KLE Technological University | Creating Value, Leveraging Knowledge

Curriculum Structure and Curriculum Content for the Academic Batch 2023-25
School /Department: Mechanical Engineering
Program: M.Tech in Advanced Manufacturing Systems

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KLE Technological University | Creating Value, Leveraging Knowledge

Vision and Mission of KLE Technological University

Vision

KLE Technological University will be a national leader in Higher Education– recognised globally for innovative culture, outstanding student experience, research excellence and social impact.

Mission

KLE Technological University is dedicated to teaching that meets highest standards of excellence, generation and application of new knowledge through research and creative endeavours.

The three-fold mission of the University is:

- To offer undergraduate and post-graduate programs with engaged and experiential learning environment enriched by high quality instruction that prepares students to succeed in their lives and professional careers.

- To enable and grow disciplinary and inter-disciplinary areas of research that build on present strengths and future opportunities aligning with areas of national strategic importance and priority.

- To actively engage in the Socio-economic development of the region by contributing our expertise, experience and leadership, to enhance competitiveness and quality of life.

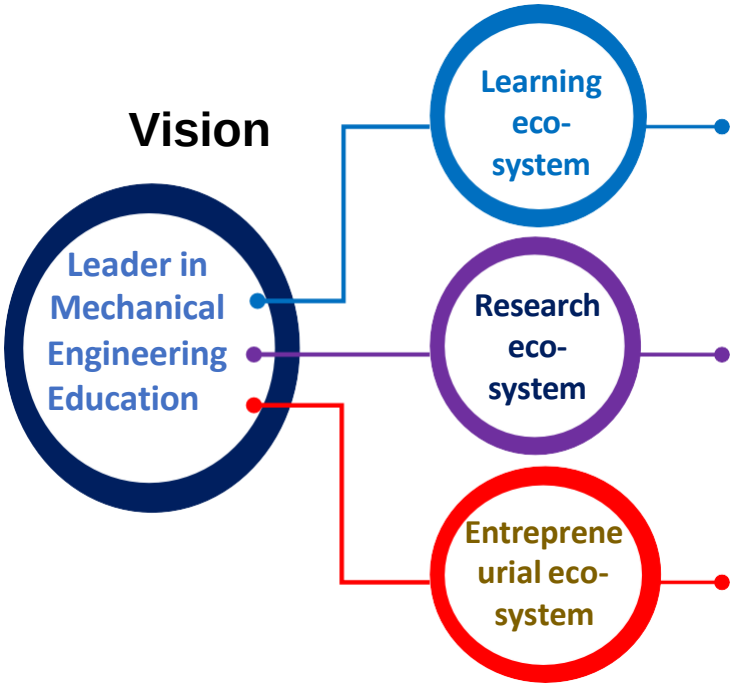
As a unified community of faculty, staff and students, we work together with the spirit of collaboration and partnership to accomplish our mission.

Vision and Mission Statements of the School / Department

Vision

KLE Tech - School of Mechanical Engineering will be a national leader in mechanical engineering education - recognized for innovative culture, outstanding research and societal outreach.

Mission



Offer programs in an **engaging and experiential learning environment**, preparing students for success in their lives and professional careers.

Engage in Mechanical-discipline and inter-disciplinary research aligned to areas of national importance and priority.

Contribute to **socio-economic development** of the region for enhanced quality of life.

Program Educational Objectives/Program Outcomes and Program-Specific Objectives

Program Educational Objectives -PEOs
1. Graduates will demonstrate technical competence in design of products, processes and systems to address identified problems through focused research directed by guiding principles of technical documentation and evaluation with due consideration to sustainability principles incorporating modern computing tools.
2. Graduates will be competent as leaders committed to strive towards attainment of professional and organizational goals with due adherence to professional ethics team expectations and sensitivities of cultural diversity.
3. Graduates will practice of engineering profession in corporate and governmental settings to meet prevailing stake holder needs, thereby contributing to societal development.
4. Graduates will get updated to actively adopt new professional development through suitable application of domain knowledge and compete for new career openings evolving in the ever-changing global enterprises.
Program Outcomes-POs
1. An ability to independently carry out research /investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4. Ability to plan and execute projects considering economical and financial factors
5. Ability to use and develop modern tools in modeling, simulation and analysis of manufacturing/ management related problems

