# PUNJAB TECHNICAL UNIVERSITY, JALANDHAR
## Study Scheme
### M.Tech.(Mechanical Engg)

### 1\(^{st}\) Semester

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Title of the Subject</th>
<th>Teaching Load/Week</th>
<th>Marks</th>
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<tbody>
<tr>
<td>MME-501</td>
<td>Optimization Techniques</td>
<td>L 4 T - P/D -</td>
<td>Theory 100</td>
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<tr>
<td>MME-503</td>
<td>Advance Heat &amp; Mass Transfer</td>
<td>L 4 T - P/D -</td>
<td>Theory 100</td>
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<tr>
<td>MME-505</td>
<td>Advance Machine Design</td>
<td>L 4 T - P/D -</td>
<td>Theory 100</td>
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<tr>
<td>MME-507</td>
<td>Advance Manufacturing Processes</td>
<td>L 4 T - P/D -</td>
<td>Theory 100</td>
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<tr>
<td>MME-509</td>
<td>Quality Assurance &amp; Reliability Engg.</td>
<td>L 4 T - P/D -</td>
<td>Theory 100</td>
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### 2\(^{nd}\) Semester

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<tr>
<th>Subject Code</th>
<th>Title of the Subject</th>
<th>Teaching Load/Week</th>
<th>Marks</th>
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<tbody>
<tr>
<td>MME-502</td>
<td>Research Methodology</td>
<td>L 4 T - P/D -</td>
<td>Theory 100</td>
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<tr>
<td>MME-504</td>
<td>Computational Fluid Dynamics</td>
<td>L 4 T - P/D -</td>
<td>Theory 100</td>
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<tr>
<td>MME-506</td>
<td>Computer Aided Design</td>
<td>L 4 T - P/D -</td>
<td>Theory 100</td>
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<tr>
<td>MME-508</td>
<td>Operations Management</td>
<td>L 4 T - P/D -</td>
<td>Theory 100</td>
</tr>
<tr>
<td>MME-510</td>
<td>Mechatronics</td>
<td>L 4 T - P/D -</td>
<td>Theory 100</td>
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<tr>
<td>MME-512</td>
<td>Project-I</td>
<td>L 1 T 4 P/D -</td>
<td>Theory 50</td>
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<td><strong>Total</strong></td>
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Linear Programming: Characteristics, Assumptions and Applications, Graphical solutions of two variables LP Problem, Linear programming in standard form, Solution of LP by Simplex (including Big M and Two phase methods) and revised Simplex methods, Special cases of LP, Duality and dual Simple method, Sensitivity analysis of LP problems.


CPM & PERT: Characteristics & uses, drawing of network, removal of redundancy in network. Computation of EOT, LOT, free slack, total slack in CPM and PERT, crashing, resource allocation

Dynamic Programming: Deterministic and Probabilistic Dynamic programming

Game theory: Two-person, Zero-sum games, Games with mixed strategies, Graphical solution, Solution by linear programming.

Non-linear Programming: Characteristics, Concepts of convexity, maxima and minima of functions of n variables using Lagrange multipliers and Kuhn-Tukker conditions, Quadratic programming, One dimensional search methods, Fibonacci and golden section method, Optimization using gradient methods for unconstrained problems.

Books Recommended:

2. Optimization for Engineering Design by Kalyanmoy Deb, PHI
3. Optimization Techniques by J.S Arora, John Wiley
Review
Review of the basic laws of conduction, radiation and convection.

Conduction
One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source, local heat source in non-adiabatic plate.
Extended surfaces-review, fins of non-uniform cross section, performance of fins (fin efficiency, thermal resistance of a fin, total surface efficiency), design consideration.
Two dimensional steady and unsteady state conduction, semi-infinite and finite flat plates; temperature field in finite cylinders and infinite semi-cylinders, numerical method, graphical method.
Unsteady state conduction; sudden changes in the surface temperatures of infinite plate, cylinders and spheres; solutions using Groeber’s and Heisler’s charts for plates, cylinders and spheres suddenly immersed in fluids.

Radiation
Introduction, properties and definitions, review of radiation principles (Planck’s law, Kirchoff’s law, Stefan Boltzman law, Lambert’s cosine law).
Radiation through non-absorbing media; Hottel’s method of successive reflections; Radiation through absorbing media; logarithmic decrement of radiation; apparent absorptivity of simple shaped gas bodies; net heat exchange between surfaces separated by absorbing medium; radiation of luminous gas flames.

