Department of Production Engineering

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

MINOR in "Production Engineering"
Syllabus (CBCS UG Program)

(OFFERED ONLY TO OTHER DEPARTMENT STUDENTS)

Students who have registered for B. Tech Minor in "Production Engineering" should complete 20 credits and shall opt for courses listed in Course Structure for the Minor Program. The credits shall be over and above minimum requirement for degree award.

Graduate Attributes

PO 1: Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem Analysis: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO 3: Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

PO 4: Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

PO 5: Modern Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO 6: The Engineer and Society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO 7: Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PO 9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

PO 11: Project Management and Finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long Learning: Recognize the need for and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.

(POs: Program Outcomes)

COURSE INFORMATION SHEET

Course code: PE 203
Course title: OPERATIONS RESEARCH
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T:0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: V (MO) / Second
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives
This course enables the students to:

1	Apply the techniques of operations research in industrial engineering problems.
2	Formulate a real-world industrial problem as a mathematical programming model
3	Understand the simplex method for linear programming and perform iterations of it by hand
4	Solve specialized linear programming problems like the transportation and assignment problems
5	Operations research helps in solving problems in different environments that needs decisions, such as sequencing, queuing and games theory .

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

CO1	Understand how to translate a real-world problem, given in words, into a mathematical formulation.
CO2	Formulate and solve engineering and managerial situations as LPP.
CO3	Formulate and solve engineering and managerial situations as transportation and assignment problems
CO4	Apply Sequencing and Queuing theory for performance evaluation of engineering and management system.
CO5	Solve engineering and managerial decision theories problems by Game Theory

SYLLABUS

Module 1 Introduction: [8]
Importance of Operation Research, Methodology, Characteristics, Scope, Application and Limitation of Operations Research
Requirement of LP, Basic Assumptions, Mathematical formulation of the of LP, Graphical solution; numerical problems based on these methods.

Module 2 Linear Programming: [8]
Analytical Methods Simplex method, Big-M method, concept of duality; numerical problems based on these methods (preferably industrial engineering-based problems)

Module 3 Transportation & Assignment Model [9]

Basic feasible solution by different methods (North west corner method, least cost method, Vogel's approximation method), finding optimal solutions (MODI method), unbalanced transportation problems; numerical problems based on these methods (preferably industrial engineering-based problems)

Balanced and unbalanced assignments, travelling salesman Problem; numerical problems based on these methods (preferably industrial engineering-based problems)

Module 4 Sequencing and Queuing Model [8]

Processing of ***n*** jobs through two machines, processing ***n*** jobs through three machines; Processing of 2 jobs through ***m*** machines –graphical method, numerical problems based on these methods

Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Queuing system and their characteristics of M/M/1/FIFO/ Queuing system

Module 5: Games Theory [7]

Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and sub games methods.

Text books:

1. Operations Research, (Revised Edition), D.S. Hira, P.K. Gupta, S. Chand & Company Ltd, 2014 [**T1]**
2. Quantitative Techniques Vol I and Vol II, L. C. Jhamb, Everest Publishing House **[T2]**
3. Operations Research, - Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons **[T3]**

Reference books:

1. Operations Research an Introduction –Hamady A. Taha, Prentice Hall. **[R1]**
2. Introduction to Operations Research, 9e, Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu, McGraw Hill **[R2]**

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

Revised Simplex, Integer programming, other queuing models, Decision theory, Goal programming, Dynamic programming, Non-linear programming and Simulation. These topics are to be covered in a advanced course.

POs met through Gaps in the Syllabus:

POs 1-3, 12

Topics beyond syllabus/Advanced topics/Design:

Advanced Operation Research

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

POs 1, 3, 5, 7, 12

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	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3	3	1		1		1			1	3
CO2	3	3	3	1		1	1	1	2		2	2
CO3	3	3	2			1	1		2		1	3
CO4	3	2	1			1	1	1	2		2	2
CO5	3	2	1			1			2		2	2

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

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

COURSE INFORMATION SHEET

Course code: PE 213
Course title: MANUFACTURING PROCESSES
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: V (MO) / Second
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Examine the technical aspect related to basic manufacturing processes
2	Get acquainted with different methods of manufacturing used
3	Analyse different aspects of a manufacturing process along with their appropriate usage and scope
4	Derive relationship and use empirical relations to study the effects of manufacturing parameters on a process
5	Develop an understanding of existing and emerging manufacturing processes

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

CO1	Explain the basic principles behind different Casting, Welding, Forming and machining processes
CO2	Select appropriate manufacturing process for a given component design
CO3	Identify advantages and limitations of various casting, welding, machining and forming techniques
CO4	Correctly explain and construct mathematical relationships existing amongst various parameters in different manufacturing processes
CO5	Select appropriate welding process for a given joint

SYLLABUS

Module 1: Casting **[8]**
Introduction to foundry process and its importance; sand casting: patterns, pattern allowances, gating system components introduction and significance. Centrifugal casting , Hot chamber and cold chamber die casting; Investment casting,

Module 2: Theory of Metal Cutting **[8]**

Geometry of single point cutting tool, Introduction to orthogonal cutting; Tool forces in orthogonal cutting, types of chips, tool failure, tool life, cutting tool materials.

