

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL  
Syllabus of M. Tech in Mechanical Engineering

**CURRICULUM FOR FOUR SEMESTER FULL TIME COURSE**

**FIRST SEMESTER**  
TOTAL CREDIT UNIT= 25

THEORY						
Sl. No.	Subject Code	Subject	Contact Hours per Week			Credit Unit
			L	T	P	
1	MM(ME)101	Advanced Engineering Mathematics	3	1	0	4
2	MME 101	Advanced Dynamics of Machinery	4	0	0	4
3	MME 102	Advanced Production Methods	4	0	0	4
4	MME 103A MME 103B MME 103C	Elective-I	4	0	0	4
5	MME 104A MME 104B MME 104C MME 104D	Elective-II	4	0	0	4
Total Theory			19	1	0	20
PRACTICAL						
6	MME 191	Advanced Manufacturing Laboratory	0	0	4	2
7	MME 192	Material Testing Laboratory	0	0	4	2
SESSIONAL						
8	MME 181	Seminar-I	0	0	2	1
Total Practical			0	0	10	5
Total :						25

**SECOND SEMESTER**  
TOTAL CREDIT UNIT= 25

Sl. No.	Subject Code	Subject	Contact Hours per Week			Credit Unit
			L	T	P	
1	MME 201	Advanced Machine Design	4	0	0	4
2	MME 202	Production & Operation Management	4	0	0	4

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3	MME 203A MME 203B MME 203C MME 203D	Elective-III	4	0	0	4
4	MME 204A MME 204B MME 204C MME 204D	Elective-IV	4	0	0	4
5	MME 205A MME 205B MME 205C MME 205D	Elective-V	4	0	0	4
Total Theory			20	0	0	20
<b>**** Electives to be chosen from list of elective subjects on page 3</b> <u>PRACTICAL</u>						
6	MME 291	Advanced Machine Design Laboratory.	0	0	4	2
SESSIONAL						
7	MME 281	Seminar-II	0	0	2	1
8	MME 282	Comprehensive Viva Voce	0	0	0	2
Total Practical			0	0	6	5
Total:						25

**THIRD SEMESTER**  
TOTAL CREDIT UNIT= 25

Sl. No.	Subject Code	Subject	Contact Hours per Week			Credit Unit
			L	T	P	
1	MME 381	Project & Thesis (Phase-I)	-	-		20
2	MME 382	Seminar & Viva-Voce	4	0		5
Total:						25

**FOURTH SEMESTER**  
TOTAL CREDIT UNIT= 25

Sl. No.	Subject Code	Subject	Lecture	Sessional	Credit Unit
1	MME 481	Project & Thesis (Phase-II)	-	-	20
2	MME 482	Seminar & Viva-Voce	4	0	5
Total:					25

**Total Credit Unit of the course: 100**

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**LIST OF COMPULSORY SUBJECTS**

Sl. No.	Subject Code	Subject
1	MM(ME)101	Advanced Engineering Mathematics
2	MME101	Advanced Dynamics of Machinery
3	MME 102	Advanced Production Methods
4	MME 201	Advanced Machine Design
5	MME 202	Production & Operation Management

**LIST OF ELECTIVE SUBJECTS**

<b>Elective - I</b>		
Sl. No.	Subject Code	Subject
1	MME 103A	Advanced Metal Cutting Theory
2	MME 103B	Production Tooling & Equipment
3	MME 103C	Advanced Machining Process
<b>Elective - II</b>		
Sl. No.	Subject Code	Subject
4	MME 104A	Numerical Method & Optimization Technique
5	MME 104B	Advanced CAD/CAM
6	MME 104C	Production Planning & Control
7	MME 104D	Conduction and Radiation Heat Transfer
<b>Elective - III</b>		
Sl. No.	Subject Code	Subject
8	MME 203A	Design of Material Handling Equipment
9	MME 203B	Theory of Elasticity & Plasticity
10	MME 203C	Design & Performance of Machine tool
11	MME 203D	Advanced Welding Technology
<b>Elective - IV</b>		
Sl. No.	Subject Code	Subject
12	MME 204A	Advanced Robotics
13	MME 204B	Engineering Fracture Mechanics
14	MME 204C	Finite Element Method in Engineering
15	MME 204D	Composite Material & Structure
<b>Elective - V</b>		
Sl. No.	Subject Code	Subject
16	MME 205A	Advanced Metrology
17	MME 205B	Value & Ethics in Industrial management
18	MME 205C	Statistical Process Control
19	MME 205D	Engineering System & Control

**CORE (COMPULSORY) SUBJECTS:**

**MM (ME) 101: Advanced Engineering Mathematics**

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

Matrix Operation: Matrix operations; Eigen value and Eigen vector by iterative methods; Diagonalisation of a square matrix. - 8

Laplace Transform, Fourier Transform; Fourier Integral and their applications. - 6

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

Ordinary Differential Equation: 2nd order homogeneous equation, Euler Cauchy equation, non homogeneous linear equation. Partial Differential equation: Wave equation- one dimension and two dimension; Heat equation- one dimension and two dimension. - 5

**Reference Books:-**

1. "Introductory Methods of Numerical Analysis" - S.S. Sastry, PHI
2. "Numerical Methods for Scientific and Engineering Computation" - M.K. Jain, S.R.K. Iyengar, R.K. Jain, New Age International Pub.
3. "An Outline of Statistical Theory" Volume I, II -A.M. Goon, M.K. Gupta, B. Dasgupta, The World Press Private Ltd.
4. "The Design of Experiments to find Optimal Conditions" - Yu.P. Adler, E.V. Markova, Ylu.V. Granovsky, MIR publication, Moscow
5. —Advanced Engineering Mathematics| - E. Kreyszig, John Wiley & Sons.
6. —Advanced Engineering Mathematics| - S. Grossman and W.R. Derrick, Harper & Row Publishers.
7. —Experimental Designs| - W.C. Cochran and G.M. Cox, John Wiley & Sons, New York.
8. —Design and Analysis of Experiments| - D.C. Montgomery, Wiley-India Edition.

