

Course Code: **18EPMC702** Course Title: **Engineering Data Management**
L-T-P**: 3-0-0** Credits: **3** Contact Hrs: **3 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

Introduction and Overview of Embedded Product Design: Background, Related Research and Research Problems, Structure of the Report, Design for Manufacture, Design of Embedded Products, Technical Design Disciplines and Document Management, Software Design, Electronics Design, Software-Hardware Co-Design, Mechanical design, Concurrent Engineering, Design Data Management, DFA and DFMA.

PDM Systems and Data Exchange: Product Data Management (PDM), State-of-the-art trends of PDM, Data Formats and Translators in Data Exchange, STEP (Standard for the Exchange of Product Model Data), CDIF (Case Data Interchange Format), SGML (Standard Generalized Markup Language).

PDM and SCM: PDM and Product Life Cycle, PDM Systems – Common Functionality, Product Structure and Document Management, System Architecture, Version Management, Configuration Selection, Concurrent Development, Build Management, Release Management, Workspace Management, Change Management.

Requirements of Design Data Management: Requirements for the Embedded Product's Design Data Management, Data Management, Process and Life-Cycle Management, Data Capture & Distribution, Support for Working Methods, Requirements for Enterprise-Level Design Data Management, Design Data Management Levels, The Design Data Management Features of Design Tools , Team-Level Design Data Management, Team-Level Design Data Management.

Analysis of Needs and Solutions: Comparison of Principles, Comparison of Key Functionalities, Requirements and Needs, Analysis, Different Scenarios in an Integrated Environment, Possible Integrations, Examples of integrations.

Product Data in PLM Environment: Relevance of Product Data in PLM, Product Data Across the Lifecycle, Tools to Represent Product Data, Data model diagrams, Reality in a Typical Company-Issues, Challenges and Objectives, Product Data Activities in the PLM Initiative-Product Data Improvement.

References:

1. Jukka Kaariainen, Pekka Savolainen,Jorma Taramaa & Kari Leppala, “Product Data Management (PDM) Design, exchange and integration viewpoints”, VTT- Technical research centre of Finland, 2000.
2. Rodger Burden “PDM: Product Data Management” Volume 1, Resource Publishing, 2003.
3. Annita Persson Dahlqvist et.al “PDM and SCM - similarities and differences”, The Association of Swedish Engineering Industries, 2001.

I Sem M. Tech. (Production Management)
Curriculum Content

Course Code: **18EPMC703** Course Title: **Product Design and Development**
L-T-P**: 3-0-0** Credits: **3** Contact Hrs: **3 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

Introduction: Characteristics of successful product development, duration and cost of product development, Challenges of product development.
Development Process and Organizations: Generic development process, concept development – Front-end process, adapting the generic product development process
Identifying Customer Needs: Defining scope, gathering data from customers, establishing relative importance of needs etc.
Establishing Product Specifications: Target specifications & refining specifications
Concept Generation: Five step methodology of concept generation.
Concept selection: Structured methodology for selecting a concept using selection matrix & ranking of concepts.
Product Architecture: Meaning & implication of product architecture.
Industrial Design: Meaning of ID, & its impact, Aesthetic & Ergonomic considerations, ID process
Design for Manufacturing: DFM meaning, DFM Methodology**.**
Value Engineering and Product Design: Definition of value. Value analysis job plan, creativity etc.

References:

1. Karl T Ulrich and Steven D Eppinger, 'Product design and development', Tata McGraw Hill Publication.
2. A. K. Chitale and R. C. Gupta, 'Product Design and Manufacturing', Prentice Hall India.
3. Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill Publications.

I Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMC704** Course Title: **Enterprise Resource Planning - I**
L-T-P**: 3-0-0** Credits: **3** Contact Hrs: **3 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

Introduction to ERP: Need for ERP, Characteristics and components of ERP, Suppliers of ERP, Integrated Management Information, Seamless Integration and Functional information system, Marketing, Accounting and Financial Management, Supply Chain Management, Resource Management, Integrated Data Model.

Business Functions and Business Processes: Functional Areas of Operation, Business Processes, A process view of business, Functional Areas and Business process of very small business. Marketing and Sales, Supply Chain Management, Accounting and Finance, Human Resources, Functional Area Information System

Business Process Reengineering: Need for reengineering, Reengineering Model, BPR Guiding principles , Business process reengineering and performance improvement, Enablers of BPR in Manufacturing, Collaborative Manufacturing, Intelligent manufacturing, Production Planning. BPR Implementation

Financial & Accounting Management: Differences between Financial accounting, Cost accounting and Management accounting, Basic finance – Concept of Cost Centre accounting, Cost – Volume – Profit Analysis, Cash Flow Analysis

Role of ERP in Purchasing: Features of purchase module, ERP Purchase System; Role of ERP in Sales and Distribution, Sub-Modules of the Sales and Distribution Module: Master data management, Order management, Warehouse management, Shipping and transportation, Billing and sales support, foreign trade, Integration of Sales and Distribution Module with Other Modules

Inventory Management: ERP inventory management system, Importance of Web ERP in Inventory Management, ERP Inventory Management Module and Sub-Modules of the ERP Inventory Management Module, Bill of Material, Safety stock, Lot number/Batch number, Inventory valuation methods

Material Requirement Planning: Product structure and Bill of Materials (BOM), MRP concept, MRP calculations, Lot sizing in MRP, capacity requirement planning, MRP-II, MRP Exercises

Production and Supply Chain Management Information Systems: Role of ERP in CAD/CAM, MRP, Closed Loop MRP, MRP-II, Manufacturing and Production Planning Module of an ERP System, Distribution Requirements Planning (DRP); ERP Approach to Production Planning, MRP to ERP.