Module 3: Machine Tools **[8]**

Construction, operations and specifications of lathe and shaper. Construction, operations and specifications of milling & drilling machine. Introduction to grinding and types of grinding processes.

Module 4: Metal Deformation Processes **[8]**

Metal forming processes: Introduction to recovery, recrystallization and grain growth; Hot working and cold working

Rolling: Classification of rolling processes, rolling mills, products of rolling and main variables

Forging: Open and closed die forging, forging operations

Extrusion: Classification of extrusion processes, hot and cold extrusion processes

Sheet metal forming operations: Blanking and piercing, deep drawing, bending.

Module 5: Welding **[8]**

Principle, working and application of oxy- acetylene gas welding. Electric arc welding: MMAW/SMAW, SAW, GTAW and GMAW, Resistance welding. Soldering and Brazing

Text books:

1. Serope Kalpakjian and Steven Schmidt, Manufacturing Processes for Engineering Materials, Pearson Education, 6th Edition
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Material. Processes, and systems, 2nd Edition, Wiley India, 2007
3. P.N. Rao, Manufacturing Technology – Metal Cutting and Machine Tools, McGraw Hill.
4. P.N. Rao, Manufacturing Technology, Foundry, Forming and Welding, McGraw Hill
5. Hajra Choudhury, Elements of Workshop Technology–Vol.-II, Media Promoters and Publishers

Reference books:

1. E. P. DeGarmo, J. T. Black, and R. A. Kohser, Materials and processes in Manufacturing, PHI.
2. P. F. Ostwald, and Jairo Munoz, Manufacturing Processes and Systems, 9th ed., Wiley, India, 2002
3. Principles of metal casting, Rosenthal. P. C, Tata Mc Graw Hill
4. M. C. Shaw, Metal Cutting Principles, Oxford University Press, Oxford, 1984

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

Non-Conventional Machining Processes, Analysis of Manufacturing Processes

POs met through Gaps in the Syllabus:

PO 1-5, PO12

Topics beyond syllabus/Advanced topics/Design:

Advanced Manufacturing Processes

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

PO 1-5, PO12

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	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√	√	√	
Quiz 2	√	√	√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (COs) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3	2	2	3		1			1		1
CO2	3	3	3	2	3		1			1		1
CO3	3	3	2	2	3		1			1		1
CO4	3	3	3	2	3		1			1		1
CO5	3	3	3	2	3		1			1		1

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

Mapping Between Course Outcomes (COs) and Course Delivery Method

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

COURSE INFORMATION SHEET

Course code: PE 307
Course title: COMPETITIVE MANUFACTURING STRATEGIES
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: V (MO) / Third
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the concept manufacturing as strategy, WTO and competitive advantages
2	Learn about the product verity, manufacturability, vendor development and vendor rating.
3	Understand the concept of JIT, MRP & ERP must be explained to the students
4	Know the effectiveness CIM, E-manufacturing and simulation as tool of competitive manufacturing
5.	Learn about the various types of Manufacturing systems i.e. Dedicated manufacturing system, Flexible manufacturing system (FMS), cellular manufacturing system (CMS), and Re-configurable manufacturing system (RMS)

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

CO1	Explain the concept of manufacturing strategy.
CO2	Recognize the role of product verity management, product modularity, vendor development, vendor rating and design for manufacturing in improving competitiveness
CO3	Comprehend JIT and MRP based systems
CO4	Explore latest advancements in manufacturing like CIM and e-manufacturing and the role of ERP and simulation as strategy in manufacturing.
CO5	Select proper manufacturing system for a given product and market scenario.

SYLLABUS

Module 1: Competitive Strategies [8]

The competitive environment in the market, The WTO agreement and its effect on Indian Industries, Manufacturing as a competitive strategy, Competitive Advantages and Disadvantages

Module 2: Product Modularity [7]

Product Variety, Modular Design, Design for manufacturability, Vendor Development, Vendor rating.