**MME 101: Advanced Dynamics of Machinery**

Generalised Forces and Coordinates.

Lagrangian Equations and Hamilton's Principle.

Mechanical Vibration: Single, two and multi-degree of freedom systems. Distributed mass and elasticity.

Cam dynamics.

Balancing of rotors, Field balancing.

Dynamics of control systems.

**Reference Books:-**

1. Theory of Vibrations with Applications: W T Thomson CBS Publishers Delhi
2. Mechanical Vibrations: S S Rao Addison-Wesley Publishing Co.

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3. Principles of Vibration Control: Asok Kumar Mallik, Affiliated East-West Press.
4. Mechanical Vibrations A H Church ,John Wiley & Sons Inc
5. Mechanical Vibration Analysis: Srinivasan, McGraw Hill.
6. A textbook of mechanical vibration – Rao V. Dukkipati, J. Srinivas, PHI
7. Advanced theory of vibration – J. S. Rao, Wiley Eastern Limited
8. Vibration, Dynamics and structural systems – Madhujit Mukhopadhyaya, Oxford IBH
9. Rotor dynamics – J. S. Rao, New Age International
10. Control System- Benjamin Kuo
11. Theory of Mechanism of Machine- Shigley
12. Control System-OGATA
13. Theory and application of Mechanical Vibration- D.K.Adhwarjee. University Science Press.

**MME 102: Advanced Production Methods**

Welding: Classification of methods and recent advances in welding, TIG and MIG Welding, Submerged Arc and Electroslug Welding, Thermit Welding, Plasma cutting and Welding; Weldability, Welding defects, Inspection and testing.

Foundry: Pattern design for castings, Selection, Preparation and 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.

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.

**Reference Books:-**

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

### **MME 201: Advanced Machine Design**

Hydrodynamic Lubrication of Sliders and Bearings, Long and Short Bearings, Pressure distribution, Oilfilm thickness, Load carrying capacity, Friction and heating of journal bearing.  
Torsion of noncircular shafts.  
Press fitted assemblies and rotating discs.  
Fatigue strength, Fluctuating loads, Cumulative fatigue damage.  
Dynamic load on gears.  
Contact stresses.

#### **Reference Books:-**

1. Mechanical Design Analysis, M.F.Spoots
2. Mechanical Design Analysis. Arthur Burr
3. Theory Of Elasticity, Timoshenko & Goodyear, McGraw-Hill
4. Machine Design, Robert L. Norton
5. Practical Gear design - D.W. Dudley
6. Optimum design - R.C.Jhonson
7. Mechanical Springs – A.M. Wahl.
8. An introduction to composite materials – D. Hull and T.W. Clyne

### **MME 202: Production & Operation Management**

Introduction to Production and Operation management: Basic management functions, Managerial skill. Concept of productivity and its analysis.  
Capacity planning, MRP II, Work measurement, facility layout and assembly line balancing, multiple criteria decision making methods, Line of Balance (LOB), Markov model.  
Operation strategy: Forecasting for operation, Process and technologies, Inventory planning & control.  
Material requirement planning, planning for production and operation scheduling.  
HR in operation management- manpower planning, training & development, health, safety, welfare, remuneration & Incentive scheme.  
Quality Assurance – The quality assurance system, choice of process and reliability, control of quality. Quality aspect in production and services.

#### **Reference Books:-**

1. Production and Operations Management – E. B Adam, Jr. and R. J. Ebert, Prentice Hall.
2. Modern Production/ Operations Management – Buffa and Sarin 8<sup>th</sup> ed. John Wiley & sons (Asia)
3. Advances in Production Management Systems – C. H. Okino, Narosa Book Distributors Pvt. Ltd.
4. Production and Operations Management – W. Bolton, Orient Longman Pub.
5. Production and Operations Management - Muhlemann, Oakland and Lockyer, Mcmillian India Lt
6. Operations Management – Russell and Taylor – Wiley India Pvt. Ltd.
7. Operation Management – B. Shore, EMH Publishing Co. Ltd. ,India.
8. Total Quality Management – A. Tenner and I. J. Detoro, Addison Wesley Publication.
9. Management Information Systems, Prentice Hall , Larry Long

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10. Enterprise Resource Planning, TMH, A.Leon
11. Human Resource Management, Sultan Chand & Sons., Gupta, C.B
12. Operations Management – B. Shore, EMH Publishing Co. Ltd., India
13. Management for Business and Industry – G.S. George, PHI Publication
14. Production and Operations Management - Concepts Models and Behaviour - 5th Ed., Adam and Ebert, PHI Publication.
15. The Management of Engineering – J.W. Bennett, Narosa Book Distributors Pvt. Ltd.
16. Production and Operations Management - A W Muthelmann, Narosa Book Distributors Pvt. Ltd.

**ELECTIVE SUBJECTS:**

**MME 103A: Advanced Metal Cutting Theory**

Tool geometry, Tool materials.

Chip formation, Mechanics of turning process, Earnst and Merchant's analysis, various shear angle relationships.

Energy considerations, Chip-tool contact and interfacial stresses.

Mechanics of Drilling, Milling and Grinding processes.

Machinability.

Tool wear and Tool life.