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Curriculum Structure-Overall

	Semester 1 to 4 (2023-25)Total Program Credits:88			
Course with course code	I	II	III	IV
	PLM Fundamentals 20EAMC701	PLM Advanced 20EAMC705	Industrial Training/Mini Project 20EAMI801	Project Work Phase II 20EAMW802
	Engineering Data Management 20EAMC702	Enterprise Resource Planning - II 20EAMC706	Project Work Phase I 20EAMW801	
	Product Design and Development 20EAMC703	Project Feasibility and Analysis 21EAMC701		
	Enterprise Resource Planning – I 20EAMC704	Research Methodology 20EAMC708		
	Programme Elective 1	Programme Elective 2		
	Collaborative Design-Modeling Lab 20EAMP701	PLM Advanced Lab 21EAMP701		
	PLM Functional Lab 20EAMP702	ERP Technical Lab 20EAMP705		
	ERP Functional Lab 20EAMP703	Product Automation Lab 20EAMP706		
		Mini Project 20EAMW701		
Credits	**25**	**25**	**18**	**20**

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Curriculum Structure-Semester wise

Semester – I

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No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	20EAMC701	PLM Fundamentals	PC	2-0-0	2	02	50	50	100	3 hours
2	20EAMC702	Engineering Data Management	PC	3-0-0	3	03	50	50	100	3 hours
3	20EAMC703	Product Design and Development	PC	3-0-0	3	03	50	50	100	3 hours
4	20EAMC704	Enterprise Resource Planning - I	PC	3-0-0	3	03	50	50	100	3 hours
5	20EAMEXXX	Programme Elective I	PE	3-0-0	3	03	50	50	100	3 hours
6	20EAMP701	Collaborative Design-Modeling Lab	PC	0-0-5	5	10	80	20	100	2 hours
7	20EAMP702	PLM Functional Lab	PC	0-0-3	3	06	80	20	100	2 hours
8	20EAMP703	ERP Functional Lab	PC	0-0-3	3	06	80	20	100	2 hours
TOTAL				**14-0-11**	**25**	**36**				

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Semester – II

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No	Code	Course	Category	L-T-P	Credit	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	20EAMC705	PLM Advanced	PC	2-0-0	2	02	50	50	100	3 hours
2	20EAMC706	Enterprise Resource Planning - II	PC	3-0-0	3	03	50			
3	21EAMC701	Project Feasibility and Analysis	PC	3-0-0	3	03	50	50	100	3 hours
4	20EAMC708	Research Methodology	PC	2-1-0	3	04	100	-	100	-
5	20EAMEXXX	Programme Elective II	PE	3-0-0	3	03	50	50	100	3 hours
6	21EAMP701	PLM Technical Lab	PC	0-0-3	3	06	80	20	100	2 hours
7	20EAMP705	ERP Technical Lab	PC	0-0-2	2	04	80	20	100	2 hours
8	20EAMP706	Product Automation Lab	PC	0-0-3	3	06	80	20	100	2 hours
9	20EAMW701	Mini Project	PC	0-0-3	3	06	50	50	100	2 hours
TOTAL				**13-1-11**	**25**	**37**				

Semester- III

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No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	20EAMI801	Industrial Training/Mini Project	PJ	0-0-10	10	30	50	50	100	2 hours
2	20EAMW801	Project Work Phase I	PJ	0-0-8	8	24	50	50	100	2 hours
TOTAL				**0-0-18**	**18**	**54**				

Semester- IV

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	20EAMW802	Project Work Phase II	PJ	0-0-20	20	40	50	50	100	2 hours
TOTAL				**0-0-20**	**20**	**40**				

List of Program Electives

←Back-1Semester

Sr.No	Name of the Course	Course Code
1	Design for Additive Manufacturing	20EAME701
2	Industrial Robotics	20EAME702
3	Supply Chain Management	20EAME703
4	Manufacturing Systems Simulation	20EAME704
5	Additive Manufacturing	20EAME705
6	Manufacturing Systems and Automation	20EAME706
7	Manufacturing Execution Systems	20EAME707
8	Robust Design Optimization	20EAME708

Curriculum Content- Course wise

←Back-1Semester

Program:PG_Advanced Manufacturing Systems		Semester: I
Course Title: PLM Fundamentals		Course Code:20EAMC701
L-T-P: 2-0-0	Credits:2	Contact Hours:2
ISA Marks: 50	ESA Marks:50	Total Marks:100
Teaching Hours: 30	Examination Duration:3hrs	

1. The PLM Environment – 7 hrs

PLM overview, Background for PLM, Scope, PLM grid, PLM paradigm – Concepts andconsequences, Strategic benefits, Operational benefits, Spread of PLM, Overcoming problems, Enabling opportunities, Challenges, Issues in the traditional environment, Product data issues, A complex changing environment.