Module 3: Manufacturing philosophy **[7]**

Just in time (JIT) manufacturing, Kanban system, Agile Manufacturing, Lean manufacturing and tools

Module 4: E-Manufacturing **[10]**

Simulation as tools for competitive manufacturing, MRP, ERP, Concept of CIM and E-Manufacturing, Industry 4.0

Module 5: Recent Manufacturing Scenarios **[8]**

Selection of manufacturing systems for different manufacturing scenarios - Dedicated manufacturing system, Flexible manufacturing system (FMS), cellular manufacturing system (CMS), and Re-configurable manufacturing system (RMS); Elementary of DMS, FMS, CMS, and RMS.

Text books:

1. Manufacturing Excellence in Global Markets W. Euershelm **[T1]**
2. Manufacturing Systems Design & Analysis B. Wa. **[T2]**
3. Computer Automation in Manufacturing T.O.Boucher **[T3]**
4. Intelligent Manufacturing Planning P. Gu. **[T4]**

Reference books:

1. SeropeKalpakjian and Steven Schmidt, Manufacturing Processes for Engineering Materials, Pearson Education, 6th Edition **[R1]**
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Material. Processes, and systems, 2nd Edition, Wiley India, 2007 **[R2]**

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

Forecasting techniques, Marketing strategies,

POs met through Gaps in the Syllabus:

POs 1-3, 12

Topics beyond syllabus/Advanced topics/Design:

Advance Management and marketing techniques

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

POs 1-3, 12

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	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution				
Mid Semester Examination	25				
Quizzes	10 + 10				
Assignment	5				
End Semester Examination	**% Distribution**				
End Semester Examination	50				
Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Semester Examination	√	√			
Quiz1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs**											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	2	3	2	2	1	1	1		1	1	3
CO2	3	2	1	1	1	1			1	1	2	2
CO3	3	3	2	1		1		1	1	1	1	3
CO4	3	2	1	1	1	1		1	1	1	2	2
CO5	3	2	1	1				1	1	1	2	2

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

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

COURSE INFORMATION SHEET

Course code: PE 206
Course title: METROLOGY & MEASUREMENT
Pre-requisite(s): Nil
Co- requisite(s): PE 207 METROLOGY & MEASUREMENT LAB
Credits: 3 L: 3 T:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI (SP) / Second
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives
This course enables the students to:

1	To understand and analyze different measurement systems, Standards of Measurement, Measurement Errors
2	To know about Limits, Fits, tolerance and gauges used in measurement and designing aspects for those
3	To familiar with different types of comparators, optical metrology and their applications
4	To enlighten students about various techniques of measurement of Screw threads, Gears, Geometric forms and Surface textures.
5	To accustom with various measuring devices for measurement of force, torque, strain and acceleration

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

CO1	Distinguish between accuracy and precision, identify different measurement errors, able to select linear or angular measuring instrument for measurement of various components
CO2	Design limit gauges used for various components and purposes
CO3	Explain principles and uses of comparators and optical instruments used in metrology
CO4	Examine various screws threads and gears parameter using different methodology and explain capabilities of machining process by measuring surface finish.
CO5	Implement and analyse appropriate measurement methods for variables like force, torque, strain and acceleration

SYLLABUS

Module – I: Introduction **[6]**

Historical development, Basics of Metrology, Need for Inspection, Accuracy and Precision, Standards of measurements, system of measurement, line, end & wavelength standards, type and source of measurement errors

Linear metrology: Steel rule, callipers, Vernier calliper, Vernier height gauge, Vernier depth gauge, micrometres, universal calliper.

Miscellaneous measurements: Taper measurement, angle measurement, radius measurement, sine bar & Angle gauges

Module – 2: Limit Fits and Gauge [10]

Interchangeable manufacture, selective assembly, concept of limits, fits and tolerances, Types of fit, Basic-Hole System, Basic-Shaft System, Problems, Tolerance grades, Metric fits, Indian standard system, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials, Considerations of gauge design, Taylor's principle of gauging, Wear allowance on gauges

Module – 3: Comparator and Optical gauges [6]

Principle and uses of mechanical, optical, Electrical, electronic and pneumatic Comparators
Principle of interferometer, concept of optical flat, projector, microscope, autocollimator and interferometer
Types of machine tool tests, alignment tests for lathe, milling and drilling machine tools

Module – 4: Form Measurement [10]

Terminology of screw threads, Measurement of minor, major, thread angle and effective diameter of screw threads by 2-wire and 3- wire methods, best size wire. Screw thread gauges, Tool maker's microscope
Gear tooth terminology, gear tooth thickness & pitch measurement, involutes profile testing of gear
Straightness, flatness and squareness and circularity tests, numerical evaluation, measurement of surface finish, related instruments.
Automated inspection system, Introduction & applications of Co-ordinate Measuring Machine (CMM)