Economics of machining.

Newer (unconventional) machining processes.

Ultrasonic and Abrasive Jet Machining.

Chemical and Electrochemical Machining and Grinding.

Electrodischarge Machining.

Plasma and Laser Beam Machining.

**Reference Books:-**

1. Milton C. Shaw- Metal Cutting Principles(2005) 2<sup>nd</sup> Edition , Oxford University Press
2. A.Bhattacharya- Metal Cutting Theory and Practice, New Central Book Agency (P) Ltd.Kolkata
3. A. Ghosh and A.K. Mallik, Manufacturing Science, Affiliated East-West Press Pvt. Ltd., New Delhi
4. S.K.Basu&D.K. Pal- Design of Machine Tools Oxford & IBH Publishing Co.
5. N.Acherkan- Machine Tool Design : 4 vols. , Mir Publishers, Moscow
6. Fundamentals of Machining and Machine Tools by Boothroyd, G. and Knight, W. A. (2006), 3rd Edition, CRC Press, Taylor and Francis Group..
7. Fundamentals of Machining Processes, H. El-Hofy (2007), CRC Press, Taylor and Francis Group.
8. Production Technology by HMT, McGraw-Hill, India.
9. N.K.Mehta - Machine Tools Design, Tata McGraw -Hill Publishing
10. Introduction to Machining Science - G.K. Lal ,New Age International Pub., New Delhi
11. Metal Cutting Theory and Cutting Tool Design - V. Arshinov and G. Alekseev Mir Publishers, Moscow
12. Metal Cutting - E.M. Trent and P.K. Wright, Butterworth Heinemann Publication
13. Metal Cutting Mechanics - N.N. Zorev, Pergamon Press.
14. 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.
15. P. N. Rao Manufacturing Technology vol-II Tata Mcgraw hill.

### **MME 103B: Production Tooling and Equipment**

Design of single point cutting tools.  
Design of Form tools.  
Design of Milling cutters.  
Broach design.  
Operational planning and Turret tool layout.  
Design of press tools.  
Design of Jigs and Fixtures.

### **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 Heinemann 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

### **MME: 103C Advanced Machining Process**

Advanced Machining Processes; Non-traditional machining: Introduction, Specific Applications and Advantages over Traditional Machining Processes; Need of High production rate machining. Mechanical Non-Traditional Machining Processes; Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, and Abrasive Water Jet Machining; Process details, parametric effects, recent advancements and modelling. Thermal Non-Traditional Machining Processes; Electro discharge Machining, Plasma Arc Machining, Electron Beam Machining, and LASER Beam Machining; process, parameters, recent advances and modelling. Chemical and Electrochemical processes; Chemical Machining, Electro Chemical Machining and Electrochemical grinding. Hybrid-type systems; Electro Chemical Discharge Machining, Ultrasonic-assisted Electro Discharge Machining, ELID during grinding and other types, High Production Rate Machining and Grinding; Designing suitable tooling, cutting fluid application; alternative processes- hot machining, stretch machining, etc.; obstacles faced and possible remedies. Micro and Nano machining, Environment friendly machining.



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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

**MME 104A: Numerical Method & Optimization Technique**

Approximate and errors in computation; solution of algebraic and transcendental equations: convergence, bisection method, Newton-Raphson method, secant method  
Solution of simultaneous algebraic equations: linear simultaneous equations, cramer's rule, Gauss elimination method, Iterative method: Gauss-seidal method; non-linear simultaneous equations: Newton- Raphson method  
Numerical differentiation and integration; Quadrature formula, trapezoidal rule, simpson's one third and three eighth rule.  
Numerical solution of ordinary and partial differentiation equations: Picard's method, Runge-Kutta method, solution of 1-D heat and wave equations  
LPP: simplex, revised simplex, dual simplex method, transportation, transshipment, assignment and sequencing problems  
Non-linear programming: Elimination method: exhaustive search, Dichotomous search, Fibonacci method and Golden-section method  
Geometric programming: posynomial, solution of constrained and un constrained minimization method  
Dynamic programming: introduction, multistage decision process  
Integer programming: Branch-bound technique  
Further topics in optimization: methods of separation of variables, Adomian decomposition method, Genetic algorithm, Neural network based optimization, optimization with Fuzzy systems

**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)

### **MME 104B: Advanced CAD/CAM**

**CAD Tools:** Definition of CAD Tools, Types of system, CAD/CAM system evaluation criteria, brief treatment of input and output devices. Graphics standard, functional areas of CAD, modelling and viewing, software documentation, efficient use of CAD software.

**Introduction to Computer Graphics Fundamentals:** Output primitives (points, lines, curves etc.), 2-d & 3-d transformation (Translation, scaling, rotation) windowing - view ports - clipping transformation.

**Geometric Modelling:** Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves her mite cubic splines Bezier curves B-splines rational curves Surface Modeling: Mathematical representation surfaces, Surface model, Surface entities surface representation, Parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder.

**Parametric Representation of Synthetic Surfaces:** Hermite Bicubic surface, Bezier surface, B- Spline surface, coons surface, Blending surface Sculptured surface, Surface manipulation — Displaying, Segmentation, Trimming, Intersection, Transformations (both 2d and 3d).

**Geometric Modelling-3d:** Solid modeling, Solid Representation, Boundary Representation (B-rep), Constructive Solid Geometry (CSG). CAD/CAM Exchange : Evaluation of data — exchange format, IGES data representations and structure, Step Architecture, implementation, ACIS & DXF. Design Applications: Mechanical tolerances, Mass property calculations, Finite Element Modeling and Analysis and Mechanical Assembly. Collaborative Engineering: Collaborative Design, Principles, Approaches, Tools, Design Systems. Introduction to CAM, Fundamental of NC, CNC and DNC, Control of NC Systems, NC Part Programming, Computer Aided Process planning, Computer Integrated Manufacturing, Artificial Intelligence in Manufacturing.

