B.O.S held on Date 01.7.2023

DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINEERING
SCHOOL OF STUDIES, ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.), 495009

EVALUATION SCHEME OF PRE-PH.D COURSE WORK

EFFECTIVE FROM SESSION 2023-24

SN.	Name of the Subject	Subject Code	Periods / Week L – T – P	ESE Duration	ESE MARKS		Credits
					Max.	Min.	
1	Research Methodology in Engineering	IPDATT1	3 – 1 – 0	3 Hrs.	100	40	4
2	Elective - Program Elective	**	3 – 1 – 0	3 Hrs.	100	40	4
3	Elective – Professional Elective	***	3 – 1 – 0	3 Hrs	100	40	4
4	Seminar	IPDASC1	-	-	Qualified/Not qualified		-
Total			**9 – 3 – 0**	**-**	**300**	**165***	**12**

Duration of the semester will be 6 months.
*Candidate has to score minimum 55% of the aggregate marks to qualify in ESE.
Two core subjects as Electives (4 credits each) to be decided by the DRC.

List of Electives - Program Elective		** Subject Code	List of Electives – Professional Elective		*** Subject Code
S.N	Name of the Subject		S.N.	Name of the subject	
1	Computer Aided Design	IPDATK1	1	Advanced optimization techniques	IPDATP1
2	Robotics	IPDATK2	2	Logistics & supply chain management	IPDATP2
3	Finite Element Method	IPDATK3	3	Manufacturing Systems Management and Quality Engineering	IPDATP3
4	Artificial Intelligence	IPDATK4	4	Mechanics of Composite Materials	IPDATP4
5	Quality Engineering and Manufacturing	IPDATK5	5	Lean Manufacturing	IPDATP5
6	Production and Operations Management	IPDATK6	6	Fundamentals of Green Manufacturing	IPDATP6
7	Industrial Engineering and Business Management	IPDATK7	7	Strategic Management in Supply Chain	IPDATP7
8	Principles of Management, Cost and Projects	IPDATK8	8	Product Design and Manufacturing	IPDATP8
9	Manufacturing Processes	IPDATK9	9	Advanced Manufacturing Processes	IPDATP9

L : Lecture, T: Theory,P: Practical,Max.: Maximum Marks in ESE; Min.: Minimum Pass Marks in each subject as 40%

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IPDATT1 - RESEARCH METHODOLOGY IN ENGINEERING

COURSE OBJECTIVES

The objective of this course is to

1. To learn basic definition of research, statistical analysis and research types.
2. To learn mathematical tools for analysis, ethics in research and critical evaluation.
3. To define graphical description of data, research report and understanding about Probability Distributions

COURSE CONTENT

Introduction: Definition and objectives of Research – Types of research, Various Steps in Research process, Mathematical tools for analysis, developing a research question-Choice of a problem.

Literature review, Surveying, synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.

Quantitative Methods for problem solving: Statistical Modeling and Analysis, Time Series Analysis. Probability Distributions, Fundamentals of Statistical Analysis and Inference, Multivariate methods.

Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Spectral Analysis, Error Analysis, Applications of Spectral Analysis.

Tabular and graphical description of data: Tables and graphs of frequency data of one variable, Tables and graphs that show the relationship between two variables , Relation between frequency distributions and other graphs, preparing data for analysis.

Use of statistical software SPSS in research. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, referencing in academic writing.

Reference Books

1. C.R. Kothari, Research Methodology Methods and Techniques, 2/e, VishwaPrakashan, 2006
2. Donald H.McBurney, Research Methods, 5th Edition, Thomson Learning, ISBN:81-315-0047-0,2006

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3. Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-Hill Co. Ltd., 2006.

COURSE OUTCOME

CO1: Explain the concepts of tabular and graphical description of data, tables and graphs of frequency data of one variable

CO2: Demonstrate an ability to impart Relation between frequency distributions and other graphs and preparing data for analysis.

CO3: Develop Fundamentals of Statistical Analysis and Inference and Multivariate methods.

CO4: Demonstrate different types of research, various Steps in Research process, mathematical tools for analysis in developed research question.

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

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3-	2	2	1	2	2	-	-	-	-	-	1	3	3	3
CO2	2	1	3	3	2	-	2	-	-	-	-	2	2	3	-
CO3	3	2	2	2	1	-	3	-	-	-	-	-	2	1	1
CO4	1	3	1	2	2	-	2	-	-	-	-	3	1	1	2

1. **Slight (Low) 2: Moderate (Medium) 3: Substantial (High)**

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IPDATK1- COMPUTER AIDED DESIGN

COURSE LEARNING OBJECTIVES:

The objective of this course is to

1. Understand the basic fundamentals of computer graphics used in CAD hardware and software.
2. Impart knowledge of various algorithms used to generate analytical, synthetic and parametric curves.
3. Introduce the new design concept and optimization technique to generate surface and solid in CAD.

COURSE CONTENT:

Basics of CAD, CAD system evaluation criteria, Principle of computer graphics, Hardware and software, Color management, Raster graphics, Lines, Circle, Ellipse, Parabola and Hyperbola drawing algorithms, Windowing, Clipping and View port, Software documentations.

Basics of curves, Parametric and non-parametric curves, Analytical and synthetic curves, Continuity of curves, Mathematical representation of curves, Wire frame models, Wire frame entities, Parametric representation of synthetic curves. Hermite cubic splines, Bezier curves, B-splines, Rational curves. Curve manipulation: Displaying, Segmentation, Trimming, and Intersection.

Coordinate systems, Fundamental of transformations, Concatenation and homogeneous transformations, Two and three dimensional geometric transformations, Projections.

Mathematical representation of surfaces, Surface model, Surface entities, Surface representation, Parametric representation of surfaces, Plane surface, Rule surface, Surface of revolution, Tabulated cylinder. Hermitebi-cubic surface, Bezier surface, B-Spline surface, COONs surface, Blending surface, Sculptured surface.

Mathematical representation of solid, Solid modeling, Solid representation, Boundary representation (B-rep), Constructive solid geometry (CSG), Analytic solid modelling, Introduction of Finite Element Method (FEM).

Text Books & References:

1. Zeid I. & Subramanian R. S., *CAD/CAM Theory and practice*, Tata McGraw Hill.
2. Zeid I., *Mastering CAD/CAM*, McGraw Hill International.
3. Groover M.P. &Zimmers E., *CAD/CAM: Computer-Aided Design and Manufacturing*, Pearson Education.

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4. Rao P.N., *CAD/CAM Principles and Applications*, Tata McGraw Hill.
5. Alavala, *CAD/CAM Concepts and Applications*, Prentice Hall of India.
6. Krishnamurthy N., *Introduction to Computer Graphics*, Tata McGraw Hill.
7. Newman W.M. &Sproull R.F., *Principles of Interactive Computer Graphics*, Tata McGraw Hill.

COURSE OUTCOMES

After successful completion of this course students are able to;
CO1: Analyze the engineering design process and its role in graphic communication process.
CO2: Generate and interpret engineering technical drawings of parts and assemblies according to engineering design standards.
CO3: Use CAD software to generate a computer model and technical drawing for a simple, well-defined part or assembly.
CO4: Fluent application of engineering techniques, tools and resources Effective oral and written communication in professional and lay domains.

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

COs	POs												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSOs 1	PSOs 2	PSOs 3
CO1	3	2	2	3	1	-	-	-	-	-	-	2	3	3	3
CO2	3	1	3	3	1	-	-	-	-	-	-	3	2	3	2
CO3	3	2	2	-2	1	-	-	-	-	-	-	2	3	2	3
CO4	3	2	2	3	1	-	-	-	-	-	-	2	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATK2 – ROBOTICS

COURSE LEARNING OBJECTIVES:

The objective of this course is to

1. Study about mechanism, mechanics and mechanical behaviour of the industrial robot.
2. Train researchers in the field of robotics and automation.
3. Learn how to design and build intelligent systems through a multidisciplinary approach.
4. Explore the concept of artificial intelligence and machine learning algorithms used in the robotics.