References

1. Ellen Monk , Bret wagner "Concepts in Enterprise Resource planning" Third Edition Course Technology.
2. R.Radha Krishnan " Business Process Reengineering PHI , New Delhi.
3. Garg V. K. and Venkatakrishna N. K., "Enterprise Resource Planning: Concepts and Practices", PHI, New Delhi.
4. Sadagopan S., "Enterprise Resource Planning: A Managerial Perspective", Tata McGraw Hill, New Delhi.

5. Pauline Weetman, "Financial and Management Accounting: An Introduction", Pearson Education Limited, 2015.

I Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **18EPME701** Course Title: **Design for Additive Manufacturing**
L-T-P**:3-0-0** Credits: **4** Contact Hrs: **3 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

Overview of Design for Additive Manufacturing (AM): How to design for AM? Challenges & opportunities, Design process, mechanical properties, performance of materials used in AM, process driven & designer driven shape, methods, Additive manufacturing principles & processes.

Drivers for AM: Material efficiency, flow optimization, integration of functions, mass customization, lead time, automated manufacturing, Limitations, Available material, accuracy of the technology, price of the industrial machines, certification of materials and processes, surface finish(supports, post processing), part dimensions.

DFMA Principles for AM: Maximum Part size, Faces requiring support, minimum wall thickness & rigidity, Minimum feature size & manufacturing quality, Typical geometries, DFX rules for additive manufacturing. cost considerations**.**

Topology Optimization for AM: Introduction to topology optimization, Topology optimization process, characteristics, link with AM potentials & Challenges, Current developments.

Accuracy Issues in AM: Properties of metallic and nonmetallic additive manufactured surfaces, Stress induced in additive manufacturing (AM) processes. Surface roughness problem in rapid prototyping, Part deposition orientation and issues like accuracy, surface finish, build time, support structure, cost etc

References:

1. Ian Gibson, David W. Rosen, Brent Stucker, "Additive manufacturing technologies: rapid prototyping to direct digital manufacturing", Springer, 2010.
2. Andreas Gebhardt, "Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing", Hanser Publishers, 2011.
3. Christoph Klahn, Bastian Leutenecker, Mirko Meboldt, "Design for Additive Manufacturing – Supporting the Substitution of Components in Series Products", Procedia CIRP 21 2014, 24th CIRP design conference
4. Rosen, D.W., 2007. "Design for additive manufacturing: A method to explore unexplored regions of the design space". In Proceedings of the 18th Annual Solid Freeform Fabrication Symposium.

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **18EPME702** Course Title: **Industrial Robotics**
L-T-P**:3-0-0** Credits: **4** Contact Hrs: **3 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

Robot fundamentals: History of robotics, Advantages & Applications of robots, Robot characteristics. Classification and structure of robotic systems, PTP and continuous path systems, JIRA and RIA, Robot components, Robot anatomy (configurations, Robot motions), Work volume, drive systems

Robot kinematics: Matrix representation, Homogeneous transformation matrices, Representation of transformations, Inverse transformation matrices, forward and inverse kinematics of robots, D-H representation of forward kinematic equations, degeneracy and dexterity

Differential motions and velocities: Differential relationships, Jocobian, differential motions of a frame, calculation of Jacobian, inverse jacobian

Dynamic Analysis and forces : Langrangian mechanics, Effective moments of inertia, Dynamic equations of multiple DOF robots, Static force analysis, Transformation of forces and moments between coordinate frames

Robot control systems: Components, Basic control system concepts and models, Controllers, control system analysis, robot actuation and feedback components

Actuators and Sensors: Characteristics of actuating systems, different types of actuators, sensor characteristics, different types of sensors

Robot Programming: Methods (lead through, textual language), program as a path in space, speed control, motion interpolation, wait, signal and delay, branching, capability and limitations of lead through methods

References:

1. Koren Yoram, "Robotics for Engineers', 2, McGraw-Hill Publication. , 2013

2. Groover M.P, 'Industrial Robotics', 3, Tata McGraw-Hill Publication, 2013

3. Niku Saeed B, "Introduction to Robotics', 4, Prantice Hall India Publication, 2014

I Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **18EPME703** Course Title: **Supply Chain Management**
L-T-P**:3-0-0** Credits: **4** Contact Hrs: **3 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

Supply Chain Concepts: Introduction to Supply Chain, SCOR model, Virtual/Extended Enterprise, Delivery Channel, Objective of a Supply Chain, Decision Phases in a Supply Chain, Production Approaches, Supply Chain Process, Push & Pull Production Systems, Push-Pull Boundary, Lack of Coordination and Bullwhip Effect, Order Management, Order-to-Cash Process, Procure-to-Pay Process, Call-off, Replenishment, Sourcing