Convection
Heat transfer in laminar flow; free convection between parallel plates; forced internal flow through circular tubes; fully developed flow; velocity and thermal entry lengths; solutions with constant wall temperature and with constant heat flux; forced external flow over a flat plate; the two dimensional velocity and temperature boundary layer equations; Karman Pohlhausen approximate integral method.

Heat transfer in turbulent flow; eddy heat diffusivity; Reynold’s analogy between skin friction and heat transfer; Von Karman integral equations, analogy between momentum and heat transfer, flow across cylinders, spheres and other bluff shapes and packed beds.

Mass Transfer
Introduction, concentration, velocities and fluxes, Fick’s law of diffusion, steady state diffusion in common geometries, equimolal counter-diffusion in gases, steady state diffusion in liquids, transient mass diffusion in common geometries, mass transfer coefficient, convective mass transfer

Recommended Books:
4. Conduction Heat Transfer Schneider Addison Wesley
5. Thermal Radiation  Siegel and Howel McGraw Hill
MME-505 Advance Machine Design

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Machine Design Review
Review of failure theories; designing against fatigue; cumulative damage theories; design of machine members (bolts, shafts, springs) under fatigue loading.

Contact Stresses
Hertzian contact stresses (cylindrical and spherical surfaces) and their effect on design; theory of limit design; Machinery construction principles.

Fracture and Creep
Fracture Mechanics approach to design. Causes and interpretation of failures; Creep behaviour; rupture theory; creep in high temperature low cycle fatigue; designing against creep.

Reliability
Probabilistic approach to design; reliability prediction; design for reliability.

Computer Aided Machine Design
Philosophy of Computer Aided Machine Design, Interactive design software, Basic advantages of analysis Software, Design of machine components (springs, gears, temporary fasteners, permanent fasteners, belts and ropes) through interactive programming, Introduction to FEM.

Books Recommended:
1. Machine Design by Sharma & Aggarwal
2. Machine Design by Back
3. Machine Design by Shigley
5. Strength of Materials by Sadhu Singh
Introduction: Overview of general trends in Manufacturing, concept and significance of important properties related to manufacturing processes; Machinability index, Formability, weldability, Fluidity, dimensional accuracy, surface integrity, residual stresses, limitations of conventional manufacturing processes need and evolution of advanced manufacturing, selection and economics of manufacturing processes. (5hours)

Advanced Machining Processes: Classification, Review of conventional machining processes (2 hours), Principles, process parameters, capabilities and mechanism of material removal of Electro discharge machining, Electrochemical Machining, Laser Beam Machining, and Abrasive Flow machining, concept and need of Hybrid machining Processes (10 hours)

Advanced Welding Processes: Classification, Review of conventional welding processes (2 hours), Principles, process parameters, capabilities and theoretical considerations for Ultrasonic Welding, friction Welding, Explosion Welding, Underwater Welding, Adhesive Bonding (10 hours)

Advanced Forming Processes: Classification, Review of conventional Forming processes (2hours), concept of High Energy Rate Forming, Principles, process parameters, capabilities and theoretical considerations for Explosive Forming, Electro hydraulic Forming, Electromagnetic Forming, Super plastic forming (10 hours)

Advanced Casting processes: Classification, Review of conventional casting processes (2 hours), brief review regarding Casting of Ferrous and Non ferrous metals, Principles, process parameters, capabilities and theoretical considerations for Shell Mould Casting, Vacuum Casting, Lost Foam Casting, Investment Casting, Centrifugal Casting, concept of rapid solidification (10 hours)

Recommended books
1. Shan and Pandey Modern Machining Processes Tata Mc Hill N. Delhi
2. ASTME High Velocity Forming pf Metals PHI N. Delhi
4. G.F Benedict Non Traditional manufacturing, Marcel Dekker
5. P.K Mishra, Non Conventional Machining Narosa Publishing House N. Delhi
MME-509 Quality Assurance & Reliability Engineering

1. Introduction:
   Concept of quality, Need, Factor influencing quality, Types of quality, Quality control, Cost of quality control, Quality assurance, Benefits, Modern concept, Inspection and quality control, Quality characteristics, Quality circles with case study. (6 hrs)

