COURSE CURRICULAM

for

M.TECH. DEGREE

in

MECHANICAL ENGINEERING

(Applicable from the academic session 2024-2025)

Approved by BOS(ME) dt 5.11.2024 &
Academic Council, Agenda-01.02, dt 21.11.2024

DR. B.C. ROY SOCIETY
ENGINEERING
AN AUTONOMOUS INSTITUTE

Dr. B. C. Roy Engineering College

An Autonomous Institution

Approved by: All India Council for Technical Education (AICTE)

Affiliated to: Maulana Abul Kalam Azad University of Technology, West Bengal
(Formerly Known as -WBUT)

Jemua Road, Durgapur, West Bengal, India,713206

Course Name: Advanced Engineering Mathematics
Course Code: MM (ME) 101
(Semester I)
Category:
Course Broad Category:

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1. **Course Prerequisite:**
   B.Tech. 1st and 2nd semester Mathematics.

2. **Course Learning Objectives:**
   The objective of these courses to familiarize the prospective engineers with techniques in differential equation, numerical methods, matrix, transform calculus and statistics. It aims to equip the students with standard concepts and tools at an intermediate to advance level that will serve them well towards tackling more advance level of mathematics and applications that they would find useful in their disciplines.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures and Field Visits.
   Evaluation System –
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   Course Name: Advanced Engineering Mathematics
   Course Code: MM (ME) 101
   Hours per Week: 3L:1T:0P
   Credits: 4

Module	Topics	40 L
1.	**Statistics:** Elements of statistics; frequency distribution, concept of mean, median, mode and different types of distribution; Standard deviation and Variance; Curve fitting by least square method; Correlation and Regression; Testing of hypothesis; Basic types of factorial design and analysis of variance (ANOVA).	10 L
2.	**Matrix Operation:** Matrix operations; Eigen value and Eigen vector by iterative methods; Diagonalisation of a square matrix.	8 L

3.	**Transform calculus:** Laplace Transform, Fourier Transform; Fourier Integral and their applications.	6 L
4.	**Numerical methods:** Interpolation by polynomials; Error analysis; Solution of system of linear equation by Gauss Seidel iterative method; Newton-Raphson method; Numerical integration by Gauss-quadrature; solution of ordinary differential equation by Rayleigh-Ritz method.	10 L
5.	**Ordinary and** Partial **Differential Equations:** 2nd order homogeneous equation, Euler Cauchy equation, non-homogeneous linear equation. Partial Differential equation: Wave equation- one dimension and two dimensions; Heat equation- one dimension and two dimensions.	6 L

6. **References:**

Text Book:

- "Advanced Engineering Mathematics"- E. Kreyszig, John Wiley & Sons.
- "Advanced Engineering Mathematics" - S. Grossman and W.R. Derrick, Harper & Row Publishers.

Reference Books:

1. G. B. Thomas & R.L. Finney--- Calculus and Analytic Geometry.
2. "Introductory Methods of Numerical Analysis" - S.S. Sastry, PHI
3. Veerarajan T.--- Engineering Mathematics for 1st year (TMG)
4. D. Poole---- Linear Algebra: A Modern Introduction.
5. Bali & Goel--- Text Book of Engineering Mathematics.

7. **Course Outcomes:**

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
MM(ME) 101.1	Remember to identify various methods of ordinary differential equations which would enable to solve different engineering problems to encounter in their profession life.	Identify	Remember

MM(ME) 101.2	Understand the concept to explain applications of numerical methods in applied sciences and engineering problems.	Explain	Understand
MM(ME) 101.3	Apply to implement the concept of statistics to solve real life problems in engineering mathematics.	Implement	Apply
MM(ME) 101.4	Analyze the basic properties of matrix operation and having the ability to compute such real-life problems.	Organize	Analyze
MM(ME) 101.5	Evaluate the Laplace transforms and inverse Laplace transforms to assess differential and integral equations in engineering fields like network analysis and control systems	Assess	Evaluate
MM(ME) 101.6	Construct logical and analytical skills to create a new idea appreciated by academics, research & emerging trends in industry.	Construct	Create

Course Name: ADVANCED DYNAMICS OF MACHINERY
Course Code: MME 101
(Semester I)
Category: Major

Course Broad Category: M. Tech in Mechanical Engineering

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1. **Course Prerequisite:**
   Undergraduate level knowledge of equilibrium, kinematics, and kinetics of rigid bodies. Proficiency in calculus, differential equations, and familiarity with the principles of oscillatory motion.