Supply Chain Performance: Supply Chain Strategies, Value Chain, Capabilities, Uncertainties, Responsiveness vs Cost, Supply Chain Performance Drivers – Facilities, Inventory, Transportation, Information, Sourcing, and Pricing, Supply Chain Visibility, Resilience, Non-Financial Metrics Examples, Financial Metrics Examples, Sustainability

Designing Distribution Network: Introduction, Factors Influencing Distribution Network Design, Design Options for a Distribution Network, Distribution Network for Online Sales, Impact of Online Sales on Cost

Network Design: Introduction, Factors Influencing Network Design Decisions, Framework for Network Design Decisions, Facility Location Mathematical Models, Capacity Allocation Mathematical Models, Network Behavior, Types of Supply Relationship, Factors influencing Nature of Network Relationship, Vertical Integration

Demand Management and Forecast: House of SCM, Managing Demand, Managing Supply, Transportation Model, Just-in-Time in Supply Chain, Forecasting in Supply Chain, Characteristics of Forecasts, Approaches to Demand Forecasting

Inventory Management: Cycle Inventory, Cycle Inventory Related Costs, Economics of Scales, Economic Order Quantity, Multiechelon Cycle Inventory, Uncertainty and Safety Inventory, Safety Inventory Level

Logistic and Warehouse Management: Transportation in Supply Chain, Modes of Transportation, Transportation Network, Trade-offs in Transportation Design, Warehouse Layout and Design, Warehouse Types, Warehouse Operating Processes, Warehouse Management System, Procurement, Material Classification, Material Codification

Trends in SCM: Gartner's Hype Cycle, Capgemini's Consulting Hype Cycle, Trend Categories, Algorithmic Supply Chain Planning, Predictive Analytics, Global Logistics Visibility, Focus on Risk Management and Supply Chain Resiliency

References:

1. Sunil Chopra, and Peter Meindl, "Supply Chain Management – Strategy, Planning, and Operation," Pearson Education.
2. APICS, "Operations Management Body of Knowledge Framework."
3. Lora Cecere, "Supply Chain Metrics that Matter," Wiley.
4. Hartmut Stadtler, "Supply chain management and advanced planning – basics, overview and challenges," European Journal of Operations Research, 163, 2015.
5. Keely L. Croxton, Sebastián J. García-Dastugue and Douglas M. Lambert, "The Supply Chain Management Processes," The International Journal of Logistic Management.

I Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **18EPMP701** Course Title: **Collaborative Design - Modeling Lab**
L-T-P**: 0-0-5** Credits: **5** Contact Hrs: **10 hrs/week**
ISA Marks: **80** ESA Marks: **20** Total Marks: **100**
Practical Hrs: **120 hrs** Exam Duration: **2 hrs**

User Interface Platform:

Understand the user interface, Connect to the PLM platform, Access your Dashboard, Use the Tags for searching content, Share various documents with other users through, 3DSpace, Use standard menus and commands, Import new data and export to required file formats, Search for a 3D data using different methods, Explore and open 3D data, Manipulate the tree, Filter data

Sketcher: Exercises on sketch tools, profile tool bar and constraint tool bar.

Part Design: Exercise on 3D models using pad, slot, shaft, groove, hole, rib and stiffener commands, cut revolve etc.

Generative Shape Design (GSD): Exercises using GSD to generate complicate surfaces using sub tool bars

Sheet Metal: Setting sheet metal parameters, bend extremities tab, creating the base wall, creating the wall on edge, creating extrusions etc.

Assembly Design: Assembly design work bench Bottom-Up and Top-Down assembly approaches invoking existing components into assembly work exercise to demonstrate Top-Down assembly approach.

Drafting: Converting existing 3D models into 2D drawings with all relevant details, sectional views etc.

Data Exchange and Collaborative Lifecycle:

Import and export different file formats, manage the Mastership of imported objects, Create a new product structure, Use different sections of the Action bar effectively, Manage the changes in a product structure, Save the product structure in the database

Design Review:

Create a design review, add markups to it, Create slides, and add markers, Create sections and measures, Export sections and measures, compare 3D Objects and 2D Drawings

References

Companion Courses – https://companion.3ds.com/

I Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMP702**		Course Title: **PLM Functional Lab**
L-T-P**: 0-0-3**	Credits: **3**	Contact Hrs: **6 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Practical Hrs: **72hrs**		Exam Duration: **2 hrs**

Collaboration and Approvals:

Illustrate the structure of PLM Business Process Services, Create and manage your folders, Create workflows, Identify and manage your assigned tasks, Subscribe to various objects and events, Report and resolve issues in objects, Create, track and organize your documents

IP Classification:

Need of IP Classification, Create different types of libraries and their related hierarchies, Create and manage documents and parts, classify the library objects based on their features, Use the Classification functionality

Engineering Bill of Material:

Create parts and specifications, Create and edit Bill of Materials, Create a Change Request to make the changes in a part or a specification, Complete Change Orders and Change Actions to implement the changes, Review and release the parts

Project Management Fundamentals:

Create programs and projects, Assign members to a project, Add tasks and assign project members to the tasks, Create folders for managing project documents, Create process flow for tasks, Review the status of programs and projects, Exchange and view projects data using Microsoft Project Integration

Project Management Advanced:

Document the various risk areas of a project and track them, Create and manage the resource requirements for a project, Create budgets and benefits to monitor the financials of a project, Track the time spent on a project using time sheets, Create calendars for the projects, Identify the quality factors of a project and monitor them, Create an assessment to measure the project's health, Use dashboards to monitor the status of your projects

Project Execution:

Manage the project schedule, Record risks for tasks, Create and submit timesheets

References

1. Companion Courses – https://companion.3ds.com/
2. Antti Saakasvuori, Anselmi Immonen, "Product Lifecycle Management" - Springer, 1st Edition, 2003.

I Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **18EPMP703** Course Title: **ERP Functional Lab**
L-T-P**: 0-0-3** Credits: **3** Contact Hrs: **6hrs/week**
ISA Marks: **80** ESA Marks: **20** Total Marks: **100**
Practical Hrs: **72 hrs** Exam Duration: **2 hrs**

Selection Criteria for ERP Packages: Survey of Indian ERP Packages

Financial Accounting: Basic Finance – Chart of accounts, Journal entries, Journal vouchers, Exchange rates; Banking (In and Out); Debit and Credit note

Master Data Management: Item master; Business partner master – Customer, vendor; Pricing; Tax

Supply chain Management

Sales: Sales quotation, Sales order, Delivery, Return, Invoice (A/R)

Purchase: Purchase quotation, Purchase order, Return, GRN, Invoice (A/P)

Production: Assembly BOM, Production order, Goods issue, Goods receipt

Reports: Generation of reports for various functions

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMC705** Course Title: **PLM Advanced**
L-T-P**: 2-0-0** Credits: **2** Contact Hrs: **2 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **30 hrs** Exam Duration: **3 hrs**

Deployment of the PLM System: Different stages of deployment, Leading a PLM Project, Understanding the need for change, PLM maturity model, Choosing a system, Realization stage of the project, Start up, Steering group, Project manager, Accomplishing change in the organization.

Challenges of Product Management in Manufacturing Industry: Life cycle thinking, value added services and after sales traceability, Special challenges of product management in the high tech industry, Case studies.

Service Industry and PLM: Introduction, Categorizing services, Rational for building service products, PLM in service business, PLM challenges in service business, Case studies.

Role of product Information Management in Collaborative Business Development: CIM, Concurrent Engineering, Product lifecycle management as an enabler of cooperation between companies, Contents of collaboration, Successful cooperation, Tools of collaboration.

Product and Product Management Strategy: PLM as a business strategy tool, Making a product strategy, Product management strategy, Time to market, Time to react, Time to volume, Time to service.

References:

1. Stark John, "Product Lifecycle Management: 21st Century Paradigm for Product Realization", Springer, Third Edition, 2015
2. Antti Saakasvuori, Anselmi Immonen, "Product Lifecycle Management" - Springer, 1st Edition, 2003.
3. Grieves Michael, "Product Lifecycle Management - Driving the Next generation of LeanThinking" , McGraw-Hill, 2006.

II Sem M. Tech. (Production Management)
Curriculum Content

Course Code: **18EPMC706** Course Title: **Enterprise Resource Planning-II**
L-T-P**: 3-0-0** Credits: **3** Contact Hrs: **3 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

ERP implementation Basics: Master Data Management – Item Master, Vendor Master, COA, Customer Master, Machine Master, etc. Vendors- Role of Vendor; Consultants: Types of consultants; Role of a Consultant, Employees; Role of employees; Resistance by employees; Dealing with employee resistance, Role of Top Management, Role of Implementation Partner

ERP –Functional modules: Functional modules of ERP software, integration of supply chain and customer relationship application.

ERP implementation Life cycle: Objectives of ERP implementation, Different phases of ERP implementation. Consultants, vendor and employees

ERP Projects: Project types, Implementation methodology, Project Preparation, Business Blueprinting, Gap Analysis, Realization, Final Preparation, Go Live and Support, User Training

ERP Post Implementation: Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors and ERP Implementation - Case studies.

ERP and e-Business: Introduction ERP and e-business process model, components of e-Business supply chain ERP/ e-business integration ERP to ERP II –Bringing ERP to the Entire Enterprise

Future Directions in ERP: Faster Implementation Methodologies; Business Modules and BAPIs; Convergence on Windows NT; Application Platform; New Business Segments; More Features; Web Enabling; Market Snapshot.

Other Related Technologies of SCM: Relation to ERP; E-Procurement; E-Logistics; Internet Auctions; E-markets; Electronic Business Process Optimization; Business Objects in SCM; E commerce

Case Studies: ERP case studies in HRM, Finance, Production, Product Database, Materials, Sales & Distribution

References:

1. Leon Alexis, “Enterprise Resource Planning”, Tata McGraw Hill, New Delhi.
2. Garg V. K. and Venkatakrishna N. K., “Enterprise Resource Planning: Concepts and Practices”, PHI, New Delhi.
3. Sadagopan S., “Enterprise Resource Planning: A Managerial Perspective”, Tata McGraw Hill, New Delhi.
4. Brady, “Enterprise Resource Planning”, Thomson Learning.

III Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **18EPMC707** Course Title: **Project Feasibility and Analysis**
L-T-P**: 3-1-0** Credits: **4** Contact Hrs: **5 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Planning Overview: Capital budgeting and Allocation, Strategic planning.

Market and Demand Analysis: Situational analysis, Demand forecasting and Uncertainties in demand forecasting.

Technical Analysis: Material inputs and utilities, Product mix, Plant capacity and Location, Environmental aspects, Project charts and layouts.

Financial Estimates and Projections: Means of finance, Estimates of sales and production, Working capital requirement and its financing, Profitability projections, projected cash flow statements. Project risk analysis: Sources, Measures and Perspectives on risks, Sensitivity analysis, Scenario analysis, Break-even analysis, Simulation analysis, Decision tree analysis, managing risk.

Sustainability in Project Management: Inter-relating life cycles, The impact of sustainability on project management processes, Measuring and reporting projects

References:

1. Prasanna Chandra, “Projects: Planning, Analysis, Financing, Implementation and Review”, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Nicholas J. M. and Steyn H. “Project Management for Business, Engineering and Technology: Principles and Practice”, Elsevier.
3. Harold R. Kerzner, “Project Management: A Systems Approach to Planning, Scheduling, and Controlling”, Wiley, New York.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **17EPME704** Course Title: **Additive Manufacturing**
L-T-P**: 3-0-0** Credits: **3** Contact Hrs: **3 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

Additive Manufacturing (AM) Overview: Introduction to reverse engineering Traditional manufacturing vs AM, Computer aided design (CAD) and manufacturing (CAM) vs AM, Different AM processes and relevant process physics, AM process chain Application level: Direct processes – Rapid-Prototyping, Rapid Tooling. Rapid Manufacturing; Indirect Processes - Indirect Prototyping. Indirect Tooling, Indirect Manufacturing

Materials Science of AM: Discussion on different materials used, Use of multiple materials, multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, Structure property relationship, Grain structure and microstructure

AM Technologies: Powder-based AM processes involving sintering and melting (selective laser sintering, shaping, electron beam melting. involvement). Printing processes (droplet based 3D Solid-based AM processes - extrusion based fused deposition modeling object Stereo-lithography Micro- and nano-additive.

Mathematical Models for AM: Transport phenomena models: temperature, fluid flow and composition, buoyancy driven tension driven free surface flow pool) Case studies: Numerical Modeling of AM process, Powder bed melting based process, Droplet based printing process Residual stress, part fabrication time, cost, optimal orientation and optimal Defect in AM and role of transport Simulations (choice of parameter, Mo del validation for different

Process selection, planning, control for AM: Selection of AM technologies using decision methods. Additive manufacturing process plan: strategies and post processing. Monitoring and control of defects, transformation.

References:

1. Ian Gibson, David W. Rosen, Brent Stucker, “Additive manufacturing technologies: rapid prototyping to direct digital manufacturing”, Springer, 2010.
2. Andreas Gebhardt, “Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing”, Hanser Publishers, 2011.
3. J.D. Majumdar and I. Manna, “Laser-assisted fabrication of materials”, Springer Series in Material Science, e-ISBN: 978-3-642- 28359-8.
4. L. Lu, J. Fuh and Y.-S. Wong, “Laser-induced materials and processes for rapid prototyping”, Kluwer Academic Press, 200 I.
5. Zhiqiang Fan and Frank Liou, “Numerical modeling of the additive manufacturing (AM) processes of titanium alloy”, lnTech, 2012.
6. C.K. Chua, K.F. Leong and C.S. Lim, “Rapid prototyping: principles and applications”, 3rd Edition, World Scientific, 20 10.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **17EPME705** Course Title: **Manufacturing Systems and Automation**

L-T-P**: 3-0-0** Credits: **3** Contact Hrs: **3 hrs/week**

ISA Marks: **50** ESA Marks: **50** Total Marks: **100**

Teaching Hrs: **40 hrs** Exam Duration: **3 hrs**

Introduction: Production system facilities, Manufacturing support systems, Automation in production system, Automation principles and strategies, Manufacturing operations, Basic elements of an automated system, Advanced automation functions, Levels of automation.

Material handling and identification technology: Considerations in material handling system design, 10 principles of material handling, Automated guided vehicle systems, Conveyor systems, Analysis of material transport system, Automated storage systems, Engineering analysis of storage system. Components of manufacturing systems, Single station automated cells, Applications and analysis of single station cells.

Flexible manufacturing systems: FMS components, FMS application and benefits, Quantitative analysis of flexible manufacturing systems.

Industrial control systems: Sensors, Actuators, Drives and other control system components. Electro-hydraulic and Electro-pneumatics in manufacturing automations

Machine vision systems: Importance of machine vision system in manufacturing automation.

Role of microcontrollers in manufacturing automation system: Microcontroller architecture, interfacing sensors and actuators with microcontroller for industrial automation, Microcontroller programming.

PLCs in manufacturing automation: Application of programmable logic controllers in manufacturing automation, PLC basic and advanced ladder logic programming using RsLogix and CoDeSys format, Usage of timers, counters, sequencing, and interlocking, latching, master control relay for developing programs for manufacturing automation. Temperature control, valve sequencing, conveyor belt control, control of a process etc

SCADA for Automation: Elements of SCADA, Benefits of SCADA, Applications, Types of SCADA systems, Features and functions of SCADA, Building applications using SCADA for manufacturing automation.