COURSE CONTENT:

An over view of Robotics, Progressive development, Classifications, Anatomy of robot and terminology, repeatability, Accuracy and precision, Yaw, Pitch and Roll, The mechanics and control of mechanical manipulator, sensors, actuators and controller.

Spatial descriptions and transformations, Description of links and joints, Coordinates frames, Fundamental of translation, rotations and transformations, Homogeneous transformations, Denavit-Hartenberg (D-H) representation, Arm equations, Forward and inverse kinematic problems, Solutions of inverse kinematic problems, multiple solutions.

General consideration in path description and generation, Joint space schemes, Trajectory planning and obstacles avoidance, Path planning, Skew motion, Joint integrated motion, Straight line motion, Robot programming languages and software packages.

Linear control of robot manipulation. Feedback and close loop control, Second-order linear systems, Trajectory following control, Modelling and control of single joint, Architecture of industrial robotic controllers, Artificial intelligence, Robot applications.

Reference Books

1. John J. Craig, "Introduction to robotics", Addison Wesley Longman.
2. Schilling Robert J., "Fundamentals of Robotics", Prentice Hall of India.
3. Nagrath I.J. & Mittal R.K., "Robotics & Control" Tata McGraw Hill.
4. Fu K.S., "Robotics", McGraw Hill.
5. Murphy, "Introduction of AI robotics", MIT press.

COURSE OUTCOMES:

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

CO1: Understanding the concept of man and machine operation of industrial robots used in industries and real-world environment.

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CO2: Analysis of kinematic and dynamic behaviour of robot.
CO3: Understanding the concept of robot control theory and its application in robot controller.
CO4: Apply the concept of artificial intelligence and machine learning in industrial robots.

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

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	1	-	-	-	-	-	-	2	3	3	2
CO2	3	1	3	2	1	-	-	-	-	-	-	3	2	3	2
CO3	3	3	2	2	1	-	-	-	-	-	-	2	3	2	1
CO4	3	3	2	3	1	-	-	-	-	-	-	2	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATK3 - FINITE ELEMENT METHOD

COURSE OBJECTIVES:

- To learn basic principles and skills of finite element modelling and analysis.
- To learn the theory and characteristics of finite elements that represent engineering structures
- Apply knowledge of mathematics to understand the basic concepts of the finite element method
- Implement the basics of FEM to relate stresses and strains.
- Recognize the need for life-long learning to keep abreast of new numerical analysis methods, and to enhance one's abilities as an analyst.
- Model engineering problems using the finite element method

COURSE CONTENT:

Historical background, Basic concept of the Finite Element Method, Basic equations in elasticity, Elemental shapes, nodes, nodal unknowns and coordinate systems, A general procedure for Finite Element Analysis, Application to the continuum, Discretization of the domain, Governing equations for continuum, Pre-processor, Processer and Post processer.

Basic concept of interpolation functions, Shape function in one, two and three dimension, Finding of shape function by Polynomial, Lagrange polynomial, Serendipity family and Hermite polynomial, Construction of shape function by degrading technique.

Strain displacement and elemental stiffness matrix, Assembling stiffness equation, boundary conditions and solution, Spring and bar elements, Direct approach, Strain energy, Castigliano's first theorem, Minimum potential energy, Galerkin's method, and Variational method, Isoparametric formulations.

Finite Element Analysis, Bars, Beams Trusses and Rigid frame, Plates and shells, Heat transfer, Fluid and solid mechanics, Introduction to non-linear Finite Element Methods, Adaptive finite analysis, Automatic mesh generation, Choice of new mesh, Transfer variables.

Reference Books

1. Rao S.S., "The Finite Element Method in Engineering", Elsevier Science & Technology.
2. Hutton D.V., "Fundamental of Finite Element Analysis", McGraw Hills.
3. Cook R.D., Malkus, D.S. and Plesha, M.E., "Concepts and Applications of Finite Element Analysis", 3 rd Ed., John Wiley & Sons.
4. Bathe K.J., "Finite Element Procedures", Prentice Hall of India, New Delhi.

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5. Huebner K.H. and Thorton, E.A., "The Finite Element Methods for Engineers" John Wiley & Sons.
6. Zienewiccz O.C. and Taylor, R.L., "The Finite Element Methods", Vol. 1, Vol. 2 and Vol.3, McGraw Hill.
7. Belytshko, T., Liu, W.K. and Moran, B., Non-linear Finite Elements for Continua and Structures", McGraw Hills.

COURSE OUTCOME

1. Explain the concepts and principles used in the formulation and application of the finite element method (focussed on stress analysis of common mechanical devices);
2. Demonstrate an ability to formulate, implement, and document solutions to solve simple engineering problems using the finite element method
3. Choose appropriate software packages to assist in the solution of a range of common engineering problems;
4. Evaluate the performance of an existing design using computer aided engineering software, in particular, to evaluate the validity of the model and solution in relation to the original problem specification;
5. Develop the finite element formulations for heat transfer problems.

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

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3-	2	2	1	2	-	-	-	-	-	-	1	3	3	3
CO2	3	1	3	3	1	-	-	-	-	-	-	-	2	2	1
CO3	3	2	2	3	1	-	-	-	-	-	-	-	2	1	1
CO4	3	3	3	2	2	-	-	-	-	-	-	3	1	1	2
CO5	3	1	3	3	1	-	-	-	-	-	-	2	2	2	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATK4 -ARTIFICIAL INTELLIGENCE

COURSE OBJECTIVES:

The primary objective of this course is to:

- Gain a historical perspective of AI and its foundations.
- Become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning.
- Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
- Experience AI development tools such as an 'AI language', expert system shell, and/or data mining tool.
- Experiment with a machine learning model for simulation and analysis. 6. Explore the current scope, potential, limitations, and implications of intelligent systems.

COURSE CONTENT:

Definition of AI, Brief history of AI, General problem Solving Approaches in AI- Learning Systems, Knowledge representation and reasoning, Planning, Knowledge Acquisition, Intelligence search, Logic Programming, Soft computing, Applications of AI techniques, Characteristic requirement for the realization of intelligent system, Programming languages for AI, Architecture for AI machine.

Cognitive perspective of pattern recognition- Template Matching, Prototype matching, feature based approach, Computational approach; Cognitive models of memory- Atkinson-Shiffrin´s model, Tulving´s model, Parallel distributed processing approach; Understanding of problem; Cybernetic view to cognition.

Production rules, Working memory, Control Unit/Interpreter, Conflict Resolution strategies, Types of production systems-Commutative Production system, Decomposable Production system, Forward verses Backward reasoning, Merits of a Production system- Isolation of knowledge and control strategy, Direct Mapping onto State-space, Modular Structure of Production rules, Knowledge base Optimization in production system.

Production Solving by Intelligent Search: General problem solving approaches- Breadth first search, depth first search, Iterative deepening search, Hill Climbing, Simulated annealing; Heuristic Search- for OR Graph, Iterative deepening algorithm, AND-OR Graph, Adversary Search- MINIMAX algorithm, Alpha-Beta heuristics.

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Logic of Propositions and Predicates- Formal definition, Propositional Logic-Semantic method for theorem proving, Syntactic method for theorem proving, Resolution in Propositional Logic, Predicate Logic, Unification of Predicates, Robinson's Interference Rule, Types of Resolution, Soundness and Completeness of Logic.