### **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.
9. 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 International Publishers.
11. Computer Aided Manufacturing"- P.N. Rao, N.K. Tewari and T.K. Kundra, Tata McGraw- Hill Publication.

### **MME 104C: Production Planning and Control**

Organisation of PPC, PPC functions.

Product design and development.

Sale forecasting.

Machine utilisation and flow balancing.

Production scheduling- single and multi product.

Deterministic and Stochastic ordering systems.

Quality control.  
Plant layout, PERT and CPM.

**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

**MME 104D: Conduction and Radiation Heat Transfer**

Derivation of heat conduction equation. Analytical solutions. Eigen value problems. Solution of heat conduction equation by Laplace transform, Fourier transform and separation of variables techniques. Contact resistance.

Transient heat conduction, conduction with moving boundary, solidification and melting. Problems with periodic boundary conditions.

Fundamentals of thermal radiation; integral equation for radiative exchange; view factors. Radiative exchange between surfaces: black surfaces, gray, diffuse, partially specular surfaces. Radiative properties of participating media: introduction to gas properties, wide band models, total emissivity, particle properties. Radiative transfer through participating media: gray, plane-parallel slab; approximate methods; non-gray media.

**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, Bergman, & 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.

**MME 203A: Design of Materials Handling Equipment.**

Classification of materials and equipments.

Conveying equipments: Belt conveyor, Construction and layouts, Belt selection and power calculation.

General features and calculations of capacity and power of bucket elevator.

Apron, Scraper and screw conveyors; Roller conveyor, Chain-trolley conveyor, pneumatic conveying.

Principles of working of vibratory conveyor.

Duties of lifting equipments.

Selection of rope, chain, sheaves and drums.

Hand operated equipments.

Electric hoists.

Electric overhead traveling cranes; construction and calculations of power for lifting and traveling.

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Crane motors and brakes.

Grab operations.

**Reference Books:-**

1. Material Handling System Design Apple, J.M --, John Wiley & Sons
2. Materials Handling: Principles and Practice, Allegri, T.H., CBS Publishers & Distributors, N.Delhi
3. Materials Handling, Immer-, J.R, McGraw Hills
4. Conveyors and Related Equipment. Spivakovsky, A and Dyachkov, V-, Peace Publishers, Moscow
5. Materials Handling Equipment, Rudenko N.- Peace Publishers, Moscow
6. Materials Handling Equipment, Alexandrov, M.P Part-I and II, Mir Publishers, Moscow
7. Mechanical Handling of Materials, Ray, T.K.- Asian Books Private Ltd., 2004
8. Introduction to Materials Handling Ray, S.-, New Age International Publishers, 2008.
9. Aspects of Materials Handling, K.C. Aroraq, V.V. Shinde, Laxmi Publication
10. Conveying machine, vol. 2 – A. Spivakovsky & V Dyachkov – MIR Publisher
11. Material Handling equipment – M. P. Alexandrov – MIR Publisher
12. Belt Conveyors for Bulk material - CEMA
13. Material Handling, John R. Immer, McGrawHill Co. Ltd., New York.
14. Material Handling in Machine Shops - Colin Hardi, Machinery Publication Co. Ltd., London.
15. Bulk Solid Handling -C. R. Cock and J. Mason, Leonard Hill Publication Co. Ltd., U.S.A.
16. Material Handling Hand Book- Kulwiac R. A., John Willy Publication, New York.
17. Material Handling Equipments -N. Rudenko, Peace Publishers, Moscow.
18. Material Handling System Design - James M. Apple, , John-Willlwy and Sons Publication, New York.
19. Material Handling Equipment -M .P. Nexandr, MIR Publication, Moscow.
20. Conveying Machines -Spivakovsy, A.O. and Dyachkov, V.K., Volumes I and II, MIR Publishers, 1985. New York.

**MME 203B: Theory of Elasticity and Plasticity**

Stresses and strains, Equations of equilibrium and compatibility.

Plane stress and plain stress problems in rectangular and polar coordinates.

Thick walled cylinders and curved bars.

Stress concentrations.

Torsion of prismatic bars and thin members, Membrane and other analogies.

Principle of virtual work, Castigliano's theorem, Reciprocal theorem, Energy methods.

Introduction to plasticity, yield criterions.

Plastic analysis of beams, cylinders and shells.

Rotating disk

Unsymmetric bending

**Reference Books:-**

- 1) Theory of Elasticity & Plasticity, Timoshenko Young
- 2) Strength of Material, Vol-II, Timoshenko
- 3) Theory of Plates and Shells- Timoshenko

**MME 203C: Design and performance of Machine Tools**

Machine Tools Drives: Layout and Design of Speed and Feed Gear boxes, Stepless speed variation.

Machine tool guides beds and columns.

Hydrostatic and hydrodynamic lubrication.

Design of lead screws, recirculating ball-screws. □ Design of machine tool spindles.

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Static and dynamic stiffness of machine tool structures. Vibration of machine tools, Chatter and stick slip vibrations.

Control of machine tools: Hydraulic and Electrical controls, Numerical control.

Static and dynamic acceptance tests, Built in inspection units.

