Department of Production Engineering

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

To educate students at Undergraduate, Post Graduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.

- To provide excellent research and development facilities to take up Ph.D. program and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

To Become a Centre of Repute Striving Continuously Towards Providing Quality Education, Research and Innovation in the Field of Production Engineering

Department Mission

- To provide quality education at both undergraduate and post graduate levels
- To provide opportunities and facilities for research and innovation
- To produce engineering graduates to meet the demands of manufacturing industries and R&D organizations
- To emphasize on integrating Manufacturing technology with management
- To impart latest technological knowledge to students by continuous development of curricula and faculty

Programme Educational Objectives (PEOs)

PEO 1: Graduates will develop into independent researchers and academicians in the broad area of production and industrial engineering

PEO 2: Graduates will demonstrate a high level of competency and problem-solving aptitude to find innovative solutions for theoretical and practical problems

PEO 3: Developing a practice of continuously updating with latest knowledge and information in their relevant field of specialization

PEO 4: Graduates should engage with engineering profession and understand the importance of ethics, team work and professionalism

PROGRAM OUTCOMES (POs)

M. Tech. in Production Engineering (Automated Manufacturing Systems)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: 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.

PO4: Application of engineering and technological knowledge to solve a wide range of Production and Industrial problems.

PO5: Developing expertise in automation related subjects both at the theory and practical level.

PO6: Developing the ability and expertise in the students to apply latest data analytics tools and techniques for computing and engineering practice.

COURSE INFORMATION SHEET

Course code: PE 501
Course title: MANUFACTURING AUTOMATION
Pre-requisite(s): None
Co- requisite(s): PE 502
Credits: 03 L:3 T:0 P:0
Class schedule per week: 3
Class: M. Tech.
Semester / Level: I/05
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	To learn the concepts and principle of manufacturing automation
2.	To understand the various types of controls, components of automation and their practical use in manufacturing application
3.	Automation Using Pneumatic Systems in various application areas
4.	Understand the Automation Using Hydraulic Systems
5.	To provide knowledge levels needed for PLC programming and operating

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Able to implement concepts of automation in machine tools and plant
CO2	Students will understand the fundamentals of control in automation as they apply to manufacturing.
CO3	Design of Pneumatic Circuit for manufacturing application
CO4	Design of Hydraulic Circuit for manufacturing application
CO5	Ability to apply PLC timers and counters for the control of industrial processes

SYLLABUS

Module 1: [8 L]
Fundamentals of Manufacturing; Production system facilities; Manufacturing support systems; Different types of manufacturing systems; Automation in Production Systems

Module 2: [8 L]
Manufacturing operations; Product, Production relationships; Production Concepts & Mathematical Models, Costs of Manufacturing Operations, Case studies

Module 3: [8 L]
Automation Principles & Strategies, Concept of automation; Basic elements and types of automation; flexibility, degree, levels and yardstick of automation;
Components of Automation: Sensors, Actuators, ADC, DAC and Input/output devices.

Module 4: [8 L]
Industrial Control: Industrial control systems; Mechanical, Hydraulic, Pneumatic, Electrical, Electronic and hybrid systems; Concepts, features and parameters governing the selection of various components of Industrial control systems.

Module 5: [8 L]
PLC: Discrete Control using PLC & PLC network, Micro PLC, Programming a PLC, Logic Functions, input & output Modules, PLC Processors, PLC Instructors, Documenting a PLC System, Timer & counter Instructions, data Handling instructions, Sequencing Instructions, Mask Data representation.

Books recommended:

TEXT BOOK

1. Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing"Pearson Education, New Delhi. ISBN: 0132393212.
2. Andrew Parr, "Hydraulic and Pneumatics", Butterworth-Heinemann. ISBN:0750644192.
3. Bolton. W. "Pneumatic and Hydraulic Systems" Elsevier Science & Technology Books.ISBN:0750638362.
4. N. Viswanandham, Y. Narhari "Performance Modeling of Automated Manufacturing Systems" Prentice-Hall. ISBN: 0136588247.
5. W Bolton., "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" Prentice-Hall. ISBN: 0131216333.

REFERENCE BOOK

1. Antony Esposito, "Fluid power with Applications" Pearson Education India. ISBN:8177585800.
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall of India, New Delhi. ISBN: 8120309871.
3. S. R. Mujumdar, "Pneumatic system", Tata McGraw Hill. ISBN: 0074602314.