2. **Course Learning Objectives:**
   i. This course introduces generalized coordinates and forces, Lagrangian equations, and Hamilton's principle to model and complex dynamic systems.
   ii. Students will also get introduced to single, two, and multi-degree-of-freedom systems, distributed mass and elasticity effects, balancing and control solutions for dynamic machinery.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and real world problem discussion.
   Evaluation System –
   Attendance
   Internal Assessment (20 Marks) - Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks) - Summative Assessment
   End-Semester Exam (70 Marks) - Summative Assessment.

4. **Course Content:**
   Course Name: Advanced Dynamics of Machinery
   Course Code: MME 101
   Hours per Week: 3L: 0T: 0P
   Credits: 3

Module	Topics		CO
1.	Generalized Forces and Coordinates. Lagrangian Equations and Hamilton's Principle.	10L	CO1 and CO2
2.	Mechanical Vibration: Single, two and multi-degree of freedom systems. Distributed mass and elasticity.	12L	CO3 and CO4
3.	Cam dynamics. Balancing of rotors, Field balancing.	12L	CO5

Module	Topics		CO
4.	Dynamics of control systems.	10L	CO6

6. References:

Text Book:

1. Mechanical Vibrations by V. P. Singh, Dhanpat Rai & Co., 5th Edition, 2022.
2. Theory and application of Mechanical Vibration- D. K. Adhwarjee. University Science Press.
3. Mechanical Vibrations: S S Rao Addison-Wesley Publishing Co.
4. Principles of Vibration Control: Asok Kumar Mallik, Affiliated East-West Press.

Reference Books:

1. Theory of Vibrations with Applications: W T Thomson CBS Publishers Delhi
2. Mechanical Vibrations A H Church ,John Wiley & Sons Inc
3. Mechanical Vibration Analysis: Srinivasan, McGraw Hill.
4. A textbook of mechanical vibration – Rao V. Dukkipati, J. Srinivas, PHI
5. Advanced theory of vibration – J. S. Rao, Wiley Eastern Limited
6. Vibration, Dynamics and structural systems – Madhujit Mukhopadhyaya, Oxford IBH
7. Rotor dynamics – J. S. Rao, New Age International
8. Control System- Benjamin Kuo8.
9. Control System-OGATA

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

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Explain the concepts of generalized forces and coordinates to derive Lagrangian equations.	Explain	Understand
CO2	Describe mechanical systems using Hamilton's principle for advanced dynamic modeling and problem-solving.	Identify	Understand
CO3	Solve vibration problems in mechanical systems, including single, two, and multi-degree-of-freedom systems.	Recognize	Understand
CO4	Compute evaluate the effects of distributed mass and elasticity on system dynamics.	Compute	Evaluate
CO5	Understand the dynamic behavior of cam mechanisms and develop effective solutions for rotor balancing, including field balancing, to enhance the performance and stability of mechanical systems.	Apply	Apply
CO6	Implement control systems for dynamic mechanical applications, ensuring stability, responsiveness, and optimized performance in various operational scenarios.	Recognize	Apply

Course Name: ENGINEERING MECHANICS
Course Code: MME102
(Semester I)
Category: Major

Course Broad Category: Engineering Science Courses

1. **Course Prerequisite:**
   Primary Manufacturing Processes, Materials Engineering

2. **Course Learning Objectives:**
   i. This course entails a details discussion of welding and various welding technologies
   ii. The course aims to provide detail knowledge of foundry engineering and industry.
   iii. The course also aims to provide scientific Approach to forming processes and analysis

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and real world problem discussion.
   Evaluation System –
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   Course Name: Advanced Production Methods
   Course Code: MME102
   Hours per Week: 4L:0T:0P
   Credits: 3

Module	Topics	42L	CO
1.	**Welding:** Classification of methods and recent advances in welding, TIG and MIG Welding,	7	CO1, CO2, CO3
2.	Submerged Arc and Electroslug Welding, Thermit Welding, Plasma cutting and Welding; Weldability, Welding defects, Inspection and testing.	8	CO2, CO3, CO4, CO5
3.	**Foundry:** Pattern design for castings, Selection, Preparation and	14	CO1, CO2,

Module	Topics	42L	CO
	testing of mould materials, Metal melting practices, Solidification of castings, Principal of gating and risers, Types of risers – open, blind, top, side, etc., riser size design, by Caine's and NRL methods, locations of risers, directional solidification, gating ratio, Special Casting processes, Casting defects and remedies.		CO3, CO4, CO5
4.	**Forging:** Metal flow in forging, Design of Forging dies. Press Tools: Press Tool operations, Design of punch and dies for Blanking, Piercing, Bending, Drawing etc.	16	CO2, CO3, CO4, CO5

6. References:

Text Book:

1. Metal Forming Handbook- Schuler - Springer Verlag Publication
2. Metal Forming:Mechanics and Metallurgy- Hosford,WF and Caddell,R.M. -, Prentice Hall, Eaglewood Cliffs,1993
3. Metal Forming-Fundamentals and applications -Altan .T. - American Society of Metals , Metals park,1983.
4. ASM Metals of Hand book on Casting - Revised Edn,1995
5. Advanced Welding Processes- J.Norish- - Woodhead Publishing Limited
6. Principal of Metal casting - Heine, Loper & Rosenthal, TMH publication

7. Reference Books:

1. Principal of Foundry Technology- P.L. jail, TMH Pub.
2. Fundamental of Metal Forming Process - B.L. Juneja
3. Metal forming by Rodford and Richardson
4. Metal forming by Rowe
5. Welding for Engineers – Udin, Funk , Wulf, John Wiley & Sons publisher
6. Modern Arc Welding Technology - S. V. Nadkarni, Oxford & IBh publishers.
7. The Metallurgy of Welding - D. Seferian , Advanced welding Process - J. Morris
8. Principal of Welding Technology - L. M. Gourd.
9. Welding Hand Book. – AWS
10. Filer Metals for joining - Orville T. Bamett.

8. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Bloom's Level
CO1	The course desribes different primary manufacturing processes of welding, casting and forming.	Describe	Remembering
CO2	The students will understand the scientific	Understand	Understanding

	background of welding, solidification and metal flow in forming processes.		
CO3	The students will be able to determine the right welding, casting and forming processes for specific application.	Determine	Applying
CO4	The students will be able to infer the cause of different defects produced during different manufacturing processes.	Infer	Analyzing
CO5	The students will be able to evaluate the right combination of manufacturing parameters for varying situation.	Evaluate	Evaluating

Course Name: ADVANCED METAL CUTTING THEORY
Course Code: MME103A
(Semester I)
Category: Majore

Course Broad Category: Engineering Science Courses

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Course Prerequisite:

Basic Manufacturing Processes: Understanding of fundamental machining processes such as turning, milling, drilling, and grinding.

Mechanics of Materials: Knowledge of the behavior of materials under different loads, stresses, and strains, which is crucial for understanding cutting forces and tool wear.

Fundamentals of Metal Cutting: A basic understanding of metal cutting, including cutting

1. **Course Learning Objectives:**
   i. This course introduces Cutting Mechanics & Analyzing Cutting Forces and Tool Wear.
   ii. Students will also get introduced to Explore Advanced Tool Materials & Understand the Heat Generation and Control in Cutting.

2. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and real world problem discussion.
   Evaluation System –
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

3. **Course Content:**
   Course Name: ADVANCED METAL CUTTING THEORY
   Course Code: MME103A
   Hours per Week: 4L:0T:0P
   Credits: 4

Module	Topics	40L	CO
1.	Tool geometry, Tool materials. Chip formation, Mechanics of turning process, Earnst and Merchant's analysis, various shear angle relationships.	12L	CO1 and CO2
2.	Energy considerations, Chip-tool contact and interfacial stresses. Mechanics of Drilling, Milling and Grinding processes. Machinability. Tool wear and Tool life.	12L	CO3 and CO4
3.	Economics of machining. Newer (unconventional) machining processes.	11L	CO5

Module	Topics	40L	CO
	Ultrasonic and Abrasive Jet Machining.		
4.	Chemical and Electrochemical Machining and Grinding Electrodischarge Machining. Plasma and Laser Beam Machining.	5L	CO5

6. References:

Text Book:

1. A.Bhattacharya- Metal Cutting Theory and Practice, New Central Book Agency (P) Ltd.Kolkata
2. A. Ghosh and A.K. Mallik, Manufacturing Science, Affiliated East-West Press Pvt. Ltd., New Delhi

Reference Books:

3. Metal Cutting Theory and Cutting Tool Design - V. Arshinov and G. Alekseev Mir Publishers, Moscow
4. Metal Cutting - E.M. Trent and P.K. Wright, Butterworth Heinemam Publication
5. Metal Cutting Mechanics - N.N. Zorev, Pergamon Press.
6. Principles of Engineering Manufacture, Black, S. C., Chiles, V., Lissaman A. J. and Martin, S.J.

(2004) 3rd Edition, New Delhi: Viva Books Pvt. Ltd.

