NUMERICAL METHODS
SH603

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 3

Course objective:
To introduce numerical methods used for the solution of engineering problems. The course emphasizes algorithm development and programming and application to realistic engineering problems.

1. Introduction, Approximation and errors of computation (4hours)
- 1.1. Introduction, Importance of Numerical Methods
- 1.2. Approximation and Errors in computation
- 1.3. Taylor's series
- 1.4. Newton's Finite differences (forward , Backward, central difference, divided difference)
- 1.5. Difference operators, shift operators, differential operators
- 1.6. Uses and Importance of Computer programming in Numerical Methods.

2. Solutions of Nonlinear Equations (5 hours)
- 2.1. Bisection Method
- 2.2. Newton Raphson method (two equation solution)
- 2.3. Regula-Falsi Method , Secant method
- 2.4. Fixed point iteration method
- 2.5. Rate of convergence and comparisons of these Methods

3. Solution of system of linear algebraic equations (8 hours)
- 3.1. Gauss elimination method with pivoting strategies
- 3.2. Gauss-Jordan method
- 3.3. LU Factorization
- 3.4. Iterative methods (Jacobi method, Gauss-Seidel method)
- 3.5. Eigen value and Eigen vector using Power method

4. Interpolation (8 hours)
- 4.1. Newton's Interpolation (forward, backward)
- 4.2. Central difference interpolation: Stirling's Formula, Bessel's Formula
- 4.3. Lagrange interpolation
- 4.4. Least square method of fitting linear and nonlinear curve for discrete data and continuous function
- 4.5. Spline Interpolation (Cubic Spline)

5. Numerical Differentiation and Integration (6 hours)
- 5.1. Numerical Differentiation formulae
- 5.2. Maxima and minima
- 5.3. Newton-Cote general quadrature formula
- 5.4. Trapezoidal, Simpson's 1/3, 3/8 rule
- 5.5. Romberg integration
- 5.6. Gaussian integration (Gaussian – Legendre Formula 2 point and 3 point)

6. Solution of ordinary differential equations (6 hours)
- 6.1. Euler's and modified Euler's method
- 6.2. Runge Kutta methods for 1st and 2nd order ordinary differential equations
- 6.3. Solution of boundary value problem by finite difference method and shooting method.

7. Numerical solution of Partial differential Equation (8 hours)
- 7.1. Classification of partial differential equation(Elliptic, parabolic, and Hyperbolic)
- 7.2. Solution of Laplace equation (standard five point formula with iterative method)
- 7.3. Solution of Poisson equation (finite difference approximation)
- 7.4. Solution of Elliptic equation by Relaxation Method
- 7.5. Solution of one dimensional Heat equation by Schmidt method

Practical:
Algorithm and program development in C programming language of following:
1. Generate difference table.
2. At least two from Bisection method, Newton Raphson method, Secant method
3. At least one from Gauss elimination method or Gauss Jordan method. Finding largest Eigen value and corresponding vector by Power method.
4. Lagrange interpolation. Curve fitting by Least square method.
5. Differentiation by Newton's finite difference method. Integration using Simpson's 3/8 rule
6. Solution of 1^{st} order differential equation using RK-4 method
7. Partial differential equation (Laplace equation)
8. Numerical solutions using Matlab.

References:

1. Dr. B.S.Grewal, "Numerical Methods in Engineering and Science ", Khanna Publication.
2. Robert J schilling, Sandra l harries , " Applied Numerical Methods for Engineers using MATLAB and C.", Thomson Brooks/cole.
3. Richard L. Burden, J.Douglas Faires, "Numerical Analysis", Thomson / Brooks/cole
4. John. H. Mathews, Kurtis Fink ,"Numerical Methods Using MATLAB" ,Prentice Hall publication
5. JAAN KIUSALAAS , "Numerical Methods in Engineering with MATLAB" , Cambridge Publication

Evaluation scheme:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below

Unit	Chapter	Topics	Marks
1	1 & 2	all	**16**
2	3	all	**16**
3	4	all	**16**
4	5	all	**16**
	6	6.1, 6.2	
5	6	6.3	**16**
	7	all	
Total			**80**

HEAT TRANSFER
ME 604

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objective:

To introduce the concepts of heat transfer to enable the students to design components subjected to thermal loading.