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Design of real-time industrial projects.
POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:
Design optimization for industrial projects, Fractional order controller
POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	-
CO2	3	-	1	3	-	2
CO3	2	3	3	2	-	2
CO4	3	2	2	3	2	3
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2, CD3
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD3,CD6,
CO4	CD1, CD2, CD3,CD6
CO5	CD1,CD2,CD3,CD6

COURSE INFORMATION SHEET

Course code: PE 503
Course title: PLANNING & CONTROL OF PRODUCTION SYSTEM
Pre-requisite(s): None
Co- requisite(s): None
Credits: 03 L:3 T:0 P:0
Class schedule per week: 3
Class: M. Tech.
Semester / Level: I/05
Branch: Production Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1.	To introduce to various inherent concepts of production systems, planning and control systems of Manufacturing Industry.
2.	To introduce of forecasting models, plant layout.
3.	To make routine process, scheduling process and identify different strategies employed in manufacturing industries to production planning.
4.	To give basic concept of inventory control and its technique.
5.	To give concept of Production monitoring & control

Course Outcomes

After the completion of this course, students will be:

CO1	Identify Various types of production systems
CO2	Understand the fundamentals of facility locations, demand forecasting.
CO3	Obtain knowledge about production planning, capacity planning.
CO4	Able to solve inventory problems and to be able to apply selected techniques for its control and management under dependent and independent circumstances.
CO5	Know production monitoring and control techniques.

SYLLABUS

Module 1 [8 L]

Generalized model of a production system, decisions in the life cycle of a production system, risk analysis using decision trees, different kinds of production systems.

Module 2 [8 L]

Mathematical models for facility location and layout, Importance of forecasting – Types of forecasting, their uses – General principles of forecasting – Forecasting techniques– qualitative methods and quantitative methods.

Module 3 [8 L]

Routing, Scheduling, Loading, dispatching, Production Planning Models, Hierarchical Production Planning, Aggregate planning, Desegregation of Aggregate Plan.

Module 4 [8 L]

Inventory planning and control, Material Requirements Planning and Lot Sizing, manufacturing resource planning & ERP.

Module 5 [8 L]

Production monitoring & control, Production Control principles and techniques, performance criteria & evaluation, resource balancing, PPC in Process Industries, Planning and Control of JIT Systems.

Books recommended:

TEXT BOOKS

1. Jay H Heizer, Barry Render, Production and operations management, Prentice Hall Publication**.(T1)**
2. Elsayed E.A. and Boucher T. O. Analysis and Control of Production systems, Prentice Hall**.(T2)**
3. King J. R., Production Planning and Control, Pergamon Press, Oxford**.(T3)**

REFERENCE BOOKS:

1. Production and operations management, S. N. Chary **(R1)**
2. Production and Operations Management Manufacturing and Services, Nicholas J. Aquilano and Richard B. Chase **(R2)**
3. Quantitative Production Management,Bestwick, P.F. and Lockyer, K **(R3)**
4. O. R. in Production Planning, Scheduling and Inventory Control Johnson, L. A. and Momtgomergy, D. C **(R4)**
5. Production and Inventory Management, Hax, A. C. and Candea, D**,.(R5)**

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements)

NIL

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Self- learning advice using internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	-	-	-
CO2	2	1	2	3	-	3
CO3	1	-	1	1	-	-
CO4	2	-	1	3	-	2
CO5	1	-	-	3	2	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	**CD1, CD4**
CO2	**CD1, CD2, CD4**
CO3	**CD1, CD2, CD3, CD4**
CO4	**CD1, CD2, CD3, CD4**
CO5	**CD1, CD2, CD3, CD4**

COURSE INFORMATION SHEET

Course code: PE 504
Course title: MODELING AND SIMULATION
Pre-requisite(s): None
Co- requisite(s): PE 505
Credits: 03 L:3 T:0 P:0
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/05
Branch: Production Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1.	To learn the concepts of modelling and simulation
2.	To understand the various types of simulation models and their practical use
3.	To know about software for modelling and simulation in various application areas
4.	Understand the statistical aspect of simulation
5.	To comprehend the verification and validation approaches for simulation models

Course Outcomes

After the completion of this course, students will be:

CO1	Develop model frameworks for discrete-event simulation
CO2	Apply pseudo-random number based manual simulation to discrete-events
CO3	Construct software models for manufacturing, logistic and material handling problems
CO4	Generate random distributions of various probability distributions for queuing systems
CO5	Analyse the simulation output for validation

SYLLABUS

Module 1 [8 L]