7. P. N. Rao Manufacturing Technology vol-II Tata Mcgraw hill.

7. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	To **Explain** metal cutting tool theories and Implement it to solve simple numerical on related concepts.	Explain	Understand
CO2	To **Understand** the cause and effect of cutting temperature and cutting tool failure. Focus on improvement of machinability by evaluation of optimum cutting velocity and tool life	Understand	Understand
CO3	To **evaluate** the role of each process parameter during machining of various advanced materials.	Evaluate	Evaluate
CO4	To **Analyze** Machining Models of various advanced manufacturing processes for achieving maximum MRR and minimum surface roughness while machining various advanced materials..	Analyze	Analyze
CO5	To **Analyze** various NTM Processes	Analyze	Analyze

Course Name: PRODUCTION TOOLING AND EQUIPMENT
Course Code: MME 103B
(Semester I)
Category: Major

Course Broad Category: Professional Elective

1. **Course Prerequisite:**
   - Introduction to Manufacturing Processes
   - Manufacturing Systems and Automation

2. **Course Learning Objectives:**
   - To understand the principles and applications of production tooling and equipment
   - To design and develop production tooling and equipment for various manufacturing processes
   - To analyze and evaluate the performance of production tooling and equipment
   - To implement and maintain production tooling and equipment in a manufacturing environment

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and real world problem discussion.
   Evaluation System –
   Attendance,
   Internal Assessment (20 Marks)- (a) Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); (b) Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (70 Marks)- Summative Assessment.

4. **Course Content:**
   Hours per Week: 4L:0T:0P
   Credits: 4

Module	Topics	42L
1	Introduction to Production Tooling and Equipment - Overview of production tooling and equipment - Types of production tooling and equipment - Importance of production tooling and equipment in manufacturing	4L
2	Cutting Tools and Equipment - Principles of cutting tools and equipment - Types of cutting tools and equipment (e.g. milling, turning, drilling)	8L

Module	Topics	42L
	- Design and development of cutting tools and equipment	
3	Forming Tools and Equipment - Principles of forming tools and equipment - Types of forming tools and equipment (e.g. pressing, forging, casting) - Design and development of forming tools and equipment	8L
4	Assembly Equipment and Tools (4 weeks) - Principles of assembly equipment and tools - Types of assembly equipment and tools (e.g. welding, brazing, soldering) - Design and development of assembly equipment and tools	8L
5	Tooling and Equipment for Specialized Manufacturing Processes (4 weeks) - Tooling and equipment for specialized manufacturing processes (e.g. 3D printing, CNC machining) - Design and development of tooling and equipment for specialized manufacturing processes	8L
6	Maintenance and Troubleshooting of Production Tooling and Equipment (2 weeks) - Maintenance and troubleshooting techniques for production tooling and equipment - Common problems and solutions for production tooling and equipment	4L
7	Case Studies and Projects (4 weeks) - Real-world case studies of production tooling and equipment - Group projects to design and develop production tooling and equipment for a specific manufacturing process	8L

6. Reference Books:

1. Metal Cutting Theory & Cutting Tool Design- V. Arshinov & G. Alekseev, MIR Publisher (Moscow)
2. Introduction to Jigs and tool Design - MHA Kempster
3. Production Tooling Equipment, The Design of Jigs tooling and gauges J. A. Parson.
4. Fundamental of tool Design – S. K. Basu & S. N. Mukherjee
5. Principal of machine Tool - Sen & Bhattacherya
6. Machine Tool- S. K. Basu.
7. Machine Tool Design - N. K. Mehta, TMH Publication.
8. Hydraulic Control of Machine Tool - Khaimavich
9. Design of Cutting Tools: Use of Metal Cutting Theory - A. Bhattacharyya and I.Ham, ASTME, Michigan, 1969.
10. Metal Cutting Principles - M.C. Shaw, Oxford University Press CBS
11. Fundamentals of Metal Machining & Machine Tools - G. Boothroyd, McGrawHill
12. Metal Cutting - E.M. Trent and P.K. Wright, Butterworth Heinemam Publication
13. Cutting Tools- P.H. Joshi, Wheeler Publication.
14. Grindings Technology: Theory and Application of Machining with abrasives - S. Malkin, Ellis Harwood Publication, U. K., 1990.
15. Injection Mould Design - R.J.W. Pye, Longman Scientific Technical
16. Die Design Fundamentals - J.R. Paquin, Industrial Press. Inc.
17. Injection/Transfer Moulding of Thermosetting Plastics - R.E. Wright, Hanser
18. Metal Forming Processes - Nagpal, Khanna Pub.
19. Product Design & Manufacturing - A.K. Chitale, R.C. Gupta

7. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	to design and develop production tooling and equipment for various manufacturing processes, including cutting, forming, and assembly.	Design	Evaluate
CO2	to analyze and evaluate the performance of production tooling and equipment, including identifying potential problems and opportunities for improvement.	Analyze	Analyze
CO3	to select and apply appropriate production tooling and equipment for specific manufacturing processes and applications, taking into account factors such as cost, quality, and productivity.	Select. Apply	Apply
CO4	to maintain and troubleshoot production tooling and equipment, including identifying and resolving common problems and issues.	Maintain	Analyze
CO5	to integrate production tooling and equipment with manufacturing systems, including CAD/CAM, CNC machining, and automation systems.	Integrate	Apply
CO6	to optimize production tooling and equipment for improved manufacturing performance, including reducing costs, improving quality, and increasing productivity.	optimize	Apply