Module – 5: Dynamic measurement [8]

Sensors and Transducers: Types of Sensors, types of transducers and their characteristics
Force and Torque measurement: Direct methods and indirect method, force measuring instruments-load cells, Dynamometer, Power Measurements
Measurement of strain: types of strain gauges, gauge factors, theory of strain gauges and method of measurement, Wheatstone bridge circuit
Vibration and Noise Measurement: Piezoelectric Accelerometer and decibel meters

Text Books:

1. R.K. Jain, Engineering Metrology Khanna Publications, New Delhi **(T1)**
2. I. C. Gupta, A Text book of Engineering Metrology, Dhanpat Rai, New Delhi **(T2)**
3.Er. R K Rajput, Mechanical Measurements and Instrumentations, Kataria Publication (KATSON) **(T3)**
4. M. Mahajan, Engineering Metrology, Dhanpat Rai & Co. New Delhi **(T4)**

Reference Books:

1. K. J. Hume, Engineering Metrology **(R1)**
2. N V Raghavendra and Krishnamurthy, Engineering Metrology and Measurement, Oxford University Press **(R2)**

3. Bentley, Engineering Metrology and Measurements, Pearson Education**(R3)**
4. Anand Bewoor, Vinay Kulkarni, Metrology and Measurement, McGraw-Hill **(R4)**

Gaps in the syllabus (to meet Industry/Profession requirements):
Limited scope to get acquainted with latest gadgets/instruments used in industries.
No direct relation with environmental, societal issues, ethics etc.

POs met through Gaps in the Syllabus:
POs 5-8, 11-12

Topics beyond syllabus/Advanced topics/Design:
Latest equipment in the field of metrology

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 5, 6-8, 11-12

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	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs**											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	1		2								
CO2	3			1								
CO3	3	2	3	2								
CO4	3	2	2	1								
CO5	3	2	2	1								

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD 3, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 3, CD 6
CO4	CD1, CD2, CD 3, CD 6
CO5	CD1, CD2, CD 3, CD 6

COURSE INFORMATION SHEET

Course code: PE 318
Course title: RAPID PROTOTYPING AND TOOLING
Pre-requisite(s): PE 213 MANUFACTURING PROCESSES
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI (SP) / Third
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives
This course enables the students to:

1	Understand technology used in rapid prototyping and tooling.
2	Recognized importance of rapid prototyping in advance manufacturing process.
3	Acquire knowledge, techniques and skills to select relevant rapid prototyping and tooling process.
4	Comprehend the potential of rapid prototyping and tooling in different industrial sectors.
5	Illustrated 3D printing technology for Rapid prototyping and tooling

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

CO1	Explain rapid prototyping and tooling for manufacturing complex geometries.
CO2	Identify and solve problems related to rapid prototyping and tooling.
CO3	Select suitable process and materials for rapid prototyping and tooling
CO4	Distinguish technique of CAD and reverse engineering for geometric transformation in rapid prototyping and tooling.
CO5	Determine part orientation, apply suitable slicing algorithm and generate tool path for minimum build time.

SYLLABUS

Module 1: Introduction [8]

Evolution, basic principle, concept, procedure and need of rapid prototyping and tooling, Classification of rapid prototyping and tooling processes (Additive/Subtractive/Deformative), Classifications of materials used for Rapid prototyping and tooling, Industrial applications of rapid prototyping and tooling, Most commonly used processes for rapid prototyping.

Module 2: Processes used for rapid prototyping and tooling [8]

Stereolithography Apparatus (SLA), Fused Deposition Modeling (FDM), Selective Deposition Lamination (SDL), Laminated Object Manufacturing (LOM), Ultrasonic Consolidation, Laser Engineered Net Shaping (LENS), Electron Beam Free Form Fabrication (EBFFF), Selective Laser Sintering (SLS), Electron Beam Melting (EBM).

Convectional Tooling vs Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect rapid tooling methods.

Module 3: CAD for rapid prototyping and tooling [8]

Preparation of 3D-CAD model in STL format, 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.

Module 4: Constructions of manipulator systems for rapid prototyping and tooling [8]

Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors, Energy delivery systems, Material delivery systems.

Module 5: Post processing in rapid prototyping and tooling [8]

Support material removal, Surface texture improvement, Accuracy improvement, Aesthetic improvement, Property enhancements using non-thermal and thermal techniques.