Introduction to modeling and simulation concepts, System analysis and components, Simulation terminology, Model of a system and types of models, Discrete *verses* continuous systems, Static and Dynamic System simulation, Pros and cons of simulation

Module 2 [8 L]

Event verses activity, General principles of event-driven simulation, Use of Pseudo-Random numbers in simulation of queuing systems, Simulation of manufacturing systems and other examples

Module 3 [8 L]

Simulation of manufacturing and material handling systems, Modeling downtime and failures, Case studies, Introduction to simulation software and languages for manufacturing and material handling

Module 4 [8 L]

Statistical models in simulation, Terminology and concepts, Useful statistical models: Discrete and continuous distribution, Poisson, Uniform, Exponential and Normal distribution, Empirical distribution

Module 5 [8 L]

Verification and validation of simulation models, Input-output validation using historical data, stochastic nature of output, Analysis of simulation results, Steady-State behavior, Output analysis and Replication method for steady-state simulation

Books recommended:

TEXT BOOKS:

1. Discrete-Event System Simulation by Jerry Banks, Carson and Nelson, Prentice Hall of India Pvt. Ltd.

REFERENCE BOOKS:

1. Simulation Modelling and Analysis by Law and Kelton, McGraw Hill, New York**.**
2. Introduction to simulation and SLAM II by Pritsker, John Wiley, New York.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements)

NIL

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Self- learning advice using internets

MAPPING OF COURSE OUTCOMES ONTO PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	-	-	-
CO2	2	1	2	3	-	3
CO3	1	-	1	1	-	-
CO4	2	-	1	3	-	2
CO5	1	-	-	3	2	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	**CD1, CD4**
CO2	**CD1, CD2, CD4**
CO3	**CD1, CD2, CD3, CD4**
CO4	**CD1, CD2, CD3, CD4**
CO5	**CD1, CD2, CD3, CD4**

COURSE INFORMATION SHEET

Course code: PE 506
Course title: MANUFACTURING TECHNOLOGY
Pre-requisite(s): None
Co- requisite(s): None
Credits: 03 L:3 T:0 P:0
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/05
Branch: Production Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	learn the concepts of casting
2.	understand the various types of forming methods
3.	know about tool life, MRR, Cutting forces and surface finish in different machining process
4.	understand the concept of joining processes
5.	realize the importance of NTM in present manufacturing scenario.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Classify the different types of casting process
CO2	Explain principles and process of Forging, Rolling, Extrusion, drawing and designing of die
CO3	Analyse the tool life, MRR, Cutting forces and surface finish
CO4	Categorize welding processes according to welding principle and material
CO5	Select a proper NTM method for given component

SYLLABUS

Module 1: Introduction to manufacturing and Foundry [8 L]

Classification of different manufacturing processes, application areas and limitations, basic engineering materials.

Sand casting process- Patterns, Core; Molding Processes, Solidification Process, Melting Furnaces,

Special casting methods - centrifugal casting and continuous casting; Permanent mold casting; Hot chamber and cold chamber die casting; Investment casting; Shell mold casting; Plaster mold casting.

Basic design considerations in casting, Casting defects and remedies.

Module 2: Metal forming [8 L]

Hot and cold working. Forming operation~-Forging, rolling, extrusion, drawing processes, sheet metal operations.

Powder metallurgy processing: Production of metal powders, compaction and sintering processes.

Module 3: Metal Removal Processes [8 L]

Classification of machining processes and machine tools. Tool's materials, different types of cutting tools, tool geometry and nomenclature of single point cutting tool, Concept of cutting speed, feed and depth of cut single and multipoint cutting operation. Turning, Drilling, shaper, grinding, milling operations.

Module 4: Joining processes [8 L]

Classification of welding processes, electric arc, special welding methods: MMAW, GTAW, GMAW, GMAW-CO2 welding, submerged arc welding, electro-slag welding, electron beam welding, laser beam welding, ultrasonic welding, resistance welding, welding defects, and arc blow heat affected zone, testing of welded joints, brazing and soldering.

Module 5: Non conventional manufacturing [8 L]

Theory and application of machining by Abrasive Jet, Water Jet, Abrasive Flow, Ultrasonic. Electrochemical Machining and grinding. Thermal energy methods of material processing by Electro-discharge, High Energy Rate Forming.