Course Name: ADVANCED MACHINING PROCESS
Course Code: MME 103C
(Semester I)
Category: Major

Course Broad Category: Professional Elective

1. **Course Prerequisite:**
   - Introduction to Manufacturing Processes
   - Manufacturing Systems and Automation

2. **Course Learning Objectives:**
   - To understand the principles and applications of advanced machining processes
   - To learn about the advantages and limitations of non-traditional machining methods
   - To understand the role of advanced machining processes in modern manufacturing
   - To develop skills in selecting and applying advanced machining processes for specific applications

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and real world problem discussion.
   Evaluation System –
   Attendance,
   Internal Assessment (20 Marks)- (a) Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); (b) Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (70 Marks)- Summative Assessment.

4. **Course Content:**
   Hours per Week: 4L:0T:0P
   Credits: 4

Module	Topics	42L
1	1. Introduction to Advanced Machining Processes - Overview of advanced machining processes - History and development of non-traditional machining methods - Importance of advanced machining processes in modern manufacturing	4L
2	2. Electrical Discharge Machining (EDM) - Principles of EDM - Types of EDM machines and tools	8L

Module	Topics	42L
	- Applications of EDM in various industries - Advantages and limitations of EDM	
3	3. Laser Beam Machining (LBM) - Principles of LBM - Types of LBM machines and tools - Applications of LBM in various industries - Advantages and limitations of LBM	8L
4	4. Ultrasonic Machining (USM) - Principles of USM - Types of USM machines and tools - Applications of USM in various industries - Advantages and limitations of USM	8L
5	5. Other Advanced Machining Processes - Introduction to other non-traditional machining methods, such as water jet machining, abrasive jet machining, and chemical machining - Applications and limitations of these processes	8L
6	6. Selection and Application of Advanced Machining Processes - Factors to consider when selecting an advanced machining process - Case studies of advanced machining processes in various industries - Group projects to select and apply advanced machining processes for specific applications	4L
7	7. Advanced Machining Process Simulation and Modeling - Introduction to simulation and modeling of advanced machining processes - Use of software tools for simulating and modeling advanced machining processes	8L

6. Reference Books:

1. Modern Machining Processes - P.C. Pandey and H.S. Shan, Tata McGraw-Hill Publication.
2. Non- Conventional Machining - P.K.Mishra, Narosa Publishers.
3. Laser Machining and Welding - N. Rykalin, A. Uglov and A. Kokora, Mir Publishers, Moscow.
4. Manufacturing Engineering and Technology - S. Kalpakjian, Addison Wesley.
5. Materials and Processes in Manufacturing - E.P. DeGarmo, J.T. Black and R.A. Kohser, Prentice Hall of India.
6. A Text Book of Production Technology - O.P. Khanna and M. Lal, Dhanpat Rai and Sons.
7. Rapid Prototyping: A Brief Introduction- A. Ghosh, East West Publication.
8. Manufacturing Processes- Amstead, Ostwald and Begeman, John Wiley and Sons.
9. Micromachines, I. Fujimasa, Oxford University Press.
10. Precision Engineering in Manufacturing, R.L. Murty, New Age International Publishers.
11. Advanced Machining Processes , V.K.Jain Allied Publishers Pvt. Limited, India
12. A general introduction to the Next Big Idea Nano technology Mark Ratner, Daniel Ratner Pearson Education.
13. Non-traditional Machining Processes, . G.F.Benedict Marcel Dekker Inc.,
14. Advanced Methods of Machining, J.A.McGeough Chapman and Hall
15. Micromachining of Engineering Materials, . Joseph McGeough Marcel Dekker
16. Fundamental of Modern Manufacturing: Materials, Processes and Syste, Willey Mikell P.Groover
17. Fundamentals of Machining Processes, H. El-Hofy (2007), CRC Press, Taylor and Francis Group

7. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	to explain the fundamental principles of advanced machining processes, including non-traditional machining methods such as EDM, LBM, and USM.	Explain	Understand
CO2	to select and apply advanced machining processes for specific applications, taking into account factors such as material properties, machining requirements, and process capabilities.	Select. Apply	Apply
CO3	to analyze and evaluate the performance of advanced machining processes, including assessing process capabilities, productivity, and quality.	Analyze	Analyze
CO4	to design and develop advanced machining process systems, including selecting and integrating equipment, tools, and software to achieve specific machining requirements.	Design	Evaluate
CO5	to troubleshoot and optimize advanced machining processes, including identifying and resolving common problems, and implementing process improvements to increase efficiency and productivity.	Opimize	Apply
CO6	to integrate advanced machining processes with manufacturing systems, including CAD/CAM, CNC machining, and automation systems, to achieve seamless production and improve overall manufacturing efficiency.	integrate	understand