References:

1. Grover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education Asia.
2. Grover M.P., Weiss M. M., Nagel R.N. and Odrey N.G., "Industrial Robotics, Technology, Programming and Applications", Mc Graw Hill Book Publications.
3. Krishna Kant, "Computer Based Industrial Control" PHI.
4. W. Bolton , "Programmable Logic Controllers" Fifth Edition, Elsevier
5. Vijay R. Jadhav, "Programmable Logic Controller", Second Edition, Khanna Publishers.

6. II Sem M.Tech. (Production Management)
Curriculum Content

Course Code: **17EPME706**		Course Title: **Robust Design Optimization**
L-T-P**: 3-0-0**	Credits: **3**	Contact Hrs: **3 hrs/week**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **40 hrs**		Exam Duration: **3 hrs**

Robust Design Overview: Taguchi's approach to quality and quality loss function, noise factors and average quality loss, exploiting non linearity, classification of parameters

Analysis of variance: No-Way ANOVA, One-Way ANOVA, Two-Way ANOVA and Three-Way ANOVA

Two Level Experiments: Two factor factorial design, model adequacy checking and estimating model parameters, 2^2 full factorial design, 2^3 full factorial design, 2^k full factorial design and Two level fractional factorial design, General 2^{k-p} fractional factorial design.

Steps in Robust Design: Identification of process and its main function, Noise factors and testing conditions, Control factors and their levels, Matrix experiment and data analysis plan, Conducting the experiment and data analysis, Verifying experiment and future plan.

Signal to Noise Ratios: Comparison of the quality of two process conditions, Relationship between Signal to Noise Ratio and quality loss after adjustment, Identification of a scaling factor, Signal to Noise Ratios for static problems, Signal to Noise Ratios for dynamic problems, Analysis of ordered categorical data.

Taguchi Inner and Outer arrays: Orthogonal arrays and fractional factorial designs, Parameter design and tolerance design, Analysis of inner/outer array experiment, Alternative inner/outer orthogonal array experiments.

Constructing orthogonal arrays: Dummy level technique, Compound factor method, Linear graphs and Interaction assignment, Modification of linear graphs, Column merging method, Branching design.

References:

1. Montgomery, D. C., "Design and Analysis of Experiments", John Wiley & Sons.
2. Khuri A. I. and Cornell J. A. "Response Surfaces: Designs and Analyses, Marcel Dekker, Inc., New York.
3. Myers R. H., Montogomery, D. C. and Anderson-Cook C. M. "Response Surface Methodology: Process and Product Optimization Using Designed Experiments", John Wiley & sons, Inc., New York.
4. Mason R. L., Gunst, R. F., Hess J. L., "Statistical design and Analysis of Experiments With Applications to Engineering and SISAnce", John Wiley & sons, Inc., New York.
5. Phadke M. S., "Quality Engineering using Robust Design", Prentice Hall PTR Englewood Cliffs, New Jersy.
6. Ross P. J., "Taguchi Techniques for Quality Engineering", McGraw -Hill International.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMP704** Course Title: **Product Automation Lab**
L-T-P**: 0-0-4** Credits: **4** Contact Hrs: **8 hrs/week**
ISA Marks: **80** ESA Marks: **20** Total Marks: **100**
Practical Hrs: **96 hrs** Exam Duration: **2 hrs**

Knowledge Based Engineering:

- Customize the tree to display knowledge ware features
- Create parametric models
- Embed design knowledge in the models
- Automate the design and modification processes
- Create design configurations using design tables

HTML:
Tags, Attributes and Elements, Links, Images, Tables, Forms
CSS: CSS basics, styles, CSS syntax

JavaScript:
JavaScript Output, JavaScript Statements, JavaScript Syntax, JavaScript Variables, JavaScript Operators, JavaScript Arithmetic, JavaScript Strings, JavaScript Events, JavaScript Loop, JavaScript Objects, JavaScript functions.

Python:
Python programming skills using data structures and constructs, python programming skills using functions and packages.

References:

1. Companion Courses – https://companion.3ds.com/

II Sem M.Tech. (Production Management)

Curriculum Content

Course Code: **18EPMP705**		Course Title: **PLM Technical Lab**
L-T-P**: 0-0-3**	Credits: **4**	Contact Hrs: **6 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Lab Hrs: **72 hrs**		Exam Duration: **2 hrs**

Variant Management Essentials & Product Architect:

Create the product structure, Define product portfolios based on product roadmaps, Create and manage product configurations and design variants, Use Enterprise Changes to track and release features, Generate BOMs

Traceable Requirements Management Essentials:

Capture requirements from MS Word and MS Excel documents, Create requirements and requirement specifications, Allocate requirements to products and models, Create test cases and use cases, Create revision and multiple versions of requirements, Generate traceability reports

Platform Management and Baseline Behavior:

Create collaborative spaces and users, Assign required access rights to different users, Explore the Control widget and its related features, Configure PLM platform to add additional features as per requirements

Data Model Customization Essentials:

Describe Unified Typing concepts, Create Subtypes and add attributes to it, Create Specialization, Customer and Deployment Extensions, Create Unique Keys, Create Specialization and Deployment Packages