Books recommended:

TEXT BOOKS:

1. Kalpakjian, S. and Schmid, S. R, "Manufacturing Engineering andTechnology", Pearson Education, 2000.
2. Groover, M. P., "Fundamentals of Modern Manufacturing", John Wiley and Sons Inc.,2002.
3. Rao, P. N., "Manufacturing Technology (Vol. 1&2)", Tata McGraw Hill 2009.
4. Choudhry, S.K.H., Choudhry, A.K.H., and Roy N., "Elements of Work Shop Technology", Vol I & II, Media Promoters & Publishers, 1994.

REFERENCE BOOKS:

1. Ghosh A., Malik A. K., "Manufacturing Science" East West Press, 2010.
2. DeGarmo, E. P, Black, J. T., Kohser, R. A. "Materials and Processes in Manufacturing", Prentice Hall of India Pvt. Limited, 1997.
3. Lindberg, R. A., "Processes and Materials of Manufacture", Prentice Hall India Limited, 1990.
4. Khanna, O.P., and Lal, M., A Text Book of Production Technology, Vol I & II, Dhanpat Rai & Sons, 1992.
5. Jain R K ., "Production Technology: Manufacturing Processes, Technology and Automation" Khanna Publication 2004.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

Design of real-time industrial projects.

POs met through Gaps in the Syllabus
Topics beyond syllabus/Advanced topics/Design
POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Self- learning advice using internets

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	1	-
CO2	1	1	1	2	1	-
CO3	1	1	2	3	1	1
CO4	1	1	1	3	1	-
CO5	1	1	2	3	2	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

	Mapping between CO and CD	
CD	**Course Delivery methods**	**Course Outcomes**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5
CD2	Tutorials/Assignments	CO2, CO3, CO4, CO5
CD3	Seminars	CO3, CO4, CO5
CD4	Self- learning advice using internets	CO2, CO3, CO4, CO5

COURSE INFORMATION SHEET

Course code: PE 507
Course title: ADDITIVE MANUFACTURING
Pre-requisite(s): None
Co- requisite(s): None
Credits: 03 L: 03 T:00 P:00
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/05
Branch: Production Engineering
Name of Teacher:

Course Objectives
This course enables the students:

1.	To exploit technology used in additive manufacturing.
2.	To understand importance of additive manufacturing in advance manufacturing process.
3.	To acquire knowledge, techniques and skills to select relevant additive manufacturing process.
4.	To explore the potential of additive manufacturing in different industrial sectors.
5.	To apply 3D printing technology for additive manufacturing.

Course Outcomes
After the completion of this course, students will be:

CO1	Able to define the various process used in Additive Manufacturing
CO2	Able to analyse and select suitable process and materials used in Additive Manufacturing.
CO3	Able to identify, analyse and solve problems related to Additive Manufacturing.
CO4	Able to apply knowledge of additive manufacturing for various real-life applications
CO5	Able to apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing.

SYLLABUS

Module 1 [8 L]

Introduction

Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing.

Module 2 [8 L]

Additive Manufacturing Processes

Z-Corporation 3D-printing, Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM).

Module 3 [8 L]

Additive Manufacturing Machines and Systems

Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors. Introduction to NC/CNC/DNC machine tools, CNC programming and introduction, Hardware Interpolators, Software Interpolators, Recent developments of CNC systems for additive manufacturing.

Module 4 [8 L]

Pre-Processing in Additive Manufacturing

Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials.

Module 5 [8 L]

Post-Processing in Additive Manufacturing

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating.

Future scope in Additive Manufacturing

Modelling and Simulation: Thermal model to predict size of deposition such as width and height of deposition, Finite element simulation of additive process.

Books recommended:

TEXT BOOKS:

1. Gibson, I, Rosen, D W., and Stucker,B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing,Springer, 2010
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014
4. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003

Reference books:

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006
3. Mahamood R.M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials, Engineering Materials and Processes, Springer International Publishing AG 2018
4. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004

Gaps in the syllabus (to meet Industry/Profession requirements)
POs met through Gaps in the Syllabus
Topics beyond syllabus/Advanced topics/Design
POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Self- learning advice using internets

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	-	3	1	-
CO2	2	1	1	-	3	1
CO3	1	3	2	3	-	2
CO4	-	-	1	3	2	3
CO5	-	-	3	2	3	3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

	Mapping between CO and CD	
CD	**Course Delivery methods**	**Course Outcomes**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5
CD2	Tutorials/Assignments	CO2, CO3, CO4, CO5
CD3	Seminars	CO3, CO4, CO5
CD4	Self- learning advice using internets	CO2, CO3, CO4, CO5

COURSE INFORMATION SHEET

Course code: PE 508
Course title: OPERATIONS AND SUPPLY CHAIN MANAGEMENT
Pre-requisite(s): None
Co- requisite(s): None
Credits: 03 L:3 T:0 P:0
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/05
Branch: Production Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1.	To provide the student the knowledge of strategic importance of supply chain design and planning of an organisation
2.	The role of inventory management and forecasting in a supply chain
3.	Knowledge of facility planning and scheduling models
4.	Knowledge of various distribution and transportation networks and their applications
5.	The role of sourcing, information technology, pricing and revenue management, and coordination in a supply chain.