References:

1. Artificial Intelligence and Soft Computing, Amit Konar
2. Journal of Artificial Intelligence, Science Direct, Elsevier Publication
3. IEEE Transaction on Computational Intelligence and AI

COURSE OUTCOMES:

Upon successful completion of this course, the student shall be able to:

1. Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.
2. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
3. Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
4. Demonstrate proficiency developing applications in an 'AI language', expert system shell, or data mining tool.
5. Demonstrate proficiency in applying scientific method to models of machine learning.

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

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	-	-	-	-	1	3	-	1	2	1	1
CO2	3	1	3	2	-		-		2	2		2	2	-	-
CO3	2	1	-	2	-	-	-	-	-	-	-	1	1	-	1
CO4	2	2	-	-	-	-	-	-	2	3		2	1	1	1
CO5	3	2	1	1	1	-	-	-	-	1	-	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATK5 - QUALITY ENGINEERING AND MANUFACTURING

COURSE LEARNING OBJECTIVES:

The objective of this course is to:

1. Recognize the basic knowledge of quality value and engineering and importance of quality engineering in design production processes.
2. Understand the tolerance design and core values of design strategy.
3. Develop the concepts and statistical methods that are employed for functional limits, tolerance design in manufacturing environment.
4. Determine the effect of DOE process steps description and analysis of variance amongst data sets.
5. Apply and analyze the concept of quality system, 6-sigma and quality circles.

COURSE CONTENT:

Quality value and Engineering: An overall quality system, quality engineering in production design, quality engineering in design production processes.

Loss function and quality level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances (N-type-, S-type and L-type)

Tolerance Design and Tolerancing: Functional limits, tolerance design for N-type, L-type and S-type characteristics, tolerance allocation for multiple components. Parameter and tolerance design: Introduction to parameter design, signal to noise ratios, parameter design strategy, Introduction to tolerance design, tolerance design using the loss function, identification of tolerance design factors.

Design of Experiments: Introduction, Task aids and Responsibilities for DOE process steps, DOE process steps description. Analysis of variance (ANOVA): Ono-WAY anova, One-way ANOVA, two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

Orthogonal Arrays: Typical test strategies, better test strategies, efficient test strategies, conducting and analyzing an experiment. Interpolation of experimental results: Interpretation methods, percent contribution, estimating the mean.

ISO-9000 Quality system, BDRE, 6-sigma, bench marking, quality circles-brain storming fish bone diagram-problem analysis.

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References Books

1. Taguchi techniques for quality engineering/Philip J.Ross / McGraw Hill Intl. 2nd Edition.
2. Quality Engineering in Production systems/G.Taguchi, A.Elasayed et al/Mc.Graw Hill Intl. Edition.
3. Taguchi methods explained: Practical steps to Robust Design/PapanP.Bagchi/Prentice Hall Ind. Pvt. Ltd. New Delhi.

COURSE OUTCOMES:

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

1. Develop conceptual understanding of Design of Experiments and identification of tolerance design factors.
2. Analyze and develop an experiment and. Interpolation of experimental results and Interpretation methods.
3. Apply the knowledge of Parameter and tolerance design and its principles for handling manufacturing operations.
4. Implicate the concept of ANOVA and philosophy of quality circles for productivity.
5. Define the quality engineering and manufacturing and implicated quality engineering in production design for inducing efficiency.

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

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	1	2	-	2	-	2	2	-	2	3	2	1
CO2	1	1	3	1	1		-			1		2	2	3	2
CO3	-	-	3	2	1		-	-	-	-	-	3	2	3	2
CO4	2	1	2	-	-	-	2	-	2	2		3	1	1	2
CO5	3	2	2	2	2	-	-	-	-	3	-	2	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATK6- PRODUCTION AND OPERATIONS MANAGEMENT

COURSE LEARNING OBJECTIVES:

The objective of this course is to

1. To define operation management, Types of production systems and current issues in operation management.
2. To categorize various processes of product development and its concepts in product development for grasping effectual performance
3. To understand about standardization, simplification and planning.
4. To outline competitive advantages, factors considerations in plant location and aggregate planning strategies
5. To elaborate JIT Production process, push system and techniques of MRP.

COURSE CONTENT:

Operation Management – Definition – Objectives – Types of production systems – historical development of operations management – Current issues in operation management. Product design – Requirements of good product design – product development – approaches – concepts in product development – standardization - simplification – Speed to market – Introduction to concurrent engineering.

Value engineering – objective – types of values –function & cost – product life cycle – steps in value engineering – methodology in value engineers – FAST Diagram –Matrix Method. Location – Facility location and layout – Factors considerations in Plant location – Comparative Study of rural and urban sites – Methods of selection plant layout – objective of good layout – Principles – Types of layout – line balancing.

Aggregate Planning – definition – Different Strategies – Various models of Aggregate Planning- Transportation and graphical models Advance inventory control systems push systems –Material Requirement – Terminology – types of demands – inputs to MRP- techniques of MRP – Lot sizing methods – benefits and drawbacks of MRP – Manufacturing Resources Planning (MRP – II). Pull systems – Vs Push system – Just in time (JIT) philosophy Kanban System - Calculation of number of Kanbans Requirements for implementation JIT – JIT Production process – benefits of JIT.

Scheduling – Policies – Types of scheduling- Forward and Backward Scheduling – Gantt Charts – Flow shop Scheduling – n jobs and 2 machines, n jobs and 3 machines – Job shop Scheduling – 2 jobs and n machines – Line of Balance.

Project Management – Programming Evaluation Review Techniques (PERT) – three times estimation – critical path – probability of completion of project – critical path method - crashing of simple nature.

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References Books

1. Operations Management by E.S. Buffa.
2. Operations Management, Theory and Problems by Joseph G. Monks.
3. Production Systems Management by James. L. Riggs.
4. Production and Operations Management by Chary.
5. Operation Management by Chase&Acquilino
6. Production & Operation Management by PannerSelvam
7. Production & Operation Analysisby Narsimha

COURSE OUTCOMES:

After the completion of this course, students will be:

1. Demonstrate a basic understanding about types of scheduling and critical paths.
2. Acquire knowledge about various models of aggregate planning and methods of selection plant layout.
3. Demonstrate technical understanding about value engineers, inventory and MRP.
4. Implement decision making policies, Gantt Charts and line balancing principles for handling manufacturing network.
5. Resolve uncertain production decision in decision making by applying critical thinking, tools and techniques.

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

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	1	2	-	2	-	2	2	-	2	3	2	1
CO2	3	1	-	1	2		2	3		2		3	2	3	3
CO3	2	-	1	2	1	-	-	-	-	-	-	3	2	1	1
CO4	2	1	2	-	2	1	2	-	2	2		2	1	2	2
CO5	1	2	3	2	2	-	-	-	-	3	-	2	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATK7- INDUSTRIAL ENGINEERING AND BUSINESS MANAGEMENT

COURSE LEARNING OBJECTIVES:

The objective of this course is to

1. To develop an understanding about work design, method design and associated terminologies.
2. To understand about capacity planning, business structure and productivity.
3. To comprehend about the nature and process and functions of communication.
4. To develop an understanding about operational control, agile management and competition

COURSE CONTENT:

Work Design and Facility layout Method study, Work measurement, applied work measurement, Physical ergonomics, Environmental factors, Productivity, Role of industrial Engineering in attaining productivity.

Plant location, Facilities layout, Group technology and line balancing, Materials handling, Break even analysis, Incentives.

Capacity analysis, Operational control, Agile management, Just-in-Time, Creative design, Innovation, Invention, Globalization, Team work, Project scheduling and management

Overview of business analytics, scope of business analytics, business analytics process, relationship of business analytics process and organisation, competitive advantages of business analytics.

Statistical tools: statistical notation, descriptive statistical methods, review of probability distribution and data modelling, sampling and estimation methods overview.