**Reference Books:-**

1. Metal Cutting Principles, Milton C. Shaw- Oxford University Press
2. Machine Tools Design, N.K.Meheta - Tata McGraw -Hill Publishing.
3. Principles of Metal Cutting G.Kuppuswamy -, Universities Press
4. Design of Machine Tools Oxford S.K.Basu&D.K. Pal- & IBH Publishing Co.
5. Machine Tool Design Edited by N.Acherkan- : 4 vols, Mir Publishers, Moscow
6. Metal Cutting Theory and Practice A.Bhattacharya- e, New Central Book Agency (P) Ltd.
7. Computer Control of Manufacturing Systems by Y. Koren, McGraw-Hill
8. Numerical Control and Computer Aided manufacturing by R. S. Pressman & J. E. Williams, John Wiley & Sons
9. Computational Geometry for Design and Manufacture, by I. D. Faux and M. J. Pratt, Ellis Horwood, Chichester, 1979.
10. Numerical Control in Manufacturing by F. W. Wilson, McGraw-Hill Book Company New York
11. Principles of Machine Tools - G.C. Sen and A. Bhattacharya
12. Machine Tool Design, N.K. Mehta, TMG Publications,
13. Fluid Power Control - J.F. Blackburn, G. Reetholf and J.L. Shearer, New York Technology Press of MIT and Wiley
14. Oil Hydraulic Power and Its Industrial Applications - W. Ernst, 2nd Ed. New York, McGraw Hill
15. Hydraulic Control Systems - H.E. Merrit
16. Testing of Machine Tools - G. Shleisinger, Pergamon Press
17. Elements of Vibration Analysis - L. Meirovitch, McGraw Hill Co.
18. Mechatronics - W. Bolton, Addition Wesley Longman, Singapore.
19. Mechatronics - HMT Limited, Tata McGraw Hill
20. Precision Engineering in Manufacturing - R. L. Murty, New Age International Publishers.
21. Ergonomics and Work Design - P.K. Nag, New Age Int. Publishers
22. Mechanical Vibration - M.P. Groover, PHI Publication.

**MME 203D: Advanced Welding Technology**

Classification of various welding processes.

Cold welding: Nature of real surface, Principle of solid phase welding,

Real joint, Figure of merit and use.

Resistance welding: Types, Principles, Contact resistance, Heat flow equations, Methods and applications.

Friction welding: Arrangements, Principles, Heat liberation and use.

TIG welding, MIG welding, Submerged arc welding, Electro-slag welding, Plasma welding and cutting,

Electron beam welding, Thermit welding, Underwater welding- Theoretical studies of above processes and principles of arc control, Uses of different gases, Advantages and uses of the processes.

Welding electrodes- Specification, selection and use.

Residual stresses and distortion in welding.

Metallurgy of welding, Weldability.

Welding of cast iron, Stainless steel, Nonferrous metals.

Welding defects.

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**Reference Books:-**

1. Basic Fabrication & Welding, Kenyon Pitman Pitman Pub. Ltd.
2. Basic Fabrication & Welding, F.J.M. Smith- Longman Group Ltd.
3. Workshop Technology Vol. 1 & 2, Hazra & Choudhuri- Media Promoters & Publications
4. Welding Technology O.P. Khanna-, Dhanpat Rai & Sons
5. Manufacturing Technology P.N.Rao-, Tata McGraw Hill
6. Materials & Processes in Manufacturing DE Garmo et al— Wiley
7. Introduction to the Theory of Theoretical and Experimental Analysis of Stress and Strainl - Durelli, Phillip's and Tsao, McGraw Hill Book Co.
8. Theory of Elasticity - Timoshenko and Goodier, McGraw Hill Book Co.
9. Engineering Plasticity - Johnson and Mellur, Van Nostrand-Reinhold Co.
10. Introduction to the Theory of Plasticity - Metal Forming Applicationsl - O. Hoffman and G. Sachs, McGraw Hill Book Co.
11. Introduction to Theory of Plasticity - Mendelson.
12. Principles of Metal Casting - Heine, Loper and Rosenthal, TMH Publication
13. Principles of Foundry Technology - P.L. Jail, TMH Publications
14. Welding for Engineers - Udin, Funk and Wulf, John Wiley and Sons.
15. Welding Process and Procedures - J.L. Morris.
16. A Text Book of Welding Technology - O.P. Khanna, Dhanpat Rai & Sons
17. Modern Arc Welding Technology - S.V. Nadkarni, Oxford & IBH Publishing Co. Pvt. Ltd./ Advani-Oerlikon Ltd.
18. Processes and Design for Manufacturing - S.D.EI Wakil, PWS Publishing.

**MME 204A: Advanced Robotics**

Introduction to Robotics: History and developments. Elements of robot anatomy; Classification of robots. Introduction to robot arm kinetics: Denavit- Hartenberg convention, Direct (forward) manipulator kinetics, Inverse manipulator kinetics. Static forces in manipulator. Velocity propagation from link to link, Singularities.

Planning of manipulator trajectories, Joint space schemes, Cartesian space schemes. Robot programming- Manual teaching, Lead-through teaching, Programming languages. Hydraulic, pneumatic and electrical manipulators; End-effectors and their design; Sensors- Range sensing, Proximity sensing, Touch sensing, Force and torque sensing. Vision for robotic systems- Lower level vision, Higher level vision. Economics of robotics.