2. Statistical Concepts and Control Charts:
   Review of fundamental statistical concept, Frequency distribution, Central tendency, measures of dispersion, Probability distributions, statistical quality control, Theory of control charts, Control charts for variables and attributes (\(x, R, P, np\) and \(C\) chart), their advantages and disadvantages, Applications. (8 hrs)

3. Acceptance Sampling:
   Introduction, Advantages and Disadvantages, Operating Characteristics curve, Producer's and consumer's risk, Quality indices for acceptance sampling plans, Types of sampling Plans-single double sequential sampling plan, Sampling plan for variables, continuous sampling plans, Skip lot sampling plans, Chain sampling plan. (8 hrs)

4. Total Quality Management:
   Introduction, Concept of Total quality, Quality function deployment tools for continuous quality improvement with case study, ISO 9000:2000 family of standards, Six sigma: DMAIC and its comparison with ISO system. (8 hrs)

5. Reliability:
   Introduction, Factors effecting Reliability, Failure and its types, Failure curve, reliability and its management, MTBF, MTTF, Relationship b/w reliability failure rate and MTBF, and its characteristics, reliability predictions and analysis, System reliability analysis, Reliability test and life testing plans, Types of test, Maintainability and Availability. (10 hrs)

Books Recommended:

1. Statistical Quality control by R.C. Gupta.
2. Modern Methods for Quality Control and Improvement by Harrism; M. Wadsworth.
3. Statistical Quality control by E.L. Grant.
4. Reliability Mathematics by B.L. Ams Tadter.
5. Fundamental of Quality Control and Improvement by Amitava Mitra.
6. Reliability Engineering and Tero technology by A.K. Gupta.
MME: 502 RESEARCH METHODOLOGY

Nature and objectives of research Methods of Research: historical, descriptive and experimental
Alternative approaches to the study of the research problem and problem formulation.
Formulation of hypotheses, Feasibility, preparation and presentation of research proposal.

Introduction to statistical analysis : Probability and probability distributions; binomial, Poisson,
exponential and normal distributions and their applications.

Sampling: Primary and secondary data, their collection and validation, methods of sampling:
Simple random sampling, stratified random sampling and systematic sampling.

Regression and correlation analysis. Tests of significance based on normal, t and chi-square
distributions. Analysis of variance.

Basic Principles of design of experiments, completely randomized and randomized block designs

Edition, tabulation & testing of hypotheses, Interpolation of results, presentation, styles for figures,
tables, text, quoting of reference and bibliography. Use of software for statistical analysis like
SPSS, Mini Tab or MAT Lab, Report writing, preparation of thesis, use of software like MS Office.

The course will include extensive use of software, report writing and seminars in the tutorial class.

Recommended Books

1. C.R. Kothari, Research Methodology, Wishwa Prakashan
2. P.G. Tripathi, Research Methodology, Sultan Chand & Sons, N. Delhi
3. Fisher, Design of Experiments, Hafner
4. Sadhu Singh, Research Methodology in Social Sciences, Himalya Publishers
1. **Introduction**
   History of CFD; Comparison of the three basic approaches in engineering problem solving – Analytical, Experimental and Computational Methods. Recent Advances in Computational Techniques. (5 hrs)

2. **Problem Formulation:**
The standard procedure for formulating a problem Physical and Mathematical classification of problems; Types of governing Differential equations and Boundary conditions. (7 hrs)

3. **Methods of Discretisation:**

4. **Numerical Solution to Heat Conduction Problems:**

5. **Numerical Solution to Fluid Flow Problems**
   Types of fluid flow and their governing equations; Viscous Incompressible flows Calculation of flow field using the stream function-vorticity method; Calculation of boundary layer flow over a flat plate; Numerical algorithms for solving complete Navier-Stokes equations- MAC method; SIMPLE algorithm; Project problem. (13 hrs)

**Books Recommended:**

2. Computational Fluid Dynamics by J. Anderson
1. Introduction:
Design process in general and using computers, hardware and software in CAD applications 4hrs

2. Two Dimensional Transformations:
Two dimensional geometric transformations-basic transformations, concatenation, reflection, shear and transformations between coordinate systems. 4hrs

3. Two and Three Dimensional Object representations:
Parametric representation of synthetic curves, spline representations, cubic spline interpolation methods, Bezier curves and surfaces, B spline curves and surfaces, conversion between spline representations 8hrs