Course Outcomes

After the completion of this course, students will be:

CO1	Define the goal of a supply chain and analysis the impact of supply chain decisions on the success of a firm
CO2	Analyse demand forecasts and supply for both an enterprise and a supply chain
CO3	Apply operations planning, MRP, and aggregate planning concepts
CO4	Design a supply chain network for a firm or organisation
CO5	Judge and select the best supplier for a firm or organisation

SYLLABUS

Module 1 [8 L]

Introduction to Supply Chain Management: Understanding the supply chain, Supply Chain Performance- Achieving strategic fit and scope, complexity, key issues, Supply Chain Drivers and Metrics, Centralized vs. decentralized systems

Module 2 [8 L]

Planning Demand and Supply in a Supply Chain: Forecasting- Need for forecasting, Quantitative methods. Inventory Management- Various costs in inventory management and need, Deterministic models and discounts, Probabilistic inventory management. Aggregate Planning- The Role of Aggregate Planning, Aggregate Planning Strategies.

Module 3 [8 L]

Facility Planning and Scheduling models: Facility layout and location- Qualitative aspects, Quantitative models for layout decisions, Product, process fixed position, group layout, Location decisions-quantitative models. Scheduling models- Scheduling in MRP system, Sequencing rules and applications, Batch production sequencing and Scheduling.

Module 4 [8 L]

Designing the Supply chain network: Distribution Networks– Design options for a distribution network, e-Business and the distribution network, Network design in an uncertain environment. Transportation Networks- Design options for a transportation network, Trade-offs in transportation design, Supply Chain Optimization.

Module 5 [8 L]

Managing Cross-Functional Drivers in a Supply Chain: Sourcing Decisions- Make or buy decisions, Third- and fourth-party logistics providers, Sourcing Processes. Pricing and Revenue Management in a Supply Chain, Information Technology in a Supply Chain, Coordination in a Supply Chain.

Books recommended:

TEXT BOOKS:

1. Chopra, S., and Meindl, P. “Supply Chain Management, strategy, planning, and operation” 6/e – PHI, second edition, 2014.
2. Operations Management by Evans and Collier.
3. R. Panneerselvan, Production and operations Management, Prentice Hall of India, Delhi (2000).

REFERENCE BOOKS:

1. Christopher, "Logistics and Supply Chain Management", Pearson Education Asia, New Delhi.
2. Taylor and Brunt, "Manufacturing Operations and Supply Chain Management (The Lean Approach)", Business Press Thomson Learning, NY.
3. Arjan J. Van Weele, "Purchasing and Supply Chain Management (Analysis Planning and Practice)", Engineering, Business Press, Thomson Learning NY.
4. Shah, J. "Supply Chain Management, text and cases", Pearson Education South Asia,2009.
5. Donald B., "Logistic Management - The Integrated Supply Chain process", McGraw Hill.
6. Operations Management by Heizer and Render.

Gaps in the syllabus (to meet Industry/Profession requirements)- NIL
POs met through Gaps in the Syllabus
Topics beyond syllabus/Advanced topics/Design
POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Self- learning advice using internets

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	3	-	-
CO2	2	1	2	3	-	-
CO3	2	1	2	3	-	-
CO4	2	1	2	3	1	-
CO5	2	1	2	3	-	-

< 34% = 1, 34-66% = 2, > 66% = 3

	Mapping between CO and CD	
CD	**Course Delivery methods**	**Course Outcomes**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5
CD2	Tutorials/Assignments	CO2, CO3, CO4, CO5
CD3	Seminars	CO3, CO4, CO5
CD4	Self- learning advice using internets	CO4, CO5

COURSE INFORMATION SHEET

Course code: PE 509
Course title: AUTOMATED MANUFACTURING
Pre-requisite(s): None
Co- requisite(s): None
Credits: 03 L:3 T:0 P:0
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/5
Branch: Production Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1.	Understand the concept of automation and manufacturing systems
2.	Write basic part programme for NC machine
3.	Knowledge about various components of automation like sensors, actuators, PLC
4.	To utilize material handling equipment like AGV, AS/RS, in manufacturing situations
5.	To identify the role of robotics in automated manufacturing systems