**Reference Books:-**

1. Introduction to Robotics by J.J.Craig, Pearson Education

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2. Robotic Engineering, Prentice-Klafter, Richard D. Chmielewaski, Thomas A. and Negin, Michael - Prentice Hall of India Pvt. Limited.
3. Industrial Robotics : Technology Programming and Applications, Groover, Mikell P. Weiss, Mitchell, Nagel, Roger N., Odrey, Nicholas G. - McGraw-Hill International Edition
4. Introduction to Robotics Analysis, Systems, Applications,-Niku, Saeed B. - Prentice Hall of India Private Limited, New Delhi
5. Fundamentals of Robotics: Analysis & Control, -Shilling , Robert J.- Prentice Hall of India, New Delhi
6. Robotics for Engineers-Koren, Yoram , McGrew-Hill Book Company, Sinagapore
7. Robotics: A User-Friendly Introduction, Hall, Ernest L. Hall Bettie C. - Holt, Rinehart and Winston, Holt-Saunders, Japan
8. Foundations of Robotics: Analysis and Control, Yoshikawa, Tsuneo Prentice Hall of India Private Limited, New Delhi
9. Mechanics of Robotic Manipulation, Mason, Matthew T. , Prentice Hall of India Private Limited, New Delhi.
10. Robotics Technology and Flexible Automation , S.R.Deb, Tata Mc Graw Hill
11. Industrial Robotics (Technology, Programming and applications), M.P.Groover, M. Weiss R.N. Nagel, N.G. Odrey McGraw, Hill
12. Robotics : Control, sensors, vision and intelligence - K.S.Fu, R.C.Gonzalez and C.S.G.Lee, - MCGraw-Hill.
13. Robotics Engineering, Klafter , Richard D., et al PhI.
14. Robotics & Control, Nagrath, TMH

**MME 204B: Engineering Fracture Mechanics**

Brief review: Strength, stiffness and toughness properties of materials, principles of elasticity and plasticity, stress concentration.

Different modes of crack opening, Stresses and displacement around the stationary crack under static load.

Irwin' approach, crack closure and strain energy release rate approach, stress intensity approach, compliance approach and energetics and J-integral.

Effects of small-scale yielding, thickness and plastic energy dissipation.and propagation of crack and its stability.

Propagation of crack under fatigue load and effect of residual stresses.

Experimental methods: different types of test specimens and testing procedures. Detection of cracks.Stress waves, dynamic nature of fracture, crack speed and crack arrest.

Brief introduction to analytical and numerical methods in fracture mechanics.

Effect of environment. Fracture control and design considerations.

**Reference Books:-**

1. Elements of Fracture Mechanics – Prasant Kumar, Wheeler Publishing, India
2. Elements of Fracture Mechanics for Modern Engineering, - Yogendra Simha, Universities Press
3. e- Book on Engineering Fracture Mechanics – Ramesh, K., IIT, Madras
4. Creep of engineering materials – R. Heller, McGraw Hill
5. Anderson T.L., Fracture Mechanics, 2nd Edition, CRC Press, 1995
6. Hertzberg, R. W. Deformation and Fracture Mechanics of Engineering Materials. 4thed. John Wiley & Sons, Inc., 1996.
7. ASTM standards

### **MME 204C: Finite Element Methods in Engineering**

Fundamental Concept: Historical background – Matrix approach – Application to the continuum – Discretisation – Matrix algebra – Gaussian elimination – Governing equations for continuum – Classical Techniques in FEM – Galerkin Weighted residual method – Virtual Energy Principle – Rayleigh-Ritz method – Properties of Stiffness Matrix – Treatment of Boundary Conditions – Solution of system of equations – Shape function and its characteristics – Basic equations of elasticity – Strain displacement relations.

1-d and 2-d Problems: 1-d structural problems – Axial bar elements – Stiffness matrix, load vectors, temperature effects, Polynomial shape function. Analysis of Trusses – Plane truss and Space truss elements. Analysis of Beams – Hermit Shape function, Stiffness matrix, Load vectors, 2-d Problems – CST, LST, Force terms, Stiffness matrix, load vector and boundary conditions.

Isoparametric element – quadrilateral element, shape functions – Numerical Integration – Subparametric and superparametric elements. 3-D problems – Tetrahedron elements, Jacobian matrix – stiffness matrix.

Dynamic Considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen Vectors, Natural frequencies – mode shapes – modal analysis.

Introduction to Non-linearity, Non-linear problems, Geometric non-linearity, Material non-linearity, Non-linear dynamic problems, analytical problems.

#### **Reference Books:-**

1. The Finite element Methods in Engineering by S.S. Rao – Pergamon, New York.
2. Finite Element Procedure in Engineering Analysis by K. J. Bathe. – Klaus-Jurgen Bathe
3. Concepts and applications of finite element analysis by Robert Cook – Wiley.
4. An introduction to finite element methods by J. N. Reddy – Mc Graw Hill
5. The Finite Element Method for Engineers, Keneth H.Huebner, Donald L.Dewhurst, Doglas E.Smith, Ted. G.Pyrson- John Willey and Sons Inc.
6. Introduction to Finite Elements in Engineering, T.R. Chandrupatla and A.D. Belegundu, Prentice Hall of India Publication, 2nd Edition
7. Applied Finite Element Analysis, L.J. Segerlind, Wiley & Sons Publication, 2nd Edition.

### **MME 204D: Composite Materials & Structure**

Introduction: Definition, Characteristics and classification, application of composite materials.

Micromechanicalbehaviour and macro-mechanical behaviour of a lamina.

Elastic moduli and Poisson's ratios of an unidirectional composite lamina.

Principles of anisotropic elasticity, Relationship among engineering constants, Relationship among engineering constants and elements of stiffness matrix and compliance matrix. Stress-strain relations for an orthotropic lamina with arbitrary orientation and transformation of engineering constants.

Strength of composite lamina and theories of failure.

Theories of laminated composite and failure analysis. Synthesis of stiffness matrix and its simplification, Thermal stresses, Determination of stresses and strains. Interlaminar stresses and their effect. Strength of laminated composites and failure analysis, Classification of laminates.