4. Representation of Solids:
Half spaces, boundary representation (B-rep), sweep representation, constructive solid geometry (CGS), solid manipulations. 6hrs

5. Three Dimensional Geometric Transformations:
Transformations-translation, rotation, scaling, reflections, shears, concatenation transformations 6hrs

6. Visual Realisation:
Basic concepts of visual realization, hidden line removal, hidden surface removal, shading surfaces and solids 4hrs

7. CAD Standards: 2hrs

8. CAD and CAM integration: 2hrs

9. Introduction to reverse engineering and rapid prototyping: 3hrs

10. Practice on available CAD packages, computer programming for geometric modelling of curves, surfaces & solids, projects involving assembly and kinematics analysis of mechanisms, surface modeling in any available CAD package. 8-12hrs

Books Recommended:
1. CAD/CAM by Groover and Zimmer, Prentice Hall
3. Geometric Modeling by M.E. Mortenson
MME: 508 OPERATIONS MANAGEMENT

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Introduction to Operation Management: Today's Global business condition, Operations strategy, forming operations strategy.

Forecasting: Demand forecasting, Qualitative forecasting methods and quantitative methods, selection of forecasting methods.


Production Planning: Production – Planning Hierarchy, Aggregate Planning, Master Production Scheduling, Types of Production-Planning and control systems, Planning and control of Projects.

Maintenance: Maintenance Management, Preventive maintenance and TPM.

Quality: Managing Quality and SQC and SPC, Quality assurance, acceptance plans.

Inventory Management: Purchase system and purchase principles, stores Management, Standardization, codification and variety, MRP, Supply Chain Management.

Reference Books:

1. Production and Operation Management Chunawala & Patel Himalaya Publishers
3. Production and Inventory Control Plossl, G.W & Prentice Hall 1967 Wight, O.We
5. Operations management by Norman Gaither and Greg Fraizer
## MME: 510 MECHATRONICS

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### 1. Introduction:
Definition, trends, control systems, microprocessor / micro controller based controllers, PC based controllers, applications: SPM, robot, CNC machine, FMS, CIM.

### 2. Sensor Technology:
Sensor and transducers, terminology, displacement, position, proximity - encoders, velocity - tachogenerators, force - strain gauges, pressure, temperature-thermocouples, RTDs, thermistors, light sensors - photoelectric sensors, IR sensors, sensor selection.

### 3. Signal Conditioning:
Introduction, the operational amplifier, protection, filtering, Wheatstone bridge, digital signals, multiplexers, data acquisition, digital signal processing, pulse-modulation.

### 4. Precision Mechanical Actuation:
Pneumatic actuation systems, electro-pneumatic actuation systems, hydraulic actuation systems, electro-hydraulic actuation systems, mechanical systems, types of motion, kinematics, inverse kinematics, timing belts, ball screw and nut, linear motion guides, linear bearings, harmonic transmission, bearings, motor / drive selection.

### 5. Electronic Devices and Circuits:
Semiconductor devices, diodes and LEDs, zener diodes and voltage regulator, inductive kick, bandwidth, frequency %& response of a measurement system, bipolar transistor circuits, amplifiers.

### 6. Electromechanical Drives:
Relays and solenoids, stepper motors, DC brushed and brushless motors, DC servo motors, AC / DC motors for non-servo motion drives, braking methods, pulse width modulated, Bipolar driver, Mosfet drives, SCR drives, variable frequency drives.

### 7. Digital Electronics:
Digital logic, number systems, logic gates, Boolean algebra, Karnaugh maps, sequential logic.

### 8. Microprocessors:
Control, microcomputer structure, microcontrollers, digital interfacing, analog interfacing, DAC, ADC, applications.

### 9. Input / Output Systems:
Interfacing, input / output ports, interface requirements, peripheral interface adapters, serial communication interface, direct memory access.

### 10. Control System:
System transfer function, Laplace transformation and its applications, continuous and discrete processes, proportional control, integral control, differential control, PID control, digital controllers, control system performance, controller tuning, adaptive control, frequency response, PLC, PMC, introduction to fuzzy logic and neural networks.

### Books Recommended:
3. Production Systems and CIM, Groover, PHI.
5. Feedback Control Systems, BC: Kuo, PHI.