Nature and process of communication, Functions of communication, Theories and models of communication. Development communication, Role of media in Development communication, communication research, research problem, objectives, variables, sampling, qualitative research methods, field observation, focus groups, interviews, case studies, quantitative methods, content analysis, survey research, questionnaire, statistics.

Text Books & References

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.
3. Management Research Methodology: Integration of Principles, Methods and Techniques, K N Krishnaswamy, A I Sivakumar and M Mathiranjan, Pearson Education.

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4. The Economics of Sustainable Development, S. Asefa, W.E. Upjohn Institute for Employment Research, 2005.
5. Production and operation management, O.Paneerselvem, TMH.
6. Charles T. Horngren and George Foster, Advanced Management Accounting.

COURSE OUTCOMES:

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

1. Identify the various process of communication, associated theories and models
2. Students will be able to classify development communication, Role of media in development communication, communication research.
3. Students will be able to use the knowledge of Innovation, Invention, Globalization, Team work, Project scheduling.
4. Students will be able to examine the factors related with Productivity and industrial Engineering in attaining productivity.
5. Students will be able to participate in business analytics process and can plan relationship amongst business analytics process and organization.

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

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	2	1	2	-	-	-	2	2	-	2	3	3	3
CO2	2	1	3	3	1		-			3		2	2	2	-
CO3	2	-	-	3	-	-	-	-	3	-	-	2	2	1	-
CO4	2	3	3	-	-	-	-	-	3	3		3	1	1	2
CO5	2	1	3	3	1		-			3		2	2	2	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATK8- PRINCIPLES OF MANAGEMENT, COST AND PROJECTS

COURSE OBJECTIVES:

The objectives of this course are:

- To understand the basic concept of the functions and responsibilities of managers.
- To learn the nature and purpose of planning, business organizations, sole proprietorship and partnership
- To understand the nature and purpose of organization, departmentalization, delegation of authority, centralization and decentralization.
- To learn the leadership qualities and the methods of directing for effective communication.
- To learn the different methods of controlling the management activities.
-

COURSE CONTENT:

Definition of management, science or art, manager v/s entrepreneur, types of managers managerial roles and skills, evolution of management- scientific, human relations, system and contingency approaches, types of business organizations, sole proprietorship, partnership, company, public and private enterprises, organization culture and environment, current trends and issues in management.

Planning objectives, policies, strategic management, planning tools and techniques, decision making steps & processes, Introduction and overview of the strategic cost management process.

Formal and informal organization, organization structure, departmentalization, delegation of authority, centralization and decentralization, job design, performance management, Cost concepts in decision-making, differential cost, incremental cost and opportunity cost. Objectives of a costing system.

Directing, individual and group behaviour, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

Project: meaning, different types, why to manage, various stages of project execution, Detailed engineering activities, use of computers and IT in management control, productivity problems and management, control and performance, Quantitative techniques for cost management, linear programming, PERT/CPM, transportation problems, assignment problems, simulation.

TEXT & REFERENCE BOOKS:

1. Management, S.P. Robins & M. Couiter, 10th Edition, 2009, Prentice Hall India.
2. Management, Jaf Stoner, R.E Freeman and D.R Gilbert, 6th Edition, 2004, Pearson Education.
3. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi

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4. Charles T. Horngren and George Foster, Advanced Management Accounting
5. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting.
6. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher.
7. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.
8. Principles of Management, P.C Tripathy & P.N. Reddy, 1999, Tata McGraw Hill.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

- Learn the basic concepts of managerial functions and current trends and issues in management.
- Explain the nature of planning with the help of tools and techniques.
- Learn the nature and purpose of organization structure and the whole management system.
- Explain the leadership qualities and learn about quantitative techniques for cost management, linear programming.
- Analyze and apply both qualitative and quantitative information to isolate issues and formulate best control methods.

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

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	1	2	3	-	-	2	2	-	2	3	3	3
CO2	2	1	2	3	1		-			3		2	2	2	-
CO3	1	-	-	3	-	1	1	-	3	-	-	2	-	1	2
CO4	1	3	3	-	-	-	-	-	3	3		3	3	1	2
CO5	3	2	2	2	2	-	-	-	-	2	-	2	-	1	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATK9- MANUFACTURING PROCESSES

COURSELEARNINGOBJECTIVES:

The objective of this course is to:

- Understand the principle, concept, thermal and metallurgical aspects during solidification of metal.
- Demonstrate about principles/ methods of casting with detail design of gating/ riser system needed for casting, defects in cast objects and requirements for achieving sound casting.
- Evaluate foundry practices like pattern making, mould making, core making and inspection of defects.
- Build knowledge about principles and criteria of yielding during forming of metals, analysis of different bulk metal forming processes following different analysis approach.
- Analyze various metal forming processes and plastic deformation during forming processes.

COURSE CONTENT:

Module –I

Foundry: Moulding method and materials, sand-clay-water system, additives, pattern making and types, pattern allowances & design considerations, types of moulding sand & their properties, testing, cores and sand core boxes, core making, moulding machine.

Gating system: Elements & design of gating system, design of riser, solidification of casting.

Module –II

Melting furnaces and practices: Melting cast iron, steel and non-ferrous material, cupola, charge calculation, open furnaces, converter and crucible furnaces, electric, direct arc furnace, inductive furnace.

Module –III

Special casting processes: Centrifugal and investment casting, shell, types and principle of die casting, squeeze casting, gravity and pressure die casting, die casting consideration, continuous casting, centrifugal casting, slush casting, casting defects.

Module –IV

Metal forming: Need and classification, elastic and plastic deformation, yield criteria, fundamentals of hot and cold working processes.

Drawing: Drawing process geometry and analysis of wire and sheet drawing for load and power calculations, maximum reduction possible.

Rolling: Classification of rolling, process geometry and analysis of plate rolling for rolling load, rolling pressure and power calculations, defects in rolled products.

Forging: Classification of Forging, determination of forces in disc forging considering sticking and slipping, forging defects.

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Extrusion: Classification, process geometry and analysis of rod and sheet extrusion for load and power calculations, maximum reduction possible, defects in extruded product.

TEXT & REFERENCE BOOKS:

1. Manufacturing processes for engineering materials - Kalpakjian and Schmid, Pearson India.
2. Manufacturing Science- A. Ghosh and A. K. Mallik, East-West Press Pvt. Ltd. New Delhi.
3. Manufacturing Technology (Foundry, Forming and Welding) – P. N. Rao, Tata McGraw Hill Publishing Company.
4. Materials and Processes in Manufacturing - E. P. DeGarmo, J. T Black, R. A. Kohser, Prentice Hall of India, New Delhi.
5. Production Engineering Sciences - P. C. Pandey and C. K. Singh, Standard Publishers Ltd.

COURSE OUTCOMES:

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

- Decide yield of a material according to different yield theory for a given state of stress.
- Analyze the different bulk metal forming process mechanics using different analysis approach and calculate the force, power requirements etc.
- Evaluate the effect of process parameters on the process mechanics during bulk metal forming.
- Select appropriate design of gating systems and manufacturing processes in order to design products.
- Identify the various metal forming techniques and the theory of plasticity and its application for analyzing various metal forming Processes.

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

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	-	2	-	-	-	-	2	1	2	2	2
CO2	3	2	1	2	1	2	2	1	-	-	2	2	3	3	3
CO3	3	2	2	2	2	1	2	2	-	-	2	3	2	3	3
CO4	3	2	2	2	2	2	2	1	-	-	2	2	2	3	3
CO5	3	1	2	2	1	2	2	1	-	-	2	2	2	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATP1 - ADVANCED OPTIMIZATION TECHNIQUES

COURSE LEARNING OBJECTIVES:

- Impart knowledge on theory of optimization and conditions for optimality for unconstraint and constraint optimization problems
- Learn quantitative methods and techniques for effective decision making process
- Inculcate modeling skills necessary to describe and formulate optimization problems in design and manufacturing
- Familiarize with the working principle of optimization algorithms used to solve linear and non-linear problems
- Train the students to solve optimization problems using software tools

COURSE CONTENT

Linear programming: Two-phase simplex method, Big-M method, duality, interpretation, applications. Assignment problem: Hungarian's algorithm, Degeneracy, applications, unbalanced problems, traveling salesman problem.