Text books:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010. **[T1]**
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003. **[T2]**
3. Ian Gibson, "Software Solutions for Rapid Prototyping", Professional Engineering Publishing Limited, UK, 2002. **[T3]**

Reference books:

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A toolbox for prototype development", CRC Press, 2007. **[R1]**
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. **[R2]**
3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000. **[R3]**

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

Rapid Freeze Prototyping

POs met through Gaps in the Syllabus:

POs 1,2,5

Topics beyond syllabus/Advanced topics/Design:

Rapid Tooling Injection Molded Prototypes

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

POs 1,8,12

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	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	1	2		3	2		1	1	1			1
CO2	1	3	1	2					2			1
CO3	1		2	1		1			1			
CO4		2	2	1	2		1		1	2		
CO5	1	3		1	1		1		2	1		1

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

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

COURSE INFORMATION SHEET

Course code: PE 314
Course title: STATISTICAL QUALITY CONTROL
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI (SP) / Third
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the philosophy of quality improvement and use of statistics in quality control.
2	Learn various methods for measurement of central tendency and dispersion
3	Understand and use various control charts for attributes and variables.
4	Learn the concept of process capability analysis.
5	Understand the concept of acceptance sampling, OC curves and preparation of acceptance sampling plans for attributes.
6	Understanding the general idea of Robust Parameter Design approaches
7	Understand the concept of quality circle, quality audit, ISO 9000 and six sigma

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

CO1.	Understand the philosophy of quality improvement, basic concept of statistical quality control, Quality audit and six sigma.
CO2.	Demonstrate the ability to design, use, and interpret control charts and perform analysis of process capability.
CO3.	Prepare and analyse sampling plans for attributes
CO4.	Understand the general idea of Robust Parameter Design approaches
CO5	Understand the concept of ISO-9000 quality system, quality audit and six sigma.

SYLLABUS

Module 1: Basics in statistical quality [6]
Introduction to Quality Control, Statistics in quality control, Cost of Quality, Graphical and Analytical Methods for Central Tendency and Dispersion

Module 2: Control charts for variables and attributes [10]
General Theory of Control Charts, Theory and Application of Control Charts for Averages, Range, Standard Deviation, Fraction Defective and Number of Defects, Process Capability Study, Interpretation of Control Chart

Module 3: Acceptance sampling plans **[10]**

100% Sampling Vs. Statistical Sampling, Elementary Concepts of Acceptance Sampling by Attributes, Concept and Characteristics of O.C. Curves, Single, Double and Multiple Sampling Plans, Construction and Use of O.C. Curves for Sampling Plans, MIL – STD Plans, Sequential Sampling Plan

Module 4: Quality Engineering **[8]**

Quality loss function, Concepts of Taguchi technique and robust design, signal-to-noise ratio, Introduction to Design of experiments (DOE), Orthogonal array and Analysis of variance (ANOVA)

Module 5: Quality management systems **[6]**

Concept of Quality Circle and TQM, ISO–9000 Quality Systems, Quality Audit, Concept of Six Sigma and DMAIC

Text Books:

1. Introduction to Statistical Quality Control, Douglas C. Montgomery, Wiley **[T1]**
2. Fundamentals of quality control and improvement, A Mitra, Wiley **[T2]**
3. Mechanical Reliability, L.S. Srinath, Affiliated East – West Press **[T3]**
4. Statistical Quality Control & Reliability, D.H. Besterfield, Prentice Hall, **[T4]**
5. Total Quality Management, D.H. Besterfield, Prentice HallStatistical, **[T5]**
6. Quality control, M. Mahajan, Dhanpat Rai & Sons, **[T6]**

Reference books:

1. Manufacturing Excellence in Global Markets, W. Euershelm **[R1]**
2. Manufacturing Systems Design & Analysis, B. Wa. **[R2]**
3. Computer Automation in Manufacturing, T.O.Boucher **[R3]**
4. Intelligent Manufacturing Planning, P. Gu. **[R4]**

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

Sampling plan for variables

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	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (COs) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3	3		1					1	1	3
CO2	3	2	1		2					1	2	2
CO3	3	3	3		2		1			1	1	3
CO4	3	2	1				1	1		1	2	2
CO5	3	2	1							1	2	2

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

Mapping Between Course Outcomes (COs) and Course Delivery Method

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

COURSE INFORMATION SHEET

Course code: PE 308
Course title: LOGISTICS AND SUPPLY CHAIN MANAGEMENT
Pre-requisite(s): PE 203 OPERATIONS RESEARCH
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI (SP) / Third
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Provide an insight on the fundamentals of supply chain strategy
2	Know the various distribution and transportation networks and their applications
3	Acquire the concepts of logistics in improving the supply chain and other functional areas of an organization
4	Understand the role of sourcing, information technology, and coordination in a supply chain
5	Know the recent trends in supply chain management

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

CO1	Define the goal of a supply chain and analyse the impact of supply chain decisions on the success of a firm
CO2	Develop a framework for making supply chain network design decisions
CO3	Apply logistics concepts to improve supply chain operations
CO4	Evaluate and select the best supplier for a firm or organisation.
CO5	Discuss the recent trends in supply chain management

SYLLABUS

Module 1: Introduction to Supply Chain Management [8]
Understanding the supply chain, Supply Chain Performance- Achieving strategic fit and scope, key issues, Supply chain modelling, Supply Chain Drivers and Metrics, Centralized vs. decentralized systems.