Web Based Customization:

Use MQL to set up the schema, Create and maintain a web application based on UI configurable components, Configure automatic business rules (triggers, notifications) and automatic object naming, Execute advanced MQL commands needed for administration, Extend the application with JSP

References

1. Companion Courses – https://companion.3ds.com/
2. Stark John, "Product Lifecycle Management: 21st Century Paradigm for Product Realization", Springer, Third Edition, 2015
3. Antti Saakasvuori, Anselmi Immonen, "Product Lifecycle Management" - Springer, 1st Edition, 2003.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMP706**		Course Title: **ERP Technical Lab**
L-T-P**: 0-0-3**	Credits: **3**	Contact Hrs: **6 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Practical Hrs: **72 hrs**		Exam Duration: **2 hrs**

Financial Accounting (Advanced): Fixed assets, Budget, Cost center accounting

MRP: Sales forecast, MRP run, Order recommendation

Admin and Technical: Application installation (APP and DB), System initialization, Set-up, Technical Enhancement – UI, Report – Query generation, Crystal report, Print layout design, Basics of Integration

Reports: Generation of reports for various functions

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Curriculum Content

Course Code: **18EPMC801** Course Title: **Manufacturing Execution Systems**
L-T-P**: 3-1-0** Credits: **4** Contact Hrs: **5 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Enterprise and Enterprise Integration: Enterprise and its characteristics, Strategic Planning, Feedback Loops, Time Definitions, Business Processes, Manufacturing Processes, Enterprise Integration, Horizontal Integration and Interoperability, Vertical Integration and Temporal Gap, Digitalization, Standards (ISO 15704)

Manufacturing Execution Systems and its Functionalities: Manufacturing Execution Systems (MES), MES Functionalities, MES Models, Manufacturing Operations Management (MOM), Functional Control Model, MES in Discrete Industry, MES in Process Industry, Standards (IEC 62264, IEC 61512, VDI 5600)

Process and Data Modeling: Enterprise Modeling, Process Modeling, Business Process Modeling Language (BPMN), Sankey Diagram, Entity-Relationship Diagrams, ARIS (ARchitecture for integrated Information Systems), Integrated Definition for Function Modelling (IDEF), Event-Driven Process Chain (EPC), Data Modeling, Data Flow Diagrams (DFDs), Unified Modeling Language (UML), Business to Manufacturing Markup Language (B2MML)

Data Collection: Process Analysis, Process Modeling, Data Modeling, Data Flow Diagrams (DFDs), Communication Patterns, Technologies, OPC (OLE for Process Control)

Traceability And Tracking: Tracing, Traceability, Enterprise Entities, Forward and Backward Traceability, Traceability Granularity, Tracking, Tracking Approaches, Regulations (GMP, US FDA, EudraLex)

PERFORMANCE MEASUREMENT: Performance Measurement, Performance Management, Performance Measurement System and Characteristics, Key Performance Indicators (KPIs), Overall Equipment Effectiveness (OEE), Metrics Maturity Model, KPI Effectiveness, Process Improvement, Standards (ISO 22400, VDMA 66412)

Managerial Accounting: Managerial Accounting, Cost Assignment Techniques, Cost Hierarchal Levels, Activity Drivers, Standard Cost, Actual Cost, Job Costing, Process Costing, Activity-Based Costing (ABC), Time-Driven ABC (TDABC), Resource Consumption Accounting (RCA), Cost of Poor Quality (COPQ)

Real-Time Enterprise: Real-Time Enterprise (RTE), Event-Driven Architecture (EDA), Events, Complex Event Processing (CEP)

Industry 4.0: Industry 4.0, Challenges, Industrial Internet of Things (IIoT), Reference Architecture for Industry 4.0, Cyber-Physical Systems (CPS), Cyber-Physical Production Systems (CPPS), Smart Product, Smart Manufacturing, Smart Logistics, Smart Services

Business Analytics and Business Intelligence, Blockchain: Knowledge Management, Case-Based Reasoning (CBR), Big Data, Decision Analytics, Descriptive Analytics, Predictive Analytics, Prescriptive Analytics, Bitcoin and Blockchain, Merkle Tree, Blockchain Types, Scope and Application of Blockchain in Manufacturing

References:

1. Sachin Karadgi, "A Reference Architecture for Real-Time Performance Measurement," Springer, 2014.
2. Opher Etzion, Peter Niblett, "Event Processing in Action," Manning, 2011.
3. Roger Wattenhofer, "The Science of the Blockchain," CreateSpace Independent Publishing Platform, 2016.
4. Bruce Silver, "BPMN Method and Style - With BPMN Implementer's Guide," Cody-Cassidy Press, 2011.
5. Charles T. Horngren, George Foster, Srikant M. Datar, Madhav V. Rajan, Chris Ittner, "Cost Accounting: A Managerial Emphasis," Prentice Hall, 13th Edition, 2008.
6. Wood C. Douglas (Editor), "Principles of Quality Costs: Financial Measures for Strategic Implementation of Quality Management," ASQ, 4th Edition, 2013.
7. Gary Cokins, "Activity-Based Cost Management: An Executive's Guide," Wiley, 2001.
8. Robert S. Kaplan, Robin Cooper, "Cost & Effect: Using Integrated Cost Systems to Drive Profitability and Performance," Harvard Business Review Press, 3rd edition, 1997.
9. ISO 15704: Industrial Automation Systems—Requirements for Enterprise-Reference Architectures and Methodologies, 2000.
10. IEC 62264: Enterprise-Control System Integration. Multi—part standard.
11. IEC 61512: Batch Control. Multi—part standard.
12. ISO 22400–2: Automation Systems and Integration—Key Performance Indicators for Manufacturing Operations Management, Multi—part standard.
13. VDI 5600 Part 1: Manufacturing execution systems (MES), 2007.
14. OPC Foundation: OPC unified architecture specification part 1: overview and concepts, http://www.opcfoundation.org/.
15. MESA, MES Explained: A high level vision, white paper number 6, 1997.GMP
16. WHO Good Practices for Pharmaceutical Quality Control Laboratories, WHO Technical Report Series, No. 957, 2010.
17. Mike Bourne, Pippa Bourne, Handbook of Corporate Performance Management, Wiley, 2011.

III Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **18EPMC802** Course Title: **Manufacturing Systems Simulation**
L-T-P**: 3-0-1** Credits: **4** Contact Hrs:**5 hrs/week**
ISA Marks: **50** ESA Marks: **50** Total Marks: **100**
Teaching Hrs: **50 hrs** Exam Duration: **3 hrs**

Principles of Modeling & Simulation: Basic Simulation Modeling, Systems – discrete and continuous systems, general systems theory, models of systems- variety of modeling approach, concept of simulation, simulation as a decision making tool, types of simulation, Principle of computer modeling- Monte Carlo simulation, Nature of computer modeling, limitations of simulation, area of application.

Random Number Generation: Random variables and their properties, Properties of random numbers, generation of Pseudo random numbers, techniques for generating random numbers, Various tests for random numbers-frequency test and test for Autocorrelation,

Random Variate Generation: Different techniques to generate random Variate: Inverse transform technique,-exponential, Normal, uniform, Weibull, direct transformation technique for normal and log normal distribution, convolution method and acceptance rejection techniques-Poisson distribution, **Statistical Techniques:** Comparison of two system designs, Comparison of several system designs – Bonferroni approaches to multiple comparisons for selecting best fit, for screening

Design and Evaluation of Simulation Experiments: Problem formulation, data collection and reduction , time flow mechanism, key variables, logic flow charts, starting condition, run size, experimental design consideration, output analysis, verification and validation of simulation models. **Simulation Languages:** Comparison and selection of simulation languages, study of any one simulation language.

Discrete Event Simulation: Concepts in discrete –event simulation, development of simulation models for queuing systems, production systems, inventory systems, maintenance and replacement systems, investment analysis and network, Programming for discrete event simulation, Case studies.

References:

1. Jerry Banks and John S Carson, Barry L Nelson, David M Nicol, “Discrete event system simulation”, Prentice Hall, India.
2. Khoshnevi. B., “Discrete system simulation”, McGraw Hill International.
3. Ronald G Askin and Charles R Standridge , “Modeling and analysis of manufacturing systems”, John Wiley & Sons.
4. Gordon G , “System Simulation”, Prentice Hall, India..
5. Thomas J Schriber., “Simulation using GPSS”, John Wiley & Sons.
6. Shannon, R.E., “System Simulation – The art and science”, Prentice Hall, India.
7. Averill Law & David M.Kelton , “Simulation, Modeling and Analysis”, TMH.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **19EPMC708**		Course Title: **Research Methodology**
L-T-P**: 2-1-0**	Credits: **3**	Contact Hrs:**4 hrs/week**
ISA Marks: **100**	ESA Marks: **--**	Total Marks: **100**
Teaching Hrs: **26 hrs**	Tutorial Hrs: **24 hrs**	Exam Duration: **--**

Research: Definition, Characteristics and Objectives; Types of Research, Research Methodology, Research Process, Literature Review, Review concepts and theories, Formulation of Hypothesis, Research design, Data collection, Processing and analysis of data collected, Interpretation of data, Computer and internet: Its role in research, Threats and Challenges to research, Writing a research paper, research project, Thesis, Research ethics, Citation methods and rules. Case studies.

References:

1. Kothari C. R. "Research Methodology – Methods & Techniques", Wishwa Prakashan,
2. Ranjit Kumar, "Research Methodology – A step by step guide for Beginners", 3rd Edition, Pearson Edition, Singapore, 2011.
3. Dawson Catherine, "Practical Research Methods", UBS Publishers, New Delhi, 2002.

II Sem M. Tech. (Production Management)

Curriculum Content

Course Code: **19EPMW701**		Course Title: **Mini Project**
L-T-P**: 0-0-3**	Credits: **3**	Contact Hrs: **6 hrs/week**
ISA Marks: **80**	ESA Marks: **20**	Total Marks: **100**
Teaching Hrs: **72 hrs**		Exam Duration: **2 hrs**

Mini Project: The Guide shall define the problem statement for the Project work. The student shall execute the Project within three months duration during the 2nd semester. The student who has opted Mini Project shall opt either ERP or PLM theme to carry out their work.