Classical optimization techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.
Numerical methods for optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, types of penalty methods for handling constraints.

Genetic algorithm (GA) : Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,
Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

Multi-Objective GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multiobjective problems .

Applications of Optimization in Design and Manufacturing systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining

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process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

References Books

1. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
2. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
3. Engineering Optimization – S.S.Rao, New Age Publishers
4. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
5. Genetic Programming- Koza
6. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI publisher.

COURSE OUTCOMES

- **CO1**: Formulate the engineering problems as an optimization problem.
- **CO2**: Apply necessary and sufficient conditions for a given optimization problem for optimality
- **CO3**: Select appropriate solution methods and strategies for solving an optimization problem and interpret and analyze the solution obtained by optimization algorithms
- **CO4**: Justify and apply the use of modern heuristic algorithms for solving optimization problems
- **CO5**: Solve Engineering Design and Manufacturing related optimization problem using software tools.

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

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PC6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1	1	1	-	-	-	1	1	-	1	1	-	-
CO2	1	3	2	1	-	-	-	-		1	-	-	1	-	-
CO3	1	3	2	1	1	-	-	-	2	1	-	-	-	-	-
CO4	2	2	2	2	2	-	-	-	2	1	-	-	-	-	-
CO5	1	3	3	2	3	-	-	-	2	2	-	1	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATP2- LOGISTICS & SUPPLY CHAIN MANAGEMENT

COURSE LEARNING OBJECTIVES:

The objective of this course is to:

1. To understand supply chain activities, process planning, decision phases, importance and management of supply chains.
2. To examine various drivers of supply chain for acquiring effectual performance, ease distribution and acquisition of production resources & Inventories.
3. To understand about uncertainty, risk management, distribution network, role of location, capacity and forecasting in SC.
4. To adapt drivers of supply chain, related framework and to appraise supply chain performance, pricing and sourcing decisions.
5. To learn the role of logistics and transportation networks.

COURSE CONTENT

Logistics and Competitive Strategy: Competitive advantage through logistic – Mission –integrated supply chains – Models in Logistics Management – Logistics to supply Chain Management – Focus areas in supply Chain Management – performance Measures for SCM. Customer Service Dimension: The marketing and logistics interface – Customer service and customer retention - Service driven logistics systems – Basic service capability – Increasing customer expectations – Value added services – Customer satisfaction and success – Time based logistics. Logistics System Design: Logistics positioning – Logistics reengineering – reengineering procedure – logistics environmental assessment – time based logistics – alternative logistics strategies – strategic integration – logistics time based control techniques. Measuring Logistics Costs and Performance: The concept of Total Cost analysis – Principles of logistics costing – Logistics and the bottom line – Impact of Logistics on Shareholder value – customer profitability analysis – direct product profitability – cost driver and activity based costing. Logistics and Supply chain relationships: Benchmarking the logistics process and SCM operation – Mapping the supply chain processes – Supplier and distributor benchmarking – setting benchmarking priorities – identifying logistics performance indicators – Channel structure – Economics of distribution – channel relationship – logistic service alliances. Sourcing, transporting and pricing products: Sourcing decisions – transportation in the supply chain – basic transportation economics and pricing – transportation documentation – pricing and revenue management in the supply chain – pricing and revenue management in supply chains. Coordination and Technology in Supply chain: Lack of coordination and Bullwhip Effect – obstacles to coordination – managerial levers to achieve coordination – Building strategic partners and trust within a supply chain. Role of IT in the supply chain – E-business. Managing global logistics and global supply chains: Logistics in a global economy –

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global operating levels – interlink global economy – Global supply chain business processes – Global strategy, purchasing, logistics – Global alliances – Issues and Challenges.

References Books

1. Donald J. Bowersox and David J. Closs, Logistical Management: The Integrated Supply Chain Process, TMH.
2. Martin Christopher, Logistics Supply Chain Management, Pitman, London.
3. Sunil Chopra and Peter Meindl: Supply Chain Management: Strategy, Planning and Operation, Pearson Education, New Delhi.
4. B.S.Sahay, supply Chain Management for Global competitivesness, Macmillan.
5. Philip B.Schary, TageSkjott – Larsen: Manageing the Global Supply Chain.
6. Arjun J Van Weele: Purchasing and Supply Chain Management- Analysis, Planning and Practice, Thomson Learning.
7. Ballou, Business Logistics/Supply chain management, Pearson Education.

COURSE OUTCOMES

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

CO1- Demonstrate basic understanding about competition, logistics network, capable factors for supply chain designs and supply chain strategies.

CO2- Acquire knowledge about distribution network, e-business, forecasting, network design and time-series analysis.

CO3- Decide technical understanding about demand, inventory, safety, pricing and information technology.

CO4- Manage and measure sourcing decisions in supply chain, product availability under capacity constraints, optimal levels of product, services and resources.

CO5- Identify and rectify barriers in coordination in a supply chain system.

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

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSOs1	PSOs2	PSOs3
CO1	3	2	3	2	2	-	2	-	2	-	2	2	3	2	3
CO2	3	3	3	2	2	3	2	-	2	-	2	-	3	2	2
CO3	3	3	2	2	2	2	-	-	2	-	2	2	2	3	-
CO4	3	3	2	2	-	2	2	-	2	-	2	2	3	2	-
CO5	3	3	-	3	-	1	-	1	2	-	2	2	2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATP3 -MANUFACTURING SYSTEMS MANAGEMENT AND QUALITY ENGINEERING

COURSE LEARNING OBJECTIVES:

The objective of this course is to:

1. Recognize the basic knowledge of Manufacturing Systems and importance of quality control and management.
2. Understand the philosophy, principles and core values of TQM.
3. Develop the concepts and statistical methods that are employed for assurance of quality in products, processes and systems in manufacturing environment.
4. Determine the effect of process capability analysis and introduction of sampling plans.
5. Apply and analyze the concept of measurement, maintenance and planning for quality.

COURSE CONTENT:

Manufacturing Processes, Advances in Manufacturing Processes, Casting, Welding, Forming, Unconventional machining processes, Additive manufacturing, Micro and Nano-Machining Processes, Metrology for quality control.

Manufacturing management and Operations research facility, Capacity & Layout Planning, Maintenance strategies. Role of Linear Programming, Sequencing.

Measurements, Errors, Accuracy, Precision, Calibration, Measuring instruments, types, Gauges, Comparators, In-process inspection, Introduction of sensors and transducers.

Control charts acceptances sampling, TQM, TPM, Design of Experiments, Statistical process control, Sampling, TQM principles and their Implementation, TQC, Maintenance, Replacement.

Statistical process control, Online/offline quality control, Process capability, Design of experiments, Reliability, Maintainability

Elimination of waste and problem exposure. Total quality control systems. Demings wheel, Deming 14 points-pros and cons in engineering context, Quality management philosophies. Quality function development, Quality control circles. Application of TQM to service type organizations.

Numerical control, Robotics, Material handling, FMS, Cellular manufacturing

Text Books & References:

1. Manufacturing Engineering and Technology – Serope Kalpak Jain, and Steven R. Smith, Pearson education.
2. Automation, Production systems and Computer Integrated Manufacturing System – Mikell P. Groover, PHI Publication.