Module 2: Designing the Supply Chain Network [9]
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, Vehicle routing and scheduling, Supply Chain Optimization.

Module 3: Logistics Management **[8]**

Logistics Management: Logistical operation, integration, network design, logistical performance cycle, customer service global logistics, logistical resources, logistics planning, Third- and fourth-party logistics providers, Measuring logistics costs and performance, e-logistics, Reverse logistics.

Module 4: Managing Cross-Functional Drivers in a Supply Chain **[8]**

Sourcing Decisions- Make or buy decisions, Sourcing Processes. Information Technology in a Supply Chain, Coordination in a Supply Chain-Bullwhip effect.

Module 5: Recent Trends in Supply Chain Management **[7]**

Lean Supply Management, Agile Supply Management, Green and Sustainable Practices of Supply Chain, Supply chain cases.

Text books:

1. Chopra, S., and Meindl, P. "Supply Chain Management, strategy, planning, and operation" 6/e – PHI, second edition, 2014. **[T1]**
2. Christopher, M., "Logistics and Supply Chain Management", Pearson Education Asia, New Delhi. **[T2]**

Reference books:

1. Taylor and Brunt, "Manufacturing Operations and Supply Chain Management (The Lean Approach)", Business Press Thomson Learning, NY. **[R1]**
2. Arjan J. Van Weele, "Purchasing and Supply Chain Management (Analysis Planning and Practice)", Engineering, Business Press, Thomson Learning NY. **[R2]**
3. Shah, J. "Supply Chain Management, text and cases", Pearson Education South Asia,2009. **[R3]**
4. Balkan Cetinkaya, Richard Cuthbertson, Graham Ewer, "Sustainable Supply Chain Management: Practical ideas for moving towards best practice", Springer, 2011. **[R4]**
5. Sople, V.V "Supply Chain Management, text and cases", Pearson Education South Asia, 2012. **[R5]**
6. Donald B., "Logistic Management - The Integrated Supply Chain process", McGraw Hill. **[R6]**

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

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Industry 4.0 in supply chain

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

POs 1-5, 7, 12

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	√

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3	1	1		2			1	1	2	1
CO2	3	3	3	2		2				1	1	1
CO3	3	3	3	3	2	1	1		1	1	1	1
CO4	3	3	3	2	2	1				1	1	1
CO5	3	3	3	3	2	2	2			1	1	1

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

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

COURSE INFORMATION SHEET

Course code: PE 207
Course title: METROLOGY & MEASUREMENT LAB
Pre-requisite(s): Nil
Co- requisite(s): PE 206 METROLOGY & MEASUREMENT
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech
Semester / Level: VI (SP) / Second
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	provide to the students an understanding and appreciation of the science of measurement.
2	expose the students to various mechanical and electrical engineering measuring devices and understand the different degree of accuracy obtained from different types of instruments.
3	impart knowledge and skill to use measuring tools related to screw threads, gears, surface texture.
4	handle appropriate measurement equipment or method for variables like strain, force, vibration

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

CO1	be familiar with the different instruments that are available for linear, angular, and various geometric form measurements.
CO2	select and use the appropriate measuring instrument according to a specific requirement (in terms of accuracy)
CO3	learn how to measure various parameters of screw threads, gears, surface texture.
CO4	measure cutting tool forces, vibration of machine tool, modulus of elasticity

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1: Linear Measurement-I**
   Objective: To study the measurement of dimensions of a given work piece using Vernier caliper. Outside and inside micrometer and calculate the least count in each equipment.

2. **EXPERIMENT – 2: Linear Measurement-II**
   Objective: To study the measurement of height and depth of a given work piece using height gauge and depth micrometer and calculate the least count in each equipment.

3. **EXPERIMENT – 3: Gauges**
   Objective: Study of Gauges (slip gauges/feeler gauge/Go-NO Go gauges etc.).