Course Name: NUMERICAL METHOD & OPTIMIZATION TECHNIQUE
Course Code: MME 104A
(Semester I)
Category: Major

Course Broad Category: Professional Elective

1. **Course Prerequisite:**
   - Calculus
   - Linear Algebra
   - Programming skills (e.g. MATLAB, Python)

2. **Course Learning Objectives:**
   - To understand the fundamental concepts of numerical methods and optimization techniques
   - To learn how to apply numerical methods to solve algebraic and differential equations
   - To learn how to apply optimization techniques to optimize functions and systems
   - To develop skills in using numerical methods and optimization techniques to solve real-world problems
   - To understand the limitations and advantages of numerical methods and optimization techniques

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and real world problem discussion.
   Evaluation System –
   Attendance,
   Internal Assessment (20 Marks)- (a) Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); (b) Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (70 Marks)- Summative Assessment.

4. **Course Content:**
   Hours per Week: 4L:0T:0P
   Credits: 4

Module	Topics	42L
1	Introduction to Numerical Methods (1 week) - Overview of numerical methods - Types of numerical methods (e.g. interpolation, approximation, numerical differentiation and integration) - Applications of numerical methods	4L
2	Numerical Solution of Algebraic Equations (4 weeks)	8L

Module	Topics	42L
	- Bisection method - Newton-Raphson method - Secant method - Iterative methods	
3	Numerical Solution of Differential Equations (4 weeks) - Euler's method - Runge-Kutta method - Finite difference method - Finite element method	8L
4	Optimization Techniques (4 weeks) - Unconstrained optimization - Constrained optimization - Linear programming - Non-linear programming	8L
5	Simulation and Modeling (4 weeks) - Introduction to simulation and modeling - Types of simulation models (e.g. discrete-event simulation, continuous simulation) - Applications of simulation and modeling	8L
6	Numerical Methods for Optimization (4 weeks) - Gradient-based optimization methods - Derivative-free optimization methods - Evolutionary optimization methods	4L
7	Case Studies and Projects (4 weeks) - Real-world applications of numerical methods and optimization techniques - Group projects to apply numerical methods and optimization techniques to solve real-world problems	8L

6. Reference Books:

1. Numerical methods- Dr. B.S Agarwal
2. Engg. Optimization- S.Rao
3. Computer oriented numerical methods-V. Rajaraman
4. Applied numerical methods- Cornahn B.,et.al.(John Wiley)

7. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	to apply numerical methods to solve algebraic and differential equations, including interpolation, approximation, numerical differentiation, and numerical integration.	Apply	Apply
CO2	to use optimization techniques to optimize functions and systems, including unconstrained and constrained optimization, linear and non-linear programming, and gradient-based and derivative-free optimization methods.	use	Apply
CO3	to analyze and interpret numerical results, including understanding the limitations and advantages of numerical methods, and identifying potential sources of error and uncertainty.	Analyze	Analyze
CO4	to develop and implement numerical algorithms using programming languages such as MATLAB or Python, including writing code to solve numerical problems and visualizing numerical results.	develop	apply
CO5	to model and simulate real-world systems using numerical methods, including discrete-event simulation, continuous simulation, and hybrid simulation, and analyze and interpret the results of these simulations.	simulate	Evaluate
CO6	to apply numerical methods and optimization techniques to solve real-world problems in various fields, including engineering, economics, computer science, and mathematics, and communicate the results of these solutions effectively to both technical and non-technical audiences.	apply	apply

Course Name: Advanced CAD/CAM
Course Code: MME 104B
(Semester I)
Category: Major

Course Broad Category: Professional Elective

1. **Course Prerequisite:**
   - Introduction to CAD/CAM
   - Engineering design and graphics

2. **Course Learning Objectives:**
   - To understand the principles and applications of advanced CAD/CAM techniques
   - To learn how to use advanced CAD/CAM software to design and manufacture complex products
   - To understand how to integrate CAD/CAM with other engineering tools and systems
   - To develop skills in using advanced CAD/CAM techniques to solve real-world problems

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and real world problem discussion.
   Evaluation System –
   Attendance,
   Internal Assessment (20 Marks)- (a) Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); (b) Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (70 Marks)- Summative Assessment.