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3. Grant E.L. and Leave Worth, Statistical Quality Control, TMH. 1996.
4. Amitava Mitra, Fundamentals of Quality Control and Improvement, Wiley, 2016.
5. Maintenance Engineering, H. P. Garg, S. Chand and Company.
6. Introduction to Manufacturing Processes by John A Schey, Mc Graw Hill.
7. Non-Traditional Manufacturing Processes by Gary F Benedict, CRC Press.
8. Advanced Methods of Machining by J. A Mc Geough, Springer
9. Jain K.C. and Chitale A.K., Quality Assurance and Total Quality Management, Khanna Publisher, India, 2003.

COURSE OUTCOMES:

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

1. Develop conceptual understanding of maintenance, manufacturing, quality cost and value.
2. Analyze and develop control charts for statistical quality control.
3. Apply the knowledge of quality control and its tools for handling manufacturing operations.
4. Implicate the concept of TQM and philosophy of quality leaders for productivity.
5. Define the manufacturing process and implicated sensors and transducers for inducing process capability analysis.

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

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	-	-	-	2	2	-	2	3	2	3
CO2	2	1	3	3	1		-			1		2	2	3	2
CO3	3	-	-	2	1	-	-	-	-	-	-	2	2	2	2
CO4	2	3	2	-	-	-	-	-	2	3		3	1	1	2
CO5	3	2	2	2	2	-	-	-	-	2	-	2	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATP4 - MECHANICS OF COMPOSITE MATERIALS

COURSE LEARNING OBJECTIVES:

The objectives of this course is to

1. Understand the fundamental properties of composite materials;
2. Apply the fundamental principles and mechanics of composite materials;
3. Apply modern analytical techniques to mechanical systems with composite materials;
4. Apply computational techniques to mechanical systems with composite materials;
5. Understand the manufacturing processes and cost analysis in composite materials;
6. Demonstrate effective communication and teamwork skills through technical presentations and reports in term projects.

COURSE CONTENTS

Introduction: Definition of composites; classification of composites; Fibers and matrix materials and their properties; generalized Hook's law- orthotropic, transversely isotropic and isotropic materials; constitutive equations under plane stress condition for orthotropic materials, restrictions on elastic constants of orthotropic materials.

Macromechanics of Lamina: Stress-strain relations for a lamina of arbitrary orientation, invariant properties of an orthotropic lamina, strength of an orthotropic lamina, experimental determination of strength and stiffness, biaxial strength theories of an orthotropic lamina: maximum stress theory, maximum strain theory, Tsai-Hill theory, Tsai-Wu tensor theory.

Micromechanics of lamina: Mechanics of materials approach to stiffness (determination of E_1, E_2, U_{12}& G_{12}); mechanics of materials approach to strength; tensile and compressive strength in fiber directions, elasticity approach to stiffness, some results of exact solution.

Micromechanics of laminate: Classical lamination theories (CLT)- laminate stress, laminate stiffness- A-B-D matrix and their implication, symmetric and non-symmetric laminates interlaminate stress, limitations of classical lamination theory.

Short Fiber Composites: Theories of stress-transfer, average fiber stress, modulus prediction, strength prediction, the effect of matrix ductility, ribbon–reinforced composites.

Text & Reference books:

1. "Modern Composite Materials" by L J Broutman and R M Krock,
2. "Composite Materials – Science and Engineering" by K K Chawla,
3. "Mechanisms and Mechanics of Composite Fracture" by R B Bhagat and S G Fishman,
4. "An Introduction to Composite Materials" by D Hull,

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5. "Structural composite materials" by F C Campbell.
6. "Composite Materials" by Berthelot,
7. "Electrostatic Discharge Sensitivity of Composite Energetic Materials" by Michelle L Pantoya and Chelsea Weir.
8. Jones, R M, Mechanics of Composite Materials, Scripta BookCo.
9. Agarwal, B D and Broutman, J. D, Analysis and Performanceof Fiber Composites, New York, John Willey, and Sons, 1990.
10. Mallik, P. K, Fiber reinforced composites: materials,manufacturing and design, New YorkMarcel and Dekker,1993 (2nd edition)
11. Arthur, K Kaw, Mechanics of Composite Materials, CRCPress, 1997.
12. Reddy J N, Mechanics of Laminated Composite Plates, CRCPress

COURSE OUTCOMES:

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

1. Determine composite mechanical properties from constituent fiber and matrix material properties including longitudinal and lateral moduli, Poisson's ratio, and shear modulus.
2. Determine the generalized stiffness and compliance matrix relating in-plane stresses to strains for a composite layer assuming plane stiffness.
3. Apply classical laminated plate theory to determine extensional, coupling, and bending stiffnesses of a composite laminate. Also be able to perform this calculation using MATLAB for a composite laminate with many layers.
4. Fabricate composite laminates and built-up composite structures such as I-beams, box beams, or model-scale aircraft wings using a composite manufacturing procedure.

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

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	-	-	-	-	2	2	1	2
CO2	3	3	2	2	2	-	-	-	-	-	-	2	3	1	3
CO3	3	2	2	3	2	-	-	-	-	-	-	2	3	1	3
CO4	3	2	2	3	2	-	-	-	-	-	-	2	3	1	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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COURSE OBJECTIVES

- Detailed knowledge and information about lean manufacturing tools and their impact on Plant Productivity and Product Cost
- The required skills to understand and/or audit lean implementation maturity in your plant across various departments in different processes to check for gaps and advice accordingly
- Tools and techniques in the efforts to introduce lean practices within the organisation
- A sense of achievement for contributing to organisational scalability and hence growth, in turn, demonstrating potential, talent and encouraging additional opportunities for higher roles and responsibilities
- The necessary flexibility to adapt to change, without letting it affect the individual, team or organisational performance
- The skill and ability to deliver higher quality and establish reliability and credibility for work

CONTENTS

Introduction Lean Manufacturing:

Introduction, Definitions of Lean manufacturing, explaining basic concepts, historical development, overview of Lean Principles / concepts / tools.

Primary Tools of Lean manufacturing:

5-S, Workplace organization, Total Productive Maintenance, Process mapping/ Value stream mapping, Work cell.

Secondary Tools of Lean manufacturing:

Objective and benefits of Secondary lean tool, Cause and Effect diagram, Pareto chart, Spider chart, Poka yoke, KANBAN, Automation, Single minute exchange of die (SMED), Design for manufacturing and assembly, Just in time (JIT), Visual workplace, OEE.

Tools and Techniques:

The seven traditional tools of quality, new management tools, concepts, methodology, applications to manufacturing, Bench marking. Reason to bench mark, Bench marking process, FMEA, Stages, and Types. Quality circles, Quality Function Deployment (QFD), Taguchi quality loss function, TPM, improvement needs, Cost of Quality, Performance measures.

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Lean Management:

Concepts and Frame Work of Lean Manufacturing, Characteristics, benefits to organizations, Management theory, six sigma, Why six sigma, case studies

Text Books & Reference Books:

1. Mitra A., "Fundamentals of Quality Control and Improvement", PHI, 2nd Ed., 1998.
2. J Evans and W Linsay, The Management and Control of Quality, 6'th Edition, Thomson, 2005
3. Besterfield, D H et al., "Total Quality Management", 3rd Edition, Pearson Education, 2008.
4. D. C. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, 6th Edition,2004
5. Dale H.Besterfiled, "Total Quality Management", Pearson Education Asia.

COURSE OUTCOMES:

1. Identify types of waste in manufacturing system and systematic eliminate it.
2. Study and implement lean principles.
3. Able to implement primary and secondary lean tools in manufacturing system.
4. Analyze and implement objectives and drivers of lean production system to achieve cost reduction and efficient service of customer demands
5. Apply appropriate approaches to project using Lean tools and techniques.