2. PLM Basic Functionalities – 4 hrs

Collaborations and approvals, Structure of PLM business process services, Workspace, Folders, Routes, Issue management, Document management, IP classification, Need for IP protection, Parts and libraries, BOM management.

3. Organizational Change Management – 6 hrs

Relevance of OCM in PLM, Benefits of OCM, Incremental and transformational change, Prerequisites for CM, The importance of OCM in the PLM Environment, Participants in change, Generic issues with change, OCM activities in the PLM environment, Pitfalls of organizational change.

4. Project Management in PLM Environment – 6 hrs

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.

5. PLM: A Key Enabler in Implementation of Industry 4.0 – 7 hrs

Digital manufacturing, Industry 4.0 – A smart era, Action areas of Industry 4.0, PLM in Industry 4.0, Collaborations in Industry 4.0 via PLM, IP protection and BOM management in Industry 4.0 via PLM, Project and variant management in Industry 4.0 via PLM, Traceability requirements management in Industry 4.0 via PLM, Benefits of incorporating PLM in Industry 4.0, Challenges and future directions for PLM in Industry 4.0.

Reference Books:

1. Stark John, "Product Lifecycle Management: 21st Century Paradigm for Product Realization", Springer, Third Edition, 2015
2. Chaudhery Mustansar Hussain & Paolo Di Sia, "Handbook of Smart Materials, Technologies, and Devices: Applications of Industry 4.0", Springer. First Edition, 2021

Program: PG_Advanced Manufacturing Systems		Semester: I
Course Title: Engineering Data Management		Course Code:20EAMC702
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4
ISA Marks: 50	ESA Marks:50	Total Marks:100
Teaching Hours: 40	Examination Duration:3hrs	

1. Introduction and Overview of Embedded Product Design - 5 hrs

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.

2. PDM Systems and Data Exchange- 5 hrs

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).

3. PDM and SCM- 10 hrs

PDM and the 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.

4. PDM and SCM Requirements of Design Data Management - 10 hrs

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.

5. Analysis of Needs and Solutions - 5 hrs

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

6. Product Data in PLM Environment- 5 hrs

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.

Reference Books:

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.

Program: PG_Advanced Manufacturing Systems		Semester: I
Course Title: Engineering Data Management		Course Code:20EAMC702
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4
ISA Marks: 50	ESA Marks:50	Total Marks:100
Teaching Hours: 50	Examination Duration: 3 hrs	

1. Introduction and Overview of Embedded Product Design - 5 hrs

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.

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Reference Books:

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.

Program: PG_Advanced Manufacturing Systems		Semester: I
Course Title: Product Design & Development		Course Code:20EAMC703
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3
ISA Marks: 50	ESA Marks:50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. Introduction - 6 hrs

Characteristics of successful product development, duration and cost of product development, Challenges of product development.

2. Development Process and Organizations - 6 hrs

Generic development process, concept development – Front-end process, adapting the generic product development process.

3. Identifying Customer Needs - 6 hrs

Defining scope, gathering data from customers, establishing relative importance of needs etc.

4. Establishing Product Specifications - 4 hrs

Target specifications & refining specifications.

5. Concept Generation - 4 hrs

Five step methodology of concept generation.

6. Concept selection - 4 hrs

Structured methodology for selecting a concept using selection matrix & ranking of concepts.

7. Product Architecture - 2 hrs

Meaning & implication of product architecture.

8. Industrial Design - 4 hrs

Meaning of ID, & its impact, Aesthetic & Ergonomic considerations, ID process.

9. Design for Manufacturing - 2 hrs

DFM meaning, DFM Methodology.

10. Value Engineering and Product Design - 2 hrs

Definition of value, Value analysis job plan, creativity etc.

Reference Books:

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.