4. **Course Content:**
   Hours per Week: 4L:0T:0P
   Credits: 4

Module	Topics	42L
1	Introduction to Advanced CAD/CAM - Overview of advanced CAD/CAM techniques - Introduction to advanced CAD/CAM software	4L
2	3D Modeling and Surface Modeling - Introduction to 3D modeling and surface modeling - Using advanced CAD/CAM software to create 3D models and surfaces	8L

Module	Topics	42L
	- Applying design for manufacturability (DFM) and design for assembly (DFA) principles	
3	Assembly Modeling and Analysis - Introduction to assembly modeling and analysis - Using advanced CAD/CAM software to create and analyze assemblies - Applying interference detection and tolerance analysis techniques	8L
4	CAM and CNC Machining - Introduction to CAM and CNC machining - Using advanced CAM software to generate NC code and optimize machining processes - Applying machining strategies and techniques	8L
5	Advanced CAD/CAM Techniques - Introduction to advanced CAD/CAM techniques, such as free-form surface modeling and parametric modeling - Using advanced CAD/CAM software to apply these techniques - Applying advanced CAD/CAM techniques to solve real-world problems	8L
6	Integration with Other Engineering Tools and Systems - Introduction to integrating CAD/CAM with other engineering tools and systems, such as CAE, PLM, and ERP - Using data exchange formats, such as STEP and IGES, to integrate CAD/CAM with other systems - Applying integration techniques to solve real-world problems	4L
7	Case Studies and Projects - Real-world case studies of advanced CAD/CAM applications - Group projects to apply advanced CAD/CAM techniques to solve real-world problems	8L

6. Reference Books:

1. CAD/CAM Theory and Practice by Ibrahim Zeid /Mc Graw Hill international.
2. CAD/CAM Principles and Applications by P N Rao/ Tata McGraw-Hill
3. Computer Aided Engineering Design by a Saxena and B Sahay/ Anamya Publications
4. Mathematical Elements for Comp. Graphics by D F Rogers and J A Adams/ McGraw-Hill
5. CAD/CAM by H P Groover and E W Zimmers /Prentice Hall
6. Chris McMohan & Jimmi Brown- CAD CAM, Addison, Wiley-2000.
7. Donatas tijunela & Kirth E- Manufacturing High Tech Handbook, Mckee-2000.
8. Narahari and Viswanadham-Performance Modelling and Analysis of Automated Manufacturing Systems - Prentice Hall-1998.

Computer Aided Mechanical Design and Analysis - V. Ramamurti, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 3rd Edition.

10. CAD/CAM/CIM - P. Radhakrishnan, S. Subramanyan and V. Raju, New Age In ternational Publishers.
11. Computer Aided Manufacturing"- P.N. Rao, N.K. Tewari and T.K. Kundra, Tata McGraw- Hill Publication.

9. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	to design and develop complex 3D models using advanced CAD techniques, including free-form surface modeling, parametric modeling, and assembly modeling.	Apply	Apply
CO2	to create and edit 2D and 3D CAD models using advanced CAD tools, including CAD software such as CATIA, SolidWorks, or Autodesk Inventor, and apply advanced CAD techniques such as geometric modeling, surface modeling, and mesh modeling.	create	Apply
CO3	to apply advanced CAM techniques to generate NC code and optimize machining processes, including 3-axis and 5-axis machining, milling, turning, and drilling, and use CAM software such as Mastercam, PowerMill, or FeatureCAM.	Apply	Apply
CO4	to analyze and optimize CAD/CAM models for manufacturing and assembly, including applying design for manufacturability (DFM) and design for assembly (DFA) principles, and using tools such as tolerance analysis and interference detection.	Analyze	Analyze
CO5	to develop and implement advanced CAD/CAM workflows and automation scripts, including using programming languages such as Visual Basic, Python, or C++, and applying CAD/CAM automation tools such as macros, scripts, and APIs.	develop	apply
CO6	to integrate advanced CAD/CAM with other engineering tools and systems, such as computer-aided engineering (CAE), product lifecycle management (PLM), and enterprise resource planning (ERP), and apply data exchange formats such as STEP, IGES, and STL.	integrate	apply

Course Name: Production Planning and Control
Course Code: MME 104C
(Semester I)
Category: Major

Course Broad Category: PG (Engineering Science Courses)

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1. **Course Prerequisite:**
   UG level knowledge of Manufacturing and production related subjects.