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

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	-	-	-	-	-	-	1	1	1	3
CO2	3	3	1	3	1	-	-	-	-	-	-	-	2	2	1
CO3	3	2	2	1	3	-	-	-	-	-	-	-	2	1	1
CO4	3	2	1	2	2	-	-	-	-	-	-	1	1	1	2
CO5	3	1	3	1	1	-	-	-	-	-	-	2	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATP6 - FUNDAMENTALS OF GREEN MANUFACTURING

COURSE LEARNING OBJECTIVES:

The objectives of this course are:

1. To develop the basic concepts of the three pillars of sustainability and how they are manifested in sustainable and green manufacturing as well as to facilitate the students to presume position of scientific and/or managerial leadership in their career paths towards green manufacturing.
2. To help students to develop the basics of the green manufacturing concepts, strategy, different technology used to implement green manufacturing.
3. To develop the basic concepts of Life Cycle Assessment approach to evaluate environmental impacts of product design, manufacturing processes, product use-phase, and product end-of-life.
4. To broaden and deepen their capabilities and understanding towards concepts of different types of green technology.
5. To help students to develop the basic understanding on lean and green technology and differences and similarities between both.

COURSE CONTENT:

Introduction: Sustainable development indicators of sustainability, sustainability strategies, sustainable manufacturing, evolution of sustainable manufacturing, elements of sustainable manufacturing, theory of green manufacturing and its principles, need for green manufacturing, drivers and barriers of green manufacturing.

Green manufacturing strategy: Manufacturing strategy, elements of manufacturing strategy, manufacturing out puts, competitive priorities: quality, delivery speed and reliability, cost efficiency, flexibility, order winners and order qualifier, tradeoff, production systems, manufacturing levers, competitive analysis, level of manufacturing capability, framework for formulating manufacturing strategy, implications of green manufacturing for manufacturing strategy.

Life cycle approach of green manufacturing: Holistic and total Life-cycle approach, six step methodologies for green manufacturing (6-R approach), life cycle assessment (LCA), elements of LCA, life cycle costing, eco labellingtarget setting, data collection and processing, final evaluation by virtue of criteria, environmental management systems.

Green manufacturing technology: Definition of green manufacturing technology and practices, classifications of green manufacturing technology, advantages and disadvantages of implementation of green technology.

Lean and Green manufacturing: Introduction, lean evolution & steps, introduction to lean manufacturing, definition of lean manufacturing, lean vs. green manufacturing: similarities and differences.

TEXT & REFERENCE BOOKS:

1. Cleaner Production: Environmental and Economic Perspectives, Misra Krishna B., Springer, Berlin, Latest edition.
2. Environmental Management Systems and Cleaner Production, Dr. Ruth Hillary, Wiley, New York, Latest edition.
3. Pollution Prevention: Fundamentals and Practice, Paul L Bishop, TMH.

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4. Costing the earth, Cairncrss and Francis, Harvard Business School Press – 2009.
5. The principle of sustainability, Simon Dresner, –Earth Scan publishers (2008).
6. Manufacturing strategy: How to formulate and implement a winning plan, Jhon Miltenburg, Productivity Press Portland, Oregon-2017.
7. Manufacturing strategy, Voss C. A, Chapman & Hall-1992
8. Manufacturing the future, Steve Brown, Prentice Hall, 2000
9. Manufacturing strategy, Terry Hill, Homewood, IL- 1989
10. Becoming Lean - Inside Stories of U.S. Manufacturers, Jeffrey K. Liker, Productivity Press, Portland, Oregon
11. Handbook of Sustainable Manufacturing, G. Atkinson, S. Dietz, E. Neumayer, Edward Elgar Publishing Limited, 2007.
12. Industrial Development for the 21st Century: Sustainable Development Perspectives, D. Rodick, UN New York, 2007.
13. An Introduction to Sustainable Development, P.P. Rogers, , K.F. Jalal & J.A. Boyd, J.A, Earth scan, London, 2007.
14. Sustainable Development Indicators in Ecological Economics, P. Lawn, Edward Elgar Publishing Limited.
15. The Economics of Sustainable Development, S. Asefa, W.E. Upjohn Institute for Employment Research, 2005.

COURSE OUTCOMES:

Upon completion of the course students will be able to

1. **CO1**-Graduate will demonstrate the ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
2. **CO2**-Graduate will become familiar with green manufacturing concepts and practices and analyze the problems within the domains of Green Manufacturing as the members of multidisciplinary teams. As well will be able to formulate appropriate green manufacturing strategy.
3. **CO3**-Graduate will be trained towards the basic concepts of Life Cycle Assessment approach to evaluate environmental impacts of product design, manufacturing processes, product use-phase, and product end-of-life.
4. **CO4**-Formulate and apply different green technologies as per the requirement and situations and able to plan good housekeeping practices for Industry/other places with concern of safety, hygiene and waste reduction.
5. **CO5-** Apply different approaches of lean and green manufacturing in the real world problem to overcome the problems arises due to manufacturing.

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

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSOs1	PSOs2	PSOs3
CO1	-	2	3	2	1	2	3	1	1	2	2	1	3	2	2
CO2	-	2	3	2	1	3	3	1	1	2	3	2	3	2	2
CO3	-	2	3	2	1	2	3	2	1	3	3	2	3	3	3
CO4	-	2	3	2	2	3	3	1	1	3	2	2	3	2	2
CO5	-	2	3	2	1	3	3	1	1	2	2	1	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATP7- STRATEGIC MANAGEMENT IN SUPPLY CHAIN

COURSE LEARNING OBJECTIVES:

The objective of this course is to

1 To define supply chain, its importance and management.
2. To categorize various drivers of supply chain for grasping effectual performance
3. To understand about uncertainty, risk management and forecasting.
4. To outline competitive advantages, distribution networks and supply chain strategies
5. To elaborate drivers and barriers of distribution networks in practice.

COURSE CONTENT:

Strategic framework to analyze supply chains, Supply chain and its objective, the importance of supply chain decisions, decision phases in a supply chain, process view of a supply chain, examples of supply chains.

Supply chain performance: achieving strategic fit and scope, competitive and supply chain strategies, achieving strategic fit, expanding strategic scope, supply chain drivers and metrics, drivers of supply chain performance, framework for structuring drivers, facilities, inventory, transportation, information, sourcing, pricing.

Forecasting, Time series method, moving average, weighted average, trend, seasonality, regression technique, Delphi method, The role of network design in the supply chain, factors influencing network design decisions framework for network design decisions, models for facility location and capacity allocation, role of IT in network design, making network design decisions in practice.

Aggregate planning in a supply chain, Master production schedule: Material requirement planning: objectives, functions, MRP, MRP-II, limitations. Capacity requirement planning, process of CRP, process sheet, rough cut capacity planning, loading, and preparation of CRP chart, Planning supply and demand in a supply chain, Planning and managing inventories in a supply chain, Managing uncertainty in a supply chain:

Text Books & References:

1. Supply Chain Management: Janat Shah, Pearson Publications 2010.
2. Supply Chain Management: Sunil Chopra and Mein del, Fourth Edition, PHI 2010.
3. Supply Chain Management: A.S.Altekar PHI Second Ed.2006.
4. Logistics Management: James Stock and Douglas Lambert. McGraw Hill International Ed.2006.
5. Supply Chain Management for Global Competitiveness :Ed.B.S.Sahay McMillan Publication 2000
6. Emerging Trends in Supply Chain Management: Ed.B.S.Sahay McMillan Publication 2000.
7. Logistics Management: Bowersox TMH 2004.

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COURSE OUTCOMES:

After the completion of this course, students will be:

1. Demonstrate a basic understanding about competition and supply chain strategies.
2. Acquire knowledge about distribution network, E-business and time-series.
3. Demonstrate technical understanding about demand, inventory, safety, pricing.
4. Implement decision making policies, infrastructure and optimum design for handling transportation network.
5. Resolve uncertain and risk decision in decision making and can capably tailored transportation and supply chain costs.