Program: PG_Advanced Manufacturing Systems		Semester: I
Course Title: Enterprise Resource Planning – I		Course Code:20EAMC704
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3
ISA Marks: 50	ESA Marks:50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. Introduction to ERP – 10 hrs

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

2. ERP – A Manufacturing Perspective – 10 hrs

Role of Enterprise Resource Planning (ERP) in manufacturing, Computer Aided Design/Computer Aided Manufacturing (CAD/CAM), Materials Requirement Planning (MRP)-Master Production Schedule (MPS);Bill of Material (BOM);Inventory Records; Closed Loop MRP; Manufacturing Resource Planning (MRP-II), Manufacturing and Production Planning Module of an ERP System , Distribution Requirements Planning (DRP), Just-in-Time(JIT) & KANBAN - Kanban; Benefits of JIT; Potential Pitfalls of JIT; Kanban, Product Data Management (PDM)- Data Management, Process Management; functions of PDM; Benefits of PDM, Manufacturing Operations- Make-to-Order (MTO) and Make-to-Stock (MTS); Assemble-to-Order (ATO); Engineer-to-Order (ETO); Configure-to-Order (CTO)

3. ERP modules structure – 20 hrs

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

Sales and Distribution Perspective: 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 Perspective: 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

CRM Perspective: Role of ERP in CRM, Concept of CRM: Objectives of CRM; Benefits of CRM; Components of CRM, Types of CRM: Operational CRM, Analytical CRM, Sales intelligence CRM, Collaborative CRM, Sub-Modules of CRM: Marketing module; Service module; Sales module

HR Perspective: Role of ERP in Human Resource Management: Workflow of ERP human resource management system; Advantages of ERP human resource management system, Human Resource Management Module: Functions of human resource management module; Features of human resource management module; Benefits of human resource management module
Reference Books: 1. Ellen Monk & Bret Wagner, Concepts in Enterprise Resource Planning, 4th edition, Course TechnologyCENGAGE Learning. 2. Alexis Leon, Enterprise Resource Planning, 3rd edition, Mcgraw Higher Ed. 3. Vinod Kumar Garg, N.K. Venkitakrishnan, Enterprise Resource Planning: Concepts and Practice, 2ndedition, Prentice Hall India Learning Private Limited. 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.

←Back-1Semester

Program: PG_Advanced Manufacturing Systems		**Semester: I**
Course Title: Collaborative Design - Modeling Lab		**Course Code:20EAMP701**
L-T-P: 0-0-5	**Credits: 5**	**Contact Hours: 10**
ISA Marks: 80	**ESA Marks:20**	**Total Marks:100**
Teaching Hours: 120	**Examination Duration: 2 hrs**	
1. 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		
2. Sketcher Exercises on sketch tools, profile tool bar and constraint tool bar.		
3. Part Design Exercise on 3D models using pad, slot, shaft, groove, hole, rib and stiffener commands, cut revolve etc.		
4. Generative Shape Design (GSD) Exercises using GSD to generate complicate surfaces using sub tool bars		
5. Sheet Metal Setting sheet metal parameters, bend extremities tab, creating the base wall, creating the wall on edge, creating extrusions etc.		
6. 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.		
7. Drafting Converting existing 3D models into 2D drawings with all relevant details, sectional views etc.		
8. 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
9. 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
Reference Books: Companion Courses – https://companion.3ds.com/

←Back-1Semester

Program: PG_Advanced Manufacturing Systems		**Semester: I**
Course Title: PLM Functional Lab		**Course Code:20EAMP702**
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours: 06**
ISA Marks: 80	**ESA Marks:20**	**Total Marks:100**
Teaching Hours: 72	**Examination Duration: 2 hrs**	
1. Collaboration and Approvals – 15 hrs 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.		
2. IP Classification – 15 hrs Need for 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.		
3. Change Management – 15 hrs Initiate a change action, Add proposed changes to change action, Work under change actions to execute a design modification, View the realized changes, Review and approve the design changes.		
4. Project Management Fundamentals – 15 hrs 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.		
5. Open Ended Experiments – 12 hrs Collaborations, IP Classification, Change management, Project management fundamentals		
References: 1. Companion Courses – https://companion.3ds.com/ 2. Antti Saakasvuori, Anselmi Immonen, "Product Lifecycle Management" - Springer, 1st Edition, 2003.		