Course Outlines:

1. Review on Basic Concepts of Heat Transfer [1 hour]

1.1. Mechanism of Heat Transfer
1.2. Factors Affecting Heat Transfer
1.3. Engineering Applications

2. Conduction Heat Transfer [12 hours]

2.1. General Differential equation of Conduction
2.2. Fourier Law of Conduction
2.3. Cartesian and Cylindrical Coordinates
2.4. One and Two Dimensional Steady State Heat Conduction
2.5. Conduction through Plane Wall, Cylinders and Spherical systems
2.6. Composite Systems
2.7. Conduction with Internal Heat Generation
2.8. Unsteady Heat Conduction
2.8.1 Lumped Analysis
2.8.2 Use of Heislers Chart

3. Convection Heat Transfer [12 hours]

3.1. Newton's law of cooling
3.2. Convective Heat Transfer Coefficients
3.3. Boundary Layer Concepts
3.4. Free Convection
3.4.1 Dimensional Analysis
3.4.2 Flow over Plates, Cylinders and Spheres
3.5. Forced Convection
3.5.1 Dimensional Analysis
3.5.2 Flow over Plates, Cylinders and Spheres
3.5.3 Laminar and Turbulent Flow
3.5.4 Combined Laminar and Turbulent
Flow over Bank of tubes

4. Radiation Heat Transfer [8 hours]

4.1. Laws of Radiation
4.1.1 Stefan Boltzman Law, Kirchoff Law
4.1.2 Relationship between Temperature, Frequency and Wavelength
4.1.3 Reflectivity, Absorbtivity and Transmissivity
4.2. Black and Grey body radiation
4.3. Shape Factor Algebra
4.4. Electrical Analogy
4.5. Radiation Shields
4.6. Introduction to Gas Radiation

5. Phase Change Heat Transfer [2 hours]

5.1. Nusselts Theory of Condensation
5.2. Pool Boiling and Flow Boiling
5.3. Correlations in Boiling and Condensation

6. Applications of Heat Transfer [6 hours]

6.1. Fins
6.1.1 Types of Fins
6.1.2 Heat Dissipation from Fins
6.1.3 Fin Performance
6.2. 6.2 Heat exchanger
6.2.1 Types of Heat Exchangers
6.2.2 LMTD Method of Heat Exchanger Analysis
6.2.3 Effectiveness
6.2.4 NTU Method of Heat Exchanger Analysis
6.2.5 Overall Heat Transfer Coefficient
6.2.6 Fouling Factors

7. Introduction to Mass Transfer [4 hours]

7.1. Basic Concepts
7.2. Diffusion Mass Transfer
7.3. Fick's Law of Diffusion
7.4. Steady State Molecular Diffusion
7.5. Convective Mass Transfer
7.6. Momentum, Heat and Mass Transfer Analogy
7.7. Convective Mass Transfer Correlations

Practical:

Lab 1 Conduction Heat Transfer
Verification of Conduction Laws
Drawing of Temperature Profile
Comparison between Thermal Conductivities of Different Types of Materials

Lab 2 Convection Heat Transfer
Free Convection from Different Types of Plates
Force Convection from Different Types of Plates

Lab 3 Radiation Heat Transfer
Relationship between Temperature, Frequency and Wavelength
Reflectivity, Absorptivity and Transmissivity

Lab 4 Boiling Heat Transfer
Mass and Energy Balances
Efficiency
Effects of Mixture on Boiling Heat Transfer

Lab 5 Heat Exchanger
Energy Balance of Different Types of Heat Exchangers
Drawing of Temperature Profiles of Different Types of Heat Exchangers
Effectiveness of Different Types of Heat Exchangers

Lab 6 Fins
Drawing of Temperature Profiles of Different Types of Fins
Heat Dissipation from Different Types of Fins

References:

1. Holman J.P "Heat Transfer" Tata McGraw-Hill.
2. Ozisik M.N, "Heat Transfer", McGraw-Hill Book Co.
3. Incropera, DeWitt, Bergman, Lavine, "Fundamentals of Heat and Mass Transfer", Wiley India.
4. Yadav R "Heat and Mass Transfer" Central Publishing House.
5. Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer" New Age International.
6. Nag P.K, "Heat Transfer", Tata McGraw-Hill, New Delhi.