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

COs	POs												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSOs 1	PSOs 2	PSOs 3
CO1	3	2	1	2	2	-	2	-	2	-	-	2	3	2	2
CO2	3	-	3	2	2	3	2	2	2	-	2	-	-	-	-
CO3	2	-	2	-	2	-	-	-	3	-	-	2	2	1	-
CO4	2	3	2	2	-	2	2	-	3	-	3	2	1	3	-
CO5	-	3	-	-	-	1	-	2	2	-	2	2	2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATP8 - PRODUCT DESIGN AND MANUFACTURING

COURSE LEARNING OBJECTIVES:

The objective of this Course is to:

1. Competence with a set of tools and methods for product design and manufacturing
2. Develop confidence in your own abilities to create a new product.
3. Create awareness of the role of multiple functions in creating a new product (e.g., marketing, finance, industrial design, engineering, production).
4. Apply creative process techniques in synthesizing information, problem-solving and critical thinking

COURSE CONTENT:

Introduction to Product Design and Manufacturing: Design by evolution, Design by innovation, Production-Consumption cycle, Ideas and methods of product realization process, Manufacturing, Logistics & Productivity, Problem Confronting the Designers, Steps of the Engineering Design Process, Defining the Problem and Setting Objectives

Product design morphology: Developing Provisional Designs, Evaluation and Decision-Making, The morphology of design (the seven phases), Product Characteristics: Developing successful products, Attributes of successful product developments, Key factors for successful products, Product Characteristics, Aesthetic Design, Design Principles, Product Message, Visual Design, Elements of Visual Design

Value engineering in product design: Advantages, Applications in product design, Problem identification and selection, Analysis of functions, Anatomy of function. Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST), Why poor Value? The Value Engineering Methodology, Information phase, Function Phase, Creativity Phase, Evaluation Phase, Development Phase, Implementation Phase, Case studies

Importance of material selection, Factors affecting the material selection process, Material selection procedures, Design Recommendations, how to select manufacturing process? Primary, secondary and tertiary manufacturing process, Design guidelines, Design for Manufacturing, Design for Assembly, Design for Environment

Product costing: Cost and Price Structure Information Need Sources, Estimating Direct and Indirect Costs, Design and Manufacturing Costs, Ways to Model Manufacturing Costs
Rapid Prototyping or Additive Manufacturing, Rapid Prototyping, Reverse Engineering: Reverse Engineering-Definition, Importance, Applications, Process ,3D Scanning Process Managing Competitiveness: Benchmarking, Outsourcing, Mass customisation

TEXT & REFERENCE BOOKS:

1. Product design and development, Eppinger, S. and Ulrich, K., 2015.McGraw-Hill Higher Education
2. Integrated product and process design and development: the product realization process, Magrab, E.B., Gupta, S.K., McCluskey, F.P. and Sandborn, P., 2009.CRC Press.

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3. Product design for manufacture and assembly, Computer-Aided Design, Boothroyd, G., 1994.
4. Product design and manufacturing by Prof J Ramkumar and Prof Amandeep Singh Oberoi IIT Kanpur, NPTEL sources

COURSE OUTCOMES:

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

1. Understand the product design and manufacturing process
2. Design and validate technological solutions to defined problems and write clearly and effectively forthe practical utilization of their work
3. Discuss various phases of value engineering, analyse the function, approach of function and evaluation of function and to determine the worth and value
4. Select suitable manufacturing processes to manufacture the products optimally and to identify/control the appropriate process parameters.
5. Use basic fabrication methods to build prototype models for hard-goods and soft-goods

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

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	1	2	-	-	-	2	1	1	2
CO2	3	2	3	2	2	2	2	2	-	-	-	2	2	2	2
CO3	3	2	3	2	2	2	2	2	-	-	-	2	2	2	2
CO4	3	2	3	2	2	2	2	2	-	-	-	2	2	2	2
CO5	3	2	2	2	1	2	1	2	-	-	-	1	1	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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IPDATP9 - ADVANCED MANUFACTURING PROCESSES

COURSE LEARNING OBJECTIVES:

The objective of this course is to:

- To understand the principle of various advanced machining processes kinematics drive of machine tool.
- To impart knowledge about cutting different material removal, joining processes.
- To understand about various advanced metal forming processes.
- Explain how to identify suitable hybrid welding processes for joining dissimilar materials.
- To understand about various advanced casting processes.

COURSE CONTENT:

Advanced machining processes: Introduction, micro machiningprocess, principle, material removal mechanism, parametric analysis and applications of processes such as ultrasonic machining (USM), abrasive jet machining (AJM), water jet machining (WJM), abrasive water jet machining (AWJM), electrochemical machining (ECM), electro discharge machining (EDM), electron beam machining (EBM), laser beam machining (LBM) processes, working principle of plasma arc machining.

Advanced machining theory & practices: Mechanisms of chip formation, shear angle relations, and theoretical determination of cutting forces in orthogonal cutting, analysis of turning, drilling and milling operations, mechanics of grinding, dynamometry, thermal aspects of machining, tool wear, economics of machining, processing of polymers, ceramics, and composites.

Advanced metal forming processes: Details of high energy rate forming (HERF) process, electro-magnetic forming, explosive forming electro-hydraulic forming, stretch forming, contour roll forming.

Advanced welding processes: Details of electron beam welding (EBW), laser beam welding (LBW), ultrasonic welding (USW),cold welding, diffusion welding, forge welding, friction welding, explosive welding, hard vacuum welding, soft vacuum welding, underwater welding processes, concept of robotized welding and welding automation.

Advanced casting processes: Metal mould casting, continuous casting, squeeze casting, vacuum mould casting, evaporative pattern casting, ceramic shell casting.

TEXT & REFERENCE BOOKS:

1. Manufacturing processes for Engineering Materials, Serope Kalpakjian, Steven R. Schemid, Fourth edition, Pearson Education.
2. Manufacturing Engineering and Technology, Serope Kalpakjian, Third Edition, Addison-Wesley Publication Co.,
3. Materials and Processes in Manufacturing, E.P. DeGarmo, J. T Black, R.A. Kohser, 8th Edition, Prentice Hall of India, New Delhi (ISBN 0-02-978760).
4. Manufacturing Science, A. Ghosh & A.K. Mallik, East-West Press Pvt. Ltd. New Delhi.
5. Non-traditional Manufacturing Processes, G.F. Benedict, Marcel Dekker, Inc. New York (ISBN 0-8247-7352-7)
6. Advanced Machining Processes, V.K. Jain, Allied Publishers Pvt. Ltd.

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7. Modern Machining Processes, P.C Pandey & H.S. Shan, McGraw Hill Education.
8. Manufacturing Technology, P. N Rao, Tata McGraw Hill Publishing Company.
9. Non-Conventional Machining, P. K Mishra, Narosa Publishers.
10. Unconventional Manufacturing Processes, K. K Singh, Dhanpat Rai & Company, New Delhi.

COURSE OUTCOMES:

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

- Basic understanding of advanced casting processes and able to analyze real-life application in various organizations.
- Categorize different material removal, joining processes as per therequirements of material being used to manufacture end product.
- Choose material processing technique with the aim of cost reduction, reducing material wastage & machining time.
- Estimate process parameters affecting the prc duct quality in various advanced machining of metals/ non-metals, ceramics and composites.

Evaluation and Analysis of the different advanced welding process to select most suitable welding procedure and consumables for a product

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

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	2	2	2	-	1	1	2	1	2	2
CO2	2	2	2	1	1	-	-	1	1	1	1	2	1	2	2
CO3	1	2	2	2	1	1	2	1	2	1	1	2	2	2	2
CO4	2	3	3	3	1	-	-	2	-	1	1	2	2	2	2
CO5	2	2	2	3	2	1	1	2	-	2	1	2	1	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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