Program: PG_Advanced Manufacturing Systems		**Semester: I**
Course Title: ERP Functional Lab		**Course Code:20EAMP703**
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours: 06**
ISA Marks: 80	**ESA Marks:20**	**Total Marks:100**
Teaching Hours: 72	**Examination Duration: 2 hrs**	
1. Selection Criteria for ERP Packages – 2 hrs Survey of Indian ERP Packages.		
2. Financial Accounting – 16 hrs Basic Finance – Chart of accounts, Journal entries, Journal vouchers, Exchange rates; Banking (In and Out); Debit and Credit note.		
3. Master Data Management – 6 hrs Item master; Business partner master – Customer, vendor; Pricing; Tax.		
4. Supply Chain Management – 38 hrs 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.		
5. Reports – 10 hrs Generation of reports for various functional modules.		
References: 1. SAP Business One Manual		

←Back-1Semester

Program: PG_Advanced Manufacturing Systems		**Semester: I**
Course Title: Design for Additive Manufacturing		**Course Code:20EAME701**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3**
ISA Marks: 50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours: 40	**Examination Duration: 3 hrs**	

1. 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.

2. 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.

3. 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.

4. Topology Optimization for AM

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

5. 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.

←Back-1Semester

Program: PG_Advanced Manufacturing Systems		Semester: I
Course Title: Industrial Robotics		Course Code:20EAME702
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3
ISA Marks: 50	ESA Marks:50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. 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

2. 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

3. Differential Motions and Velocities

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

4. 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

5. 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

6. 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

Program: PG_Advanced Manufacturing Systems		Semester: I
Course Title: Supply Chain Management		Course Code:20EAME703
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3
ISA Marks: 50	ESA Marks:50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. 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

2. 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

3. 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

4. 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

5. 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

6. Inventory Management

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

7. 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

8. 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.
6. Nickel Slack and Michael Lewis, Operations Strategy, Prentice Hall.

←Back-1Semester

Program: PG_Advanced Manufacturing Systems		Semester: I
Course Title: Manufacturing Systems Simulation		Course Code:20EAME704
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3
ISA Marks: 50	ESA Marks:50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. Simulation Modeling and Analysis

Simulation Modeling and Analysis, Other types of simulation models, purpose of simulation, Advantages and Disadvantages of simulation, Limitations of simulation, Other considerations.

2. Principles of Modeling & Simulation

Basic simulation modeling systems – discrete and continuous systems, general systems theory, models of systems- variety of modeling approach, Simulation as a decision making tool, Principle of computer modeling- Monte Carlo simulation, Nature of computer modeling.

3. Problem Formulation and Project Planning

Formal problem statement, Orientation, Project objectives, Decision making tools for determining project objectives. Simulation in project management, Simulation project managers function, Developing the simulation project plan, Compressing projects, Advanced project management concepts.

4. System Definition, Input Data Collection and Analysis

Systems classification, High level flow chart basics, Components and events to model, Data to be included in the model, Output data. Sources of input data, Collecting input data, Deterministic versus Probabilistic data, Discrete vs. Continuous data, Common input data distributions, Analyzing input data.

5. Model Translation, Verification and Analysis

Simulation program selection, Model translation section, Program organization, Divide-and-Conquer approach, Advancing the simulation clock event by event, Need for validation, Two types of validation, Validation data analysis process.

6. Simulation Application Areas

Manufacturing and material handling system, Automobile industry, Logistics and transportation systems, Health care, Service systems, Military.

References:

1. Jerry Banks and John S Carson, Barry L Nelson, David M Nicol, Discrete event system simulation, Prentice Hall, India.
2. Ronald G Askin and Charles R Standridge, Modeling and analysis of manufacturing systems, John Wiley & Sons.
3. Gordon G, System Simulation, Prentice Hall, India..
4. Shannon, R.E., System Simulation – The art and science, Prentice Hall, India.
5. Averill Law & David M.Kelton, Simulation, Modeling and Analysis, TMH.

←Back 2semester

Program: PG_Advanced Manufacturing Systems		Semester: II
Course Title: PLM Advanced		Course Code:20EAMC705
L-T-P: 2-0-0	Credits: 3	Contact Hours: 2
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours: 30	Examination Duration: 3 hrs	

1. PLM Systems – 6 hrs

System Architecture, Information Models and Product Structures, Reasons for Deployment of PLM Systems, Use of PLM Systems in Different Organizational Verticals, Integration of the PLM System with other Applications.