2. **Course Learning Objectives:**
   i. This course introduces production and process techniques in elaborate form.
   ii. Students will also get introduced to the subject production planning and control

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and real world problem discussion.
   Evaluation System –
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. **Course Content:**
   Course Name: Production Planning and Control
   Course Code: MME 104C
   Hours per Week: 4L: 0T :0P
   Credits: 3

Module	Topics	42L	CO
1.	Organisation of PPC, PPC functions. Product design and development.	8L	CO1
2.	Sale forecasting. Machine utilisation and flow balancing.	12L	CO2 and CO3
3.	Production scheduling- single and multi product.	8L	CO4
4.	Deterministic and Stochastic ordering systems. Quality control	6L	CO5
5.	Plant layout, PERT and CPM.	5L	CO6

6. **Reference Books:-**

1. Production and Operations Management - E.S. Buffa, New Age International (P) Ltd., New Delhi.

2. Production Systems: Planning, analysis and Control - J.L. Riggs, John Wiley & Sons, New York.
3. Production and Operations Management - S.N. Chary, Tata McGraw-Hill Publishing Co. Ltd., New Delhi

7. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	**Understand** the role of Production Planning and control activities in Manufacturing and Services.	Explain	Understand
CO2	**Understand** and **Perform** various Forecasting techniques and problems	Explain, Compute	Evaluate
CO3	**Understand** and **Perform** various Inventory Management techniques and apply in real manufacturing scenario	Explain	Understand
CO4	**Analyze** various Scheduling procedures	Apply	Apply
CO5	**Understand** and **Evaluate** Dispatching procedures	Evaluate	Apply
CO6	**Understanding** and **Applying** Quality control, plant layout, PERT & CPM.	Recognize	Understand

Course Name: CONDUCTION AND RADIATION HEAT TRANSFER
Course Code: MME 104D
(Semester I)
Category: Major

Course Broad Category: Professional Elective

1. **Course Prerequisite:**
   - Thermodynamics
   - Fluid mechanics
   - Mathematics (e.g. differential equations, linear algebra)

2. **Course Learning Objectives:**
   - To understand the principles of conduction and radiation heat transfer
   - To learn how to analyze and design heat transfer systems and equipment
   - To develop skills in using mathematical and computational models to solve heat transfer problems
   - To apply heat transfer principles to real-world engineering problems

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and real world problem discussion.
   Evaluation System –
   Attendance,
   Internal Assessment (20 Marks)- (a) Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); (b) Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (70 Marks)- Summative Assessment.

4. **Course Content:**
   Hours per Week: 4L:0T:0P
   Credits: 4

Module	Topics	42L
1	Introduction to Heat Transfer - Overview of heat transfer modes (conduction, convection, radiation) - Introduction to heat transfer equations and principles	4L
2	Conduction Heat Transfer - Steady-state and transient conduction heat transfer - Heat transfer in various geometries (e.g. plates, cylinders, spheres) - Thermal resistance and heat transfer coefficients	8L

Module	Topics	42L
3	Radiation Heat Transfer (4 weeks) - Introduction to radiation heat transfer - Blackbody radiation and emissivity - Radiation heat transfer between surfaces	8L
4	Heat Transfer in Engineering Systems - Heat transfer in electronic systems - Heat transfer in mechanical systems (e.g. engines, pumps) - Heat transfer in aerospace systems (e.g. aircraft, spacecraft)	8L
5	Design of Heat Transfer Equipment - Design of heat exchangers (e.g. shell-and-tube, plate-and-frame) - Design of radiators and heat sinks - Design of thermal insulation systems	8L
6	Numerical Methods in Heat Transfer - Introduction to numerical methods for heat transfer problems - Finite difference and finite element methods - Computational fluid dynamics (CFD) and heat transfer	4L
7	Case Studies and Projects - Real-world case studies of heat transfer applications - Group projects to design and analyze heat transfer systems and equipment	8L

6. Reference Books:

1. V.S Arpaci – Conduction Heat Transfer, Addison-Wesley Pub. Co.,
2. E.M Sparrow, R.D Cess – Radiation Heat Transfer, Hemisphere Pub. Corp.,
3. M. F. Modest, Radiative Heat Transfer, Elsevier Science
4. Introduction to Heat Transfer – S.K.Som, PHI.
5. Yunus A. Cengel, "Heat and Mass Transfer", The McGraw- Hill Companies.
6. Fundamentals of Heat & Mass Transfer – Sarif K. Das, Narosa.
7. Incropera, DeWitt, Bergmam, & Lavine, "Fundamentals of Heat and Mass Transfer", Wiley, India Edn.

8. Engineering Heat Transfer – N.V.Suryanarayana, Penram International.
9. Principles of Heat Transfer-Kreith; Cengage learning.

9. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Understand the principles of conduction and radiation heat transfer	understand	understand
CO2	Analyze and design heat transfer systems and equipment	analyze	analyze
CO3	Develop skills in using mathematical and computational models to solve heat transfer problems	Apply	Apply
CO4	Apply heat transfer principles to real-world engineering problems	Apply	Apply
CO5	Design and optimize heat transfer equipment and systems	Design	apply
CO6	Communicate effectively the results of heat transfer analysis and design	communicate	understand