Evaluation Scheme:
There will be questions covering all the chapters of the syllabus. The evaluation scheme for the questions will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	2	2.1 to 2.6	**16**
2	2	2.7 & 2.8	**16**
	3	3.1 to 3.4	
3	3	3.5	**16**
	5	all	
4	1 & 4	all	**16**
5	6 & 7	all	**16**
Total			**80**

FLUID MACHINES
ME605

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objective:
This course is designed to give ideas about fluid-force and power. It covers general introductory part of hydropower plant. Most of the parts deal with water-turbine, water-pumps, steam-turbine and hydraulic machine.

1. Introduction of Turbomachine and Dynamic Action of Fluid (10 hours)
- 1.1. Turbomachines
- 1.2. Hydraulic Machines
- 1.3. History of Development of Water Wheels and Water Turbine
- 1.4. Dynamic Force and Power
- 1.5. Linear Momentum and Impulse Equations
- 1.6. Application of Linear Momentum Principle
- 1.7. Dynamic Force Exerted by Fluid Jet;
- 1.8. Stationary and moving plates, flat and curved surfaces
- 1.9. Jet Propulsion Principle; Boat and ship propulsion

2. Hydroelectric Plant (4 hours)
- 2.1. Essential Components and Features
- 2.2. Classification of Hydroelectric plants
- 2.3. Existing Hydroelectric plants

3. Water Turbine (14 hours)
- 3.1. Types of turbines: Pelton, Francis, Kaplan, Cross Flow
- 3.2. Working Principles
- 3.3. Components and Their Functions, Specific speed, Design, Efficiency
- 3.4. Characteristics and application
- 3.5. Governor Principle, Types, Qualities, Control
- 3.6. Oil pressure governor:: Components, Working Principle

4. Pump (8 hours)
- 4.1. Centrifugal and Reciprocating Types
- 4.2. Theory of the Centrifugal Pump, Specific Speed, Pump Head
- 4.3. Pump Characteristics, Energy loss, Cavitation, Efficiency, Effect of Viscosity, Series and parallel combination
- 4.4. Selection of Pumps

5. Steam turbine and Hydraulic machine (9 hours)
- 5.1. Steam Nozzles and Types
- 5.2. Flow of Steam Through Nozzles;
- 5.3. Steady flow energy equation, Momentum equation
- 5.4. Principle of Operation of Steam Turbines
- 5.5. Types of Steam Turbine and Applications
- 5.6. Impulse and Reaction Turbine: Components and Their Functions, Working Principles, Efficiency
- 5.7. Hydraulic machine Types, Working Principle: Hydraulic Ram, Hydraulic lift, Hydraulic torque converter

Practical:
1. Performance Characteristics of Different Types of Pumps
2. Performance Characteristics of the Series and parallel combination of pumps
3. Performance Characteristics of the Pelton Turbine
4. Performance Characteristics of the Francis Turbine
5. Performance Characteristics of the Propeller Turbine
6. Performance Characteristics of the Cross-flow Turbine

References:

1. Robert L. Daugherty, Joseph B. Franzini and E. John Finnemore, "Fluid Mechanics with Engineering Applications", McGraw Hill Book Company, SI Metric Edition
2. Dr. P.N. Modi and Dr. M. Sethi, "Hydraulics and Fluid Mechanics", Standard Book house
3. Dr. J. Tritton, "Physical Fluid Dynamics", Second Edition, Claredon Press, Oxford Press
4. Dr. Jagadish Lal, "Hydraulics Machines", Metropoliton Co.
5. R.K Rajput, "A text book of Hydraulic Machine", S. Chandand Company Ltd. India

Evaluation Scheme:
There will be questions covering all the chapters of the syllabus. The evaluation scheme for the questions will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	all	**16**
2	2	all	**16**
	3	3.1 & 3.2	
3	3	3.3 to 3.6	**16**
4	4	all	**16**
5	5	all	**16**
Total			**80**

Evaluation Scheme

Units	Testing Items	No. of Questions	Type of Questions	Marks Distribution	Total Marks	Remarks
I	Reading	3	For grammar = objective and for the rest = short	2 Short questions 5+5 Interpretation of text 5 Note + Summary 5+5 Grammar 5	30	For short questions 2 to be done out of 3 from the seen passages, for interpretation an unseen paragraph of about 75 words to be given, for note + summary an unseen text of about 200to 250 to be given, for grammar 5 questions of fill up the gaps or transformation type to be given
II	Introduction to technical writing process and meeting	3	MLA/APA = objective, Editing and Meeting = short	MLA/APA = 4 Editing = 5 Meeting = 5	14	For APA/MLA 4 questions to be given to transform one from another or 4 questions asking to show citation according to APA/MLA technique, For meeting minute alone or notice with agendas to be given
III	Proposal Writing	1	Long	10	10	A question asking to write a very brief proposal on any technical topic to be given
IV	Report writing	2	Informal report = short, Formal report = long	Informal report = 6 Formal report = 10	16	A question asking to write very brief informal report on technical topic to be given, for formal report a question asking to write in detail on any three elements of a formal report on technical topic to be given
V	Research article	1	Long	10	10	A question asking to write a brief research article on technical topic to be given