Course Outcomes

After the completion of this course, students will be:

CO1	Explain the principles and strategies of automation in different manufacturing systems
CO2	Demonstrate programme for NC machining using part programming
CO3	Interpret different types of controller
CO4	Analyse different types of material handling systems
CO5	Apply fundamentals of Robotics, CIMS and FMS in designing manufacturing systems

SYLLABUS

Module 1 Introduction to Automation [8 L]

Basic Elements of an Automated Systems, Advanced Automation Functions, Levels of automation, Automation Principles & Strategies, concept of automation; types of automation; flexibility, degree, level and yardstick of automation; Components of automation, Introduction to NC/CNC/DNC

Module 2 CNC Part Programming [8 L]

Axes identification, coordinate system, movements and interpolation with other axis, Application of rotary axis, Manual programming for CNC turning and Milling– offline, Programming formats, Tool offsets, Type of compensations and cutting parameters, Introduction to G codes and M codes for CNC Turning and Milling, single and multipass canned cycle in turning, drilling canned cycles in milling, sub programing.

Module 3 Controller [8 L]

Industrial Control Systems, Mechanical, Electrical, Hydraulic, Pneumatic, Electronic and Hybrid systems. Concepts features & parameters governing the Selection of various components Necessary for Building the elements.

Introduction to Programmable logical controller (PLC): Discrete Control using PLC & PLC network, Introduction, Micro PLC, Programming a PLC, Logic Functions, input & output Modules, PLC Processors, PLC Instructors, Documenting a PLC System, Timer & counter Instructions, Comparison & data Handling instructions, Sequencing Instructions, Mask Data representation.

Module 4Automated material handling and quality control [8 L]

Types of equipment, functions, analysis ,conveyor systems, automated guided vehicle systems (AGVs), guidance, routing and control, Automated Storage and Retrieval systems (AS/RS), Components, Controls and applications, Integration of automated material handling and storage systems to manufacturing environment. Introduction to CMM, Non-Contact Inspection Method

Module 5 Robotics CIM and FMS [8 L]

Introduction, Fundamentals of robot technology, Robot applications in manufacturing, Robot programming Methods - Robot programming languages and ROS.

Elements of CIM, Different modules and information flow, CIM planning & implementation process, requirements of CIM, Computerized production activities, Computerized integrated quality concept.

Definition & concept, flexible automation & productivity, components of FMS, Different types of FMS, Design problem of FMS, Technology required for FMS system. Their function & programming in FMS.

Books recommended:

TEXT BOOKS:

1. Groover M.P., Automation, "Production Systems and Computer Integrated Manufacturing :3 edition PHI,2009 **(T1)**.
2. Asfahl C. R., "Robots and Manufacturing Automation" John Wiley & Sons, 1992 **(T2)**.
3. Viswanandham N., "Performance modeling of automated Manufacturing Systems", PHI, 1992 **(T3)**.
4. Viswanathan,N., and Narahari,Y., "Performance Modeling and Automated Manufacturing Systems", Prentice Hall of India Pvt. Ltd., 2000 **(T4)**.

REFERENCE BOOKS:

1. Deb S. R.,"Robotics Technology & Flexible Automation" Tata McGraw Hill, 2001 **(R1)**.
2. Thomas R. Kurfess, "Robotics and Automation Handbook" 1 ed., CRC Press 2005 **(R2)**.
3. Anthony Esposito," Fluid Power with Applications", Prentice Hall, 1997 **(R3)**.
4. Bolton, W., "Mechatronics: A Multidisciplinary Approach" 4th ed., Pearson 2008 **(R4)**.

Gaps in the syllabus (to meet Industry/Profession requirements)

NIL

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Self- learning advice using internets

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	2	1
CO2	1	1	1	3	3	1
CO3	1	1	1	3	2	1
CO4	1	1	2	3	3	1
CO5	1	1	2	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

	Mapping between CO and CD	
CD	**Course Delivery methods**	**Course Outcomes**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4, CO5
CD2	Tutorials/Assignments	CO2, CO3, CO4, CO5
CD3	Seminars	CO3, CO4, CO5
CD4	Self- learning advice using internets	CO2, CO3, CO4, CO5