Experimental methods for determination of different properties of composite materials.

Special topics: Impact properties of Composites, Fracture of composite materials, degradation of composite materials at elevated temperature, Visco-elastic response Bulking and Vibration of laminated plates, etc.



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Brief introduction to materials and manufacturing of composite materials.

**Reference Books:-**

1. K.H.G. Ashbee, Fundamental Principle of Fiber Reinforced Composites (2<sup>nd</sup> Edition), Technomic Publishing AG, Switzerland, 1993.
2. N.K. Naik, Woven Fabric Composites, Technomic Publishing AG, Switzerland, 1993.
3. G.S. Springer and S.R. Finn, Composite Plates Impact Damage: An Atlas, Technomic Publishing Co., Lancaster, 1991.
4. R.A. Kline, Nondestructive Characterization of Composite Media, Technomic Publishing Co., Lancaster, 1992.
5. A. Brent Strong, High Performance and Engineering Thermoplastic Composites, Technomic Publishing Co., Lancaster, 1993.
6. S.M. Lee, Dictionary of Composite Materials Technology, Technomic Publishing Co., Lancaster, 1989.
7. G. Cederbaum, B. Gurion, I. Elishakoff, J. Aboudi and L. Librescu, Random Vibration and Reliability of Composite Structures, Technomic Publishing Co., Lancaster, 1992.
8. A.M. Skudra, Structural Analysis of Composite Beam Systems, Technomic Publishing Co., Lancaster, 1991.
9. P. Zinoviev and Y.N. Ermakov, Energy Dissipation in Composite Materials, Technomic Publishing AG, Switzerland, 1994.
10. S.V. Hoa, Analysis for Design of Fibre Reinforced Plastic Vessels and Piping, Technomic Publishing Co., Lancaster, 1991.
11. P.W.R. Beaumont, R.L. Crane and J.T. Ryder, Fracture and Damage Mechanics of Composite Materials, Technomic Publishing Co., Lancaster, 1992.
12. S.C. Tan, Stress Concentrations in Laminated Composites, Technomic Publishing Co., Lancaster, 1994.
13. L. Hollaway (Ed.), Handbook of Polymer Composites for Engineers, Woodhead Publishing Ltd., Cambridge, 1994.
14. G.C. Eckold, Design and Manufacture of Composite Structures, Woodhead Publishing Ltd., Cambridge, 1994.
15. J. Maxwell, Plastics in the Automotive Industry, Woodhead Publishing Ltd., Cambridge, 1994.
16. A. Miravete, Optimisation of Composite Structures Design, Woodhead Publishing Ltd., Cambridge, 1995.
17. G. Cuff, Fibre Reinforced Industrial Thermoplastic Composites, Woodhead Publishing Ltd., Cambridge, 1995.
18. B. Harris, Engineering Composite Materials, Broodfield Publishing, Brookfield, 1986.
19. R. Talreja, Fatigue of Composite Materials, Technomic Publishing Co., Lancaster, 1986.
20. D.H. Kaelble, Computer-Aided Design of Polymers and Composites, Dekker, NY, 1985.
21. T.L. Richardson, Composites: A Design Guide, Industrial Pres, NY, 1987.
22. R. M. Hussein, Composite Panels/Plates: Analysis and Design, Technomic Publishing Co., Lancaster, 1986.
23. P.K. Mallick, Fiber-Reinforced Composite Materials, Manufacturing and Design, Dekker, NY, 1987.
24. J.B. Donnett and R.C. Bansal, Carbon Fibres, Dekker, NY, 1984.
25. A. Watt and B.V. Perov (Eds.), Strong Fibres, Elsevier, NY, 1985.

**MME 205A: Advanced Metrology**

Generalised measurement system- Accuracy, Precision and errors.  
Indian system of limits and fits, Limit gauging.  
Screw thread tolerances.  
Dimension chain.  
Statistical tolerancing.  
Error of flatness and surface texture.

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Screw thread and gear metrology.  
Linear and angular measurements.  
Electrical transducers and their principles.  
Comparators- Principles and use.  
Alignment test of machine tools.

**Reference Books:-**

1. Mechanical Measurement and Instrumentation. R. K. Rajput, Published by S. K. Kataria & Sons.
2. Engineering Metrology , R.K. Jain, Published by Khanna Publisher.

**MME 205B: Value & Ethics in Industrial management**

Value and ethics in engineering profession. Causes of value crisis; value crisis in temporary Indian society; different remedial measures to check value crisis in individual level, societal level, intellectual level and cultural level.

Impact of rapid industrial and technological growth towards society, environment, population, rapid depletion of natural resources along with other factors like food production etc. Neoclassical growth concept and concept of sustainable growth. Effect of induction of ecofriendly technology and environmental ethics. Renewable energy and its application. Energy crisis.

Appropriate technology movement of E.F. Schumacher. Technology assessment. Concept of whistle blower. Risk of whistle blowers and method to check the risk.

Technology transfer. Problems faced by underdeveloped countries during technology transfer and methods to overcome this problem.

Conflicts between business demands and professional ideals. Purpose of code of ethics in engineering profession. Concept of ethical judgment by engineering.

Industrial safety and hazards and safety engineering. Why safety engineering plays an important role in production and productivity.

Business and social responsibility. Area of social responsibility for any corporate sector of a big business house.

Human centered technology. Human operator in engineering, mechanization, automation, assembly line. Morals, virtues, ethics of virtues, ethics of duty. Emanuel Kant's proposal. Canons of ethics. Ethics of responsibility, moral judgment.