4. **EXPERIMENT – 4: Angular Measurement**
   Objective: Measurement of angle using Sine bar, angle gauges

5. **EXPERIMENT – 5: Optical Metrology I**
   Objective: To study the profiles of single point cutting tool ("V" tool) / thread by profile projector

6. **EXPERIMENT – 6: Optical Metrology II**
   Objective: To study the working of optical flat and monochromatic light source.

7. **EXPERIMENT – 7: Gear Metrology**
   Objective: Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer

8. **EXPERIMENT – 8: Screw Thread Metrology**
   Objective: Measurement of Screw thread parameters using two wire or Three-wire method

9. **EXPERIMENT – 9: Comparator**
   Objective: To study the working of electronic comparator, measurement of thickness of given workpiece

10. **EXPERIMENT – 10: Geometric Form Measurement**
    Objective: Measurement of flatness and roundness using dial gauge and electronic comparator.

11. **EXPERIMENT – 11: Surface Profile**
    Objective: To study the Taylor Hobson contour measurement instrument and determine the contour of a given test-piece.

12. **EXPERIMENT – 12: Dynamic Measurement I**
    Objective: Measurement of cutting tool forces using tool Dynamometer

13. **EXPERIMENT – 13: Dynamic Measurement II**
    Objective: Determination of modulus of elasticity of a mild steel specimen using strain gauges

14. **EXPERIMENT – 14: Dynamic Measurement III**
    Objective: To study the piezoelectric accelerometer and determine the vibration response of machine tool during operation

Text Book

1. R.K. Jain, Engineering Metrology Khanna Publications, New Delhi **(T1)**
2. I. C. Gupta, A Text book of Engineering Metrology, Dhanpat Rai, New Delhi **(T2)**

Reference Book

1. M. Mahajan, Engineering Metrology, Dhanpat Rai & Co. New Delhi **(R1)**
2. N V Raghavendra and Krishnamurthy, Engineering Metrology and Measurement, Oxford University Press **(R2)**

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

Availability of limited number of advanced equipment.

POs met through Gaps in the Syllabus:

PO 5

Topics beyond syllabus/Advanced topics/Design:

Latest equipment in the field of metrology and measurement

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

POs 5, 6-8, 11-12

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	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	
Quiz 1	√	√			
Quiz 2			√	√	
Viva-voce	√	√	√	√	
Examination: Experiment Performance	√	√	√	√	

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	2		3					3			2
CO2	3	2		3					3			2
CO3	3	2		3					3			2
CO4	3	2		3					3			2

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD3, CD6
CO2	CD3, CD6
CO3	CD3, CD6
CO4	CD3, CD6

COURSE INFORMATION SHEET

Course code: PE 304
Course title: PRODUCTION & OPERATIONS MANAGEMENT
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 4 L:4 T: P:
Class schedule per week: 4
Class: B. Tech
Semester / Level: VII (MO) / Third
Branch: All (MINOR in "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, Product mix and aggregate planning.
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, EOQ, ABC analysis.
5	To know Facility design process and its all component.

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

CO1	Able to understand the functions of production system its planning and control.
CO2	Able to make demand forecasts in the manufacturing sectors using selected quantitative and qualitative techniques.
CO3	Able to explain the importance and function of pre planning and post planning of production system.
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	Understand plant layout, building layout and location theory.

SYLLABUS

Module 1: Introduction to production and operation management [10]
Definition and Objectives of production and operation management, Functions of production and operation management, type of Production systems and their characteristics, discrete and process types, mass, batch, unit flexible manufacturing types, manufacturing operations: selection of a process, difference between manufacturing and service operations, 5 Ps in the organization, functions of production manager & materials management.

Module 2: Preplanning [10]
Importance of forecasting – Types of forecasting, their uses – General principles of forecasting – Forecasting techniques– qualitative methods and quantitative methods, product mix and batch size decisions, aggregate planning.

Module 3: Production Planning **[8]**

Definition – Routing procedure – Route sheets – Bill of material – Factors affecting routing procedure. Scheduling – definition –Difference with loading. Loading and scheduling with their different techniques, dispatching.

Production observation, Progress Report, Expediting and corrective measures

Module 4: Inventory Control **[10]**

Field and scope of inventory control, inventory types and classification, Inventory control models, static model, dynamic model both deterministic and stochastic, Economic lot size, reorder point and their application, ABC analysis, VED analysis, modern practices in purchasing and store Management.

Module 5: Facility design **[12]**

Objectives of a good plant layout, principles of a good layout, classical types of layouts like product layout, process layout, fixed-position layouts, cellular layouts and hybrid layouts. Factors affecting plant layout: man, material, machine, movement, waiting, service, building and change, features and considerations of each factor.