2. Deployment of the PLM System – 6 hrs

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.

3. Business benefits of a PLM System – 6 hrs

Factors leading to PLM, Benefits of PLM in product lifecycle management, Measuring the business benefits in daily operations, PLM and data warehousing as a tool to support decision-making, Analyzing the cost of acquisition and the deployment of a PLM system, PLM software licenses, Database licenses, Hardware acquisition, Maintenance.

4. Challenges of Product Management in Manufacturing and Service Industries – 8 hrs

Life cycle thinking, Value added services and after sales traceability, Special challenges of product management in the high-tech industry, Case studies. Categorizing services, PLM in service business, PLM challenges in service business, Case studies.

5. Understanding the product Lifecycle – 4 hrs

The basic behavior of products and lifecycles, Using metrics to steer your business performance in various phases of the product lifecycle, Other aspects of product lifecycle, Building a product business case, Case studies.

Reference Books:

1. Antti Saakasvuori, Anselmi Immonen, Product Lifecycle Management - Springer, 1st Edition, 2003.
2. Grieves Michael, Product Lifecycle Management - Driving the Next generation of Lean Thinking, McGraw-Hill, 2006.

←Back 2semester

Program: PG_Advanced Manufacturing Systems		Semester: II
Course Title: Enterprise Resource Planning-II		Course Code:20EAMC706
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. ERP implementation Basics – 4 hrs

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

2. ERP implementation Life cycle – 10 hrs

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; Difference between Implementation, Upgrade & Re-implementation; Configuration vs Customization in ERP project

3. ERP and e-Business – 6 hrs

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

4. Future Directions in ERP – 6 hrs

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

5. Other Related Technologies of SCM – 6 hrs

Relation to ERP; E-Procurement; E-Logistics; Internet Auctions; E-markets; Electronic Business Process Optimization; Business Objects in SCM; E commerce

6. Case Studies– 8 hrs

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

Reference Books:

1. Ellen Monk & Bret Wagner, Concepts in Enterprise Resource Planning, 4th edition, Course TechnologyCENGAGE Learning.
2. Alexis Leon, Enterprise Resource Planning, 3rd Edition, Mcgraw Higher Ed.
3. Vinod Kumar Garg, N.K. Venkitakrishnan, Enterprise Resource Planning: Concepts and Practice, 2nd Edition, Prentice Hall India Learning Private Limited.
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.

←Back 2semester

Program: PG_Advanced Manufacturing Systems		Semester: II
Course Title: Project Feasibility and Analysis		Course Code:21EAMC701
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. Planning overview – 7 hrs

Capital investments, Types of capital investments, Phases of capital budgeting, Levels of decision-making, Facets of project analysis, Key issues in major investment decisions, Objectives of capital budgeting, Common weaknesses in capital budgeting.

2. Generation and Screening of Project Ideas – 7 hrs

Concept of strategy, Portfolio strategy, Business level strategies, Strategic planning and capital budgeting, Generation of ideas, Corporate appraisal, Tools for Identifying Investment opportunities. Scouting project ideas, Preliminary screening.

3. Market and Demand Analysis– 6 hrs

Situational analysis, Specification of objective, Portfolio management techniques, Conduct of market survey, Characteristics of market, SWOT analysis, Demand forecasting, Uncertainties in demand forecast, Marketing plan.

4. Technical Analysis– 7 hrs

Manufacturing process/technology, Material inputs and utilities, Product mix and Plant capacity, Location and site, Machineries and equipment, Structures and civil works, Environmental aspects, Project charts and layouts.

5. Financial Estimates and Projections – 7 hrs

Means of finance,Estimates of sales and production, Cost of production, Working capital requirement and its financing, Profitability projections, Projected cash flow statements, projected balance sheet.

6. The Impact of Sustainability on Project Management – 6 hrs

The concept of sustainability, Sustainability in project management, Inter-relating life cycles, The impact of sustainability on project management processes, Measuring and reporting projects, The impact of sustainability on project management competencies.

Reference Books:

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.