Introduction of ethical management in Indian Industry to help in the field of

- i) Worker- management relation
- ii) Motivation of employees
- iii) Right sizing of manpower
- iv) Improvement of production and productivity
- v) Employees welfare

**Reference Books:-**

- i) Human Values by N.Tripathy
- ii) Engineering ethics by N. Govindarajan & S. Natarajan

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- iii) Business Ethics : Concepts & Cases by Valesquez PEARSON
- iv) Ethics & Management & Indian Ethos by Ghosh VIKAS
- v) Blending the best of the East & West by Dr.Subir Chowdhury EXCEL

**MME 205C: Statistical Process Control**

History of statistical process control, quality and quality management techniques, basic principles of statistics and probabilities (application of set theories and modern methods of determination of probabilities); normal, student's  $t$ ,  $X^2$  (chi-square), exponential and Poisson's distributions; HYPOTHESIS TESTING, concept of type I and II error; sampling techniques; Causes of variations of jobs produced from a process (with examples), parameter selection to control a process, different types of control charts, preparation of control charts for variables ( $X$  and  $R$  bar charts), control charts for attributes ( $p$ -and  $n.p$ -chart,  $c$ -chart,  $u$ -chart,  $U$ -chart), general patterns of plots to determine the assignable causes, control charts for standard deviation and mean, control charts for individual items, trend chart, moving average control chart, cumulative control chart, acceptance control chart; Introduction to process capability, specification and control limits, natural tolerance limits, process capability indices, process capability analysis procedure, setting tolerances on assemblies and components, estimation of natural tolerance; Introduction to Acceptance sampling, producer's and consumer's risk, O.C curve, types of sampling plans, sampling plans for continuous production, lot by lot attribute sampling plans, variable sampling plans for a process parameter.

**Reference Books:-**

1. Reliability for Technology, Engineering and Management., Paul Kales, Prentice Hall
2. Terotechnology : Reliability Engineering and Maintenance Management- Bikas Bhadury & S.K.Basu -- Asian Books Private Limited
3. Reliability Engineering- E. Balguruswamy -- Tata McGraw Hill Publishing Co-Limited.
4. Fundamentals of Quality Control and Improvement- Amitava Mitra - Prentice Hall of India Pvt. Ltd., New Delhi
5. Principles of Total Quality- Jill A.Swift, Joel E. Ross and Vincent K.Omachonu - St. Lucie Press Boca
6. Concept, Systems, Strategies and Tools- William J. Kolarik - Creating Quality :
7. Introduction to Statistical Quality Control by Douglas C. Montgomery, Wiley Pub, U.K.
8. Statistical Quality Control by E. L. Grant, Tata Mc Graw Hill.
9. Statistical Quality control by M. Mahajan, Dhanpat Rai & Co.
10. Quality Planning and Analysis by Juran, Tata Mc Graw Hill.

**MME 205D: Engineering Systems and Controls**

System concepts and models.

Open and closed loop control systems, Block diagrams, Transfer functions.

Transient and steady state responses, Modifying error signals

Stability: Routh criterion, Nyquist criterion and Bode plots.

Root locus method: Fluid control and hydraulic servo systems.

**Reference Books:-**

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL  
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1. Automatic control system – Benjamin & Kuo – PHI
2. Modern control engineering – Katsuhiko Ogata, PHI
3. Automatic control systems – F. H. Raven, McGraw Hill
4. Control systems principle and design – M. Gopal, Tata McGraw-Hill Publishing Co. Ltd.
5. Control systems engineering – I.J. Nagrath and M. Gopal, New Age International (P) Ltd Publishers
6. Elements of control system – Sudhir Gupta, PHI
7. Control systems – Ashok Kumar, Tata McGraw-Hill

**PRACTICAL PAPER**

**LABORATORY:**

**MME 191: Advanced Manufacturing Laboratory**

Experiments to demonstrate the features of CNC machines; CNC programming on turning and milling machines. Study of the geometry of the robot arm; study the motion of different axes of the robot. Experiment on robot programming and simple sensors experimentation. Experiments on advanced modeling using 3D modeling and analysis. Experiments on EDM.

**MME 192: Material Testing Laboratory**

Surface / subsurface crack testing by using DP test, Magnaflux test, ultrasonic test. Study of micro- structural changes after heat treatment of different materials. Drawability test of sheet metals. Destructive testing: By impact test, tensile test, fatigue test.

**MME 291: Advanced Machine Design Laboratory.**

Assignments on design analysis of Mechanical component using software packages like CATIA / PROE on similar software. Assignments on design practice using code / handbook. Assignments on selection of component for Mechanical design of equipment from manufacturer's catalogue.

**SESSIONAL PAPER**

**MME 181: Seminar I**  
**MME 281: Seminar II**

Seminar would be based on literature review on some emerging areas related to the course. Seminar presentation would be made by an individual student, and a report would have to be submitted by each student separately.

**MME 282: Comprehensive Viva Voce**

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Comprehensive Viva Voce would be based on the theoretical, practical and sessional papers of the course of study.

**MME 381: Project & Thesis (Phase-I)**

The Project & Thesis to be submitted at the end of the Third Semester (Phase-I) by individual student.

**MME 382: Seminar & Viva-Voce**

Presentation and Viva-Voce will be based on Third Semester Project & Thesis.

**MME 481: Project & Thesis (Phase-II)**

The final Project & Thesis would have to be submitted in form of a bound thesis containing literature review, objective, details of work done, conclusion, reference, etc ( Phase-II).

**MME 482: Seminar & Viva-Voce**

Final presentation and Viva-Voce will be based on the final Project & Thesis.

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