Facility design process, facility design problems and their analysis, Factors affecting the location and site selection, techno economic analysis, multi-plant location, Concept of location theory and models.

Text books:

1. S. N. Chary, Production and operations management, Tata McGraw-Hill Education, 5th Edition **[T1]**
2. Richard B. Chase, Nicholas J. Aquilano, Production and Operations Management: Manufacturing and Services, Publisher: Richard D Irwin; 7th edition **[T2]**
3. R. Panneerselvam, Production and operations management, PHI Learning Pvt. Ltd **[T3]**
4. P K Gupta, D.S Hira, Operations Research, S chand 7th edition **[T4]**

Reference books:

1. Norman Gaither, Production and Operations Management, Publisher: Dryden Press **[R1]**
2. S.P. Singh, Production and Operations Management, Vikas Publishing House **[R2]**

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

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Logistics and supply chain management, Inventory model design

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

POs 1 -4, 9, 11, 12

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	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3	3	2	2		1		1	2	3	3
CO2	3	3	1	2	2		1		1	2	3	2
CO3	3	3	3	2	2		1		1	2	2	3
CO4	3	3	1	2	2		1		1	2	2	2
CO5	3	3	1	3	2		1		1	2	2	2

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

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

COURSE INFORMATION SHEET

Course code: PE 404
Course title: MODELLING AND SIMULATION LAB
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: VII (MO) / Fourth
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Impart skill to use simulation software
2	Develop the ability to build models before simulation.
3	Think of various practical applications of simulation in manufacturing
4	Manually solve small simulation problems using random numbers and probability distributions.

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

CO1	Comprehend the basics of discrete event simulation as applied to various manufacturing and service problems
CO2	Build soft models in computer program/software for a given situation using randomly generated distributions
CO3	Develop a simulation table using pseudo-random numbers or a simulation model using software program
CO4	Analyze the output from a simulation model

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1: Introduction to simulation**
   Objective: To explain the basics of modelling and simulation like discrete events, activities, queue and random numbers in simulation

2. **EXPERIMENT – 2: Simulation software**
   Objective: To study the various simulation software and their features particularly useful in manufacturing and logistics

3. **EXPERIMENT – 3: Introduction to simulation exercise (Manual)**
   Objective: To use pseudo-random numbers in solving simulation problems

4. **EXPERIMENT – 4: Simulation of bank operation**
   Objective: Simulation of a bank is to be performed using manual approach using probability distributions for arrival and service time

5. **EXPERIMENT – 5: Simulation of robotic work cell**
   Objective: Simulation of a robotic work cell is to be performed using manual approach using probability distributions for machine operation, loading unloading by robot

6. **EXPERIMENT – 6: Simulation of drill press operation**
   Objective: Simulation of a drill press is to be performed using manual approach using probability distributions for operation.

7. **EXPERIMENT – 7: Simulation of a grocery shop**
   Objective: Simulation of a grocery shop is to be performed using manual approach using probability distributions for arrival and service for customers

8. **EXPERIMENT – 8: Simulation exercise using GPSS software**
   Objective: Simulation of a food store is to be performed using GPSS software and analyze the output

9. **EXPERIMENT – 9: Simulation of factory maintenance**
   Objective: Simulation of a factory maintenance service is to be performed using GPSS software and analyze the output

10. **EXPERIMENT – 10: Simulation of ambulance dispatch**
    Objective: Simulation of an ambulance dispatch service is to be performed using GPSS software and analyze the output

11. **EXPERIMENT – 11: Simulation using WITNESS software**
    Objective: To learn the software WITNESS and its features for simulation

12. **EXPERIMENT – 12: Simulation of factory shop floor**
    Objective: To apply the software WITNESS for simulation of a factory shop floor

13. **EXPERIMENT – 13: Monte Carlo simulation**
    Objective: To apply MINITAB software for a Monte Carlo simulation problem

Reference Book

1. Jerry Banks, Discrete event system simulation, Pearson new International Edition **[R1]**
2. Averil M. Law and David Kelton, Simulation modelling and analysis, McGraw Hill **[R2]**

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

Warehouse and logistic simulation

POs met through Gaps in the Syllabus:
POs 3,5

Topics beyond syllabus/Advanced topics/Design:
Simulation of sheet metal forming, casting and welding

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 2,4,5

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	√

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	
Quiz 1	√	√	√		
Quiz 2			√	√	
Viva-voce	√	√	√	√	
Examination: Experiment Performance	√	√	√	√	

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs**											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	1	2			3		1				1	1
CO2		2	2	3	2	1		1				1
CO3		2		3	3		1	1	3		1	
CO4			2	2	2	1			2	2		1

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

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