

**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 2022-23

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
SN	Name of the Subject		SN	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	Production and operations management	IPDATP3
4	Artificial Intelligence	IPDATK4	4	Mechanics of Composite Materials	IPDATP4
5	Quality engineering and manufacturing	IPDATK5	5	Lean Manufacturing	IPDATP5

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

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


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IPDATK1- COMPUTER AIDED DESIGN

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).

Reference Books

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


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IPDATK2 - ROBOTICS

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.




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IPDATK3 - FINITE ELEMENT METHOD

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, Processor and Post processor.


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.
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.


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IPDATK4 - ARTIFICIAL INTELLIGENCE

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 versus 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.

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

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IPDATK5 - QUALITY ENGINEERING AND MANUFACTURING

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 quadratle 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 Responsibilites 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.

References Books

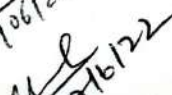
1. Taguchi techniques for quality engineering/Philip J.Ross / McGraw Hill Intl. 2nd Edition.
2. Quality Engineering in Production systems/G.Taguchi, A.Elasayed et al/Mc.Graw Hill Intl. Edition.
3. Taguchi methods explained: Practical steps to Robust Design/PapanP.Bagchi/Prentice Hall Ind. Pvt. Ltd. New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


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IPDATP1 - ADVANCED OPTIMIZATION TECHNIQUES

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 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.


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IPDATP2- LOGISTICS & SUPPLY CHAIN MANAGEMENT

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 – Ebusiness. Managing global logistics and global supply chains: Logistics in a global economy – 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 competitiveness, 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.


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7. Ballou, Business Logistics/Supply chain management, Pearson Education.

IPDATP3 - PRODUCTION AND OPERATIONS MANAGEMENT

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.

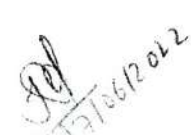
Project Management – Programming Evaluation Review Techniques (PERT) – three times estimation – critical path – probability of completion of project – critical path method - crashing of simple nature.

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 & Aquilino
6. Production & Operation Management by Panner Selvam
7. Production & Operation Analysis by Narsimha


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IPDATP4 - MECHANICS OF COMPOSITE MATERIALS

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.

Macro mechanics 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 their implication, symmetric and non-symmetric laminates interlaminar stress, limitations of classical Lamination theory.

Short fiber composites:- Theories of stress-transfer, average fiber stress, modulus prediction, strength effect of matrix ductility, Ribbon -Reinforced composites.

Reference books:

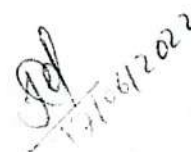
1. "Modern Composite Materials" by L J Broutman and R M Krock.
2. "Composite Materials - Science and Engineering" by K K Chawla
3. "Mechanisms and Mechanics of Composite Fracture" by R B Bhagat and S G Fishman
4. "An introduction to composite materials" by D Hull,
5. "Structural composite materials" by F C Campbell
6. Composite Materials by Berthelot
7. Electrostatic Discharge sensitivity of composite energetic materials " by Michelle L Pantoya and Chelsea Weir

Suggested Books

1. Jones, R M, Mechanics of Composite Materials, Scripta BookCo.
2. Agarwal, B D and Broutman, J. D, Analysis and Performance of Fiber Composites, New York, John Willey and Sons, 1990
3. Mallik, P. K, Fiber reinforced composites : materials, manufacturing and design, New York Marcel and Dekker, 1993 (2nd edition)
4. Arthur, K Kaw, Mechanics of Composite Materials, CRC Press, 1997.
5. Reddy J N, Mechanics of Laminated Composite Plates, CRC Press 6. Mallik, P. K, Composite



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IPDATP5 - LEAN MANUFACTURING

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.

Lean Management:

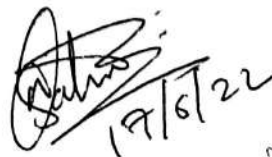
Concepts and Frame Work of Lean Manufacturing, Characteristics, benefits to organizations, Management theory, six sigma, Why six sigma, case studies

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. Besterfield, "Total Quality Management", Pearson Education Asia.






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