←Back 2semester

Program: PG_Advanced Manufacturing Systems		Semester: II
Course Title: Research Methodology		Course Code: 20EAMC708
L-T-P: 2-1-0	Credits: 3	Contact Hours: 5
ISA Marks: 100	ESA Marks: -	Total Marks:100
Teaching Hours: 50	Examination Duration: 3 hrs	

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.

Reference Books:

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.

←Back 2semester

Program: PG_Advanced Manufacturing Systems		Semester: II
Course Title: Additive Manufacturing		Course Code:20EAME705
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. 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

2. 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

3. 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.

4. 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

5. 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, 2001.

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Program: PG_Advanced Manufacturing Systems		Semester: II
Course Title: Manufacturing Systems & Automation		Course Code:20EAME706
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. 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.

2. 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.

3. Flexible manufacturing systems

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

4. Industrial control systems

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

5. Machine vision systems

Importance of machine vision system in manufacturing automation.

6. Role of microcontrollers in manufacturing automation system

Microcontroller architecture, interfacing sensors and actuators with microcontroller for industrial automation, Microcontroller programming.

7. 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

8. 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.

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Program: PG_Advanced Manufacturing Systems		Semester: II
Course Title: Manufacturing Execution Systems		Course Code:20EAME707
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. 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)

2. 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)

3. 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)

4. Data Collection

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

5. Traceability And Tracking

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

6. 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)

7. 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)

8. Real-Time Enterprise

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

9. 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

10. 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.

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Program: PG_Advanced Manufacturing Systems		Semester: II
Course Title: Robust Design Optimization		Course Code:20EAME708
L-T-P: 3-0-0	Credits:3	Contact Hours: 3
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. Robust Design Overview

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

2. Analysis of variance

No-Way ANOVA, One-Way ANOVA, Two-Way ANOVA and Three-Way ANOVA

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

Program: PG_Advanced Manufacturing Systems		Semester: II
Course Title: Robust Design Optimization		Course Code:20EAME708
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours: 40	Examination Duration: 3 hrs	

1. Robust Design Overview

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

2. Analysis of variance

No-Way ANOVA, One-Way ANOVA, Two-Way ANOVA and Three-Way ANOVA

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

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Program: PG_Advanced Manufacturing Systems		Semester: II
Course Title: PLM Advanced Lab		**Course Code:21EAMP701**
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours: 4**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks:100**
Teaching Hours: 72	**Examination Duration: 2 hrs**	

1. Project Management Advanced – 15 hrs

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

2. Variant Management Essentials – 15 hrs

Create the product structure, Define product portfolios based on product roadmaps, Create and manage product configurations and design variants.

3. Traceable Requirements Management Essentials – 15 hrs

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.

4. Platform Management and Baseline Behaviour – 15 hrs

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.

5. Open Ended Experiments – 12 hrs

Project management advanced, Variant management essentials, Traceability requirements management essentials, Platform management and baseline behavior.

References:

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

←Back 2semester

Program: PG_Advanced Manufacturing Systems		**Semester: II**
Course Title: ERP Technical Lab		**Course Code: 20EAMP705**
L-T-P: 0-0-2	**Credits: 2**	**Contact Hours: 4**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks:100**
Teaching Hours: 48	**Examination Duration: 2 hrs**	
1. Financial Accounting (Advanced) – 16 hrs Fixed assets, Budget, Cost center accounting		
2. MRP – 15 hrs Sales forecast, MRP run, Order recommendation		
3. Admin and Technical – 15 hrs Application installation (APP and DB), System initialization, Set-up, Technical Enhancement – UI, Report – Query generation, Crystal report, Print layout design, Basics of Integration		
4. Reports – 02 hrs Generation of reports for various functional modules		
References: SAP Business One Manual.		

Program: PG_Advanced Manufacturing Systems		Semester: II
Course Title:Product Automation Lab		Course Code: 20EAMP706
L-T-P: 0-0-3	Credits: 3	Contact Hours: 6
ISA Marks: 80	ESA Marks: 20	Total Marks:100
Teaching Hours: 72	Examination Duration: 2 hrs	

1. 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

2. JAVA:

-OPPS Concept:
-String Handling
-Exception Handling
-Collection Framework.
-Database Concepts.

3. JSP:

JSP-Lifecycle, JSP Syntax, JSP Directives, JSP Actions, JSP –Client request, JSP Server Response.

4. HTML:

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

5. JavaScript:

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

6. Python:

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

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