COURSE INFORMATION SHEET

Course code: PE 502
Course title: COMPUTER AIDED MANUFACTURING LAB
Pre-requisite(s): None
Co- requisite(s): PE 501
Credits: 03 L:0 T:0 P: 4
Class schedule per week: 4
Class: M. Tech.
Semester / Level: I/05
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	To learn the concepts and principles of Computer aided Manufacturing (CAM)
2	To understand the various types of CAM Software's like Fanuc, Siemen's, etc. and their practical usage in manufacturing applications
3	Understand concepts of machining for selection of appropriate machining parameters, and cutting tools for CNC milling and turning jobs
4	Develop industrial components by interpreting 3D part models/ part drawings
5	Understand the concepts of CAM Software, CNC technology, to convert a CNC-lathe into a CNC-Milling machine and vice-versa

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Apply the concepts of machining for selection of appropriate machining centers, machining parameters, select appropriate cutting tools for CNC milling and turning equipment, set-up, program, and operate CNC milling and turning equipment.
CO2	Create and validate NC part program data using manual data input (MDI) for manufacturing of required component using CNC milling or turning applications Through CAM Software's like Fanuc, Siemen's, Unimat etc.
CO3	Produce an industrial component by interpreting 3D part model/ part drawings using Computer Aided Manufacturing technology through programming, setup, and ensuring safe operation of Computer Numerical Control (CNC) machine tools.
CO4	Apply the concepts of CNC technology to convert a CNC-lathe into a CNC-Milling machine and vice-versa and also to carry out machining using programmed part programs.
CO5	Develop prototype models by interpreting 3D part model/ part drawings

SYLLABUS

List of experiments

Experiment No. 1
Write a manual part program for step turning operation for a given drawing. Write the program and simulate in FANUC/SIEMENS CNC lathe simulator.

Experiment No. 2
Write a manual part program for radius cutting and taper turning operation for a given drawing. Write the program and simulate in FANUC/SIEMENS CNC lathe simulator.

Experiment No. 3
Write a manual part program for grooving operation for a given drawing. Write the program and simulate in FANUC/SIEMENS CNC lathe simulator.

Experiment No. 4
Write a manual part program for thread cutting operation for a given drawing. Write the program and simulate in FANUC/SIEMENS CNC lathe simulator.

Experiment No. 5
Convert a modular CNC-mill Unimat machine into CNC-Lathe Unimat machine and write a manual part program for step turning operation for a given drawing in Unimat CNC Lathe.

Experiment No. 6
Write a manual part program for taper turning operation for a given drawing in Unimat CNC Lathe.

Experiment No. 7
Write a manual part program for profile milling operation using linear and circular interpolation cutting for a given drawing. Write a program and simulate in FANUC/SIEMENS CNC milling simulator.

Experiment No. 8
Write a manual part program for Profile cutting with sub-program and right compensation for given drawing. Write a program and simulate in FANUC/SIEMENS CNC milling simulator.

Experiment No. 9
Write a manual part program for circular and rectangular pocketing for a given drawing. Write a program and simulate in FANUC/SIEMENS CNC milling simulator.

Experiment No. 10
Write a manual part program for drilling operation for a given drawing. Write a program and simulate in FANUC/SIEMENS CNC milling simulator.

Experiment No. 11
Convert a modular CNC-lathe Unimat machine into CNC-mill Unimate machine and write a manual part program for contouring operation for a given drawing in Unimat CNC Milling.

Experiment No. 12
Write a manual part program for contouring operation with tool compensation right for a given drawing.

Experiment No. 13
To study and learn how to operate CNC milling (VMC 300) machine-Siemens controller.

Experiment No. 14
To machine a mill part for a given drawing on a CNC milling machine (VMC 300).

Books recommended:

TEXT BOOK

1. Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing" Pearson Education, New Delhi. ISBN: 0132393212.**(T1)**
2. Rao, P.N. "CAD/CAM: Principles and Applications", McGraw Hill Publication, 2nd Edition, 2004. **(T2)**
3. Mikell P. Grover, E. Zimmer, "Computer Aided Design and Manufacturing (CAD/CAM)", Pearson Publication, 2nd Edition, 2006. **(T3)**

EFERENCE BOOK

1. David Bedworth, "Computer Integrated Design and Manufacturing" Tata McGraw Hill, New Delhi, 1998. **(R1)**
2. Radhakrishan P., Subramaniyam S., "CAD CAM and CIM", New Age International, 2002 **(R2)**

Course Evaluation:
Progressive evaluation, end semester performance and viva-voce

Gaps in the syllabus (to meet Industry/Profession requirements) :
Design of real-time industrial projects.
POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:
POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	2	1	3	2	2
CO3	2	3	3	2	3	2
CO4	3	2	2	3	2	3
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3
CO2	CD1, CD3, CD7
CO3	CD1, CD3, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1,CD2,CD3,CD6, CD7

COURSE INFORMATION SHEET

Course code: PE 505
Course title: MANUFACTURING SIMULATION LAB
Pre-requisite(s): None
Co- requisite(s): PE 504
Credits: 03 L:0 T:0 P:4
Class schedule per week: 4
Class: M. Tech.
Semester / Level: I/05
Branch: Production Engineering (AMS)
Name of Teacher:

Course Objectives

This course enables the students:

A.	To apply the concepts of modeling and simulation to real problems
B.	To develop various types of simulation models
C.	To use some software for modelling and simulation
D.	To understand the statistical aspect of simulation
E.	To apply the verification and validation approaches for simulation models

Course Outcomes

After the completion of this course, students will be:

CO1	Able to develop models for discrete-event simulation
CO2	Apply pseudo-random number based manual simulation to discrete-events
CO3	Develop software models for manufacturing, logistic and material handling problems
CO4	Apply various probability distributions for queuing systems
CO5	Analyse the simulation output for validation

SYLLABUS

List of experiments

1. Modelling & Simulation Concepts and Simulation software

Aim: To understand and make a list of the basic terms, concepts and software related to modelling and simulation

2. Discrete Event Simulation (Using Random Numbers) of a Bank

Aim: Consider the operation of a one-teller bank where customers arrive for service in 1 ± 10 minutes. The customers are served in time 1 ± 6 minutes. Simulate the bank operation until twenty customers are served assuming customer 1 arrives at time 0, and compute measures of performance such as the percentage of idle time and the average waiting time per customer.

3. Simulation of a Robotic work cell

Aim: Simulate a robotic work cell to find the cycle time of job and production rate. Assuming a 90% efficient and 8 hours shift, find the per day production. Also give your suggestion for improving the system productivity.

4. Simulation of a Drill press operation

Aim: Parts are machined on a drill press. They arrive at a rate of one every 5 ± 3 minute and it takes 3± 2 minute to machine them. Every 60 ± 60 minutes, a rush job arrives which takes 12 ± 3 minute to complete. The rush job interrupts the present job. When the regular job returns to the machine, it stays only for its remaining process time. Simulate the mean system response time for each type of part. Response time is the total time that a part spends in the system.

5. Simulation of a Grocery shop

Aim: A small grocery has only one checkout counter. Customers arrive at this checkout counter at random in the interval of [1, 8] minutes. The service time vary from 1 to 6 minutes with the probabilities shown. Simulate the problem/system for arrival and service of 20 customers.

6. Discrete Event Simulation (Using aGPSS© software) of a Food Store

Aim: Use aGPSS© software to construct the model for simulation

7. Simulation of a Self-Service Cafeteria Using aGPSS© software

Aim: Use aGPSS© software to construct the model for simulation

8. Simulation of Ambulance Dispatch

Aim: Use aGPSS© software to construct the model for simulation

9. Simulation of Factory Maintenance

Aim: Use aGPSS© software to construct the model for simulation

10. Simulation of Ships (Un)Loading Cargo at a Harbor

Aim: Use aGPSS© software to construct the model for simulation

11. Simulation of Hospital's Emergency Room

Aim: Use aGPSS© software to construct the model for simulation

12. Monte Carlo Simulation (Using MINITAB©)

Aim: Use MINITAB© to conduct a Monte Carlo simulation for finding the distribution of machining time in a lathe when the probability distribution for length of job, feed rate and rotational rpm are known

Books recommended:

TEXT BOOKS:

1. Discrete-Event System Simulation by Jerry Banks, Carson and Nelson, Prentice Hall of India Pvt. Ltd. **(T1)**

REFERENCE BOOKS:

1. Simulation Modelling and Analysis by Law and Kelton, McGraw Hill, New York**. (R1)**

Course Evaluation:

1. Progressive evaluation, end semester performance and viva-voce

Gaps in the syllabus (to meet Industry/Profession requirements):

1. Design of real-time industrial projects.
2. POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

1. POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors
CD2	Hands on training on computers
CD3	Self- learning advice

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	1	-	2	-
CO2	-	1	1	-	3	-
CO3	1	2	1	2	1	1
CO4	-	1	-	-	2	-
CO5	-	-	1	-	2	-

< 34% = 1, 34-66% = 2, > 66% = 3