Evaluation Scheme for Lab

Units	Testing items	No. of Questions	Type of questions	Marks Distribution	Remarks
I	Listening • instruction • description • conversation	2	objective	5+5	listening tape to be played on any two out of instruction, description and conversation followed by 10multiple choice type or fill in the gaps type questions
II	Speaking • group/round table discussion • presenting brief oral report • delivering talk	2	subjective	Round table discussion 5, talk or brief oral report =10	Different topics to be assigned in groups consisting of 8 members for group discussion and to be judged individually, individual presentation to be judged through either by talk on assigned topics or by brief oral reports based on their previous project, study and field visit.

Prescribed books

1. Adhikari, Usha, Yadav, Rajkumar, Yadav, Bijaya, ; " A Course book of Communicative English", Trinity Publication, 2012.
2. Adhikari, Usha, Yadav, Rajkumar, Shrestha, Rup Narayan ; “Technical Communication in English", Trinity Publication, 2012.

(Note: 50 marks excluding reading to be covered on the basis of first book and reading part (i.e. 30 marks) to be covered on the basis of second book)

3. Khanal, Ramnath, “Need-based Language Teaching (Analysis in Relation to Teaching of English for Profession Oriented Learners)”, Kathmandu: D, Khanal.
4. Konar, Nira, “Communication Skills for Professional”, PHI Learning Private Limited, New Delhi.
5. Kumar, Ranjit, “Research Methodology”, Pearson Education.
6. Laxminarayan, K.R, “English for Technical Communication”, Chennai; Scitech publications (India) Pvt. Ltd.
7. Mishra, Sunita et. al. , “Communication Skills for Engineers”, Pearson Education First Indian print.
8. Prasad, P. et. al , “The functional Aspects of Communication Skills”, S.K. Kataria & sons.
9. Rutherfoord, Andrea J. Ph.D, “Basic Communication Skills for Technology”, Pearson Education Asia.
10. Rizvi, M. Ashraf), “Effective Technical Communication”, Tata Mc Graw Hill.
11. Reinking A James et. al, “Strategies for Successful Writing: A rhetoric, research guide, reader and handbook”, Prentice Hall Upper Saddle River, New Jersey.
12. Sharma R.C. et al., “Business Correspondence and Report Writing: A Practical Approach to Business and Technical communication”, Tata Mc Graw Hill.
13. Sharma, Sangeeta et. al, “Communication skills for Engineers and Scientists”, PHI Learning Private Limited, New Delhi.
14. Taylor, Shirley et. al., “Model Business letters, E-mails & other Business documents”, Pearson Education.

MACHINE DESIGN I
ME651

Lecture : 3 **Year : III**
Tutorial : 0 **Part : II**
Practical : 3

Course objective
To provide fundamental knowledge and skills to the students that are needed to design the most commonly used machine elements. To make students able to design different kinds of machine elements and components.

Course Outlines:

1. Design Process (3 hour)
- 1.1. Introduction
- 1.2. Basic Steps in the Design and Synthesis Process
  - 1.2.1 Recognition of need
  - 1.2.2 Definition of the problem
  - 1.2.3 Gathering relevant information, functional requirements
  - 1.2.4 Conceptualization
  - 1.2.5 Evaluating alternatives
  - 1.2.6 Communication
  - 1.2.7 Feedback from manufacturer and user
- 1.3. Communicating the design
  - 1.3.1. Drawings and CAD
  - 1.3.2. Charts and graphs

2. Materials Selection (2 hour)
- 2.1. Information on Materials Properties
- 2.2. Economics of Materials
- 2.3. Evaluation Methods for Materials Selection
- 2.4. Cost versus Performance Relations
- 2.5. Cost and Value Analysis

3. New Product Design (2 hours)
- 3.1. Feasibility Studies
- 3.2. Preliminary design
- 3.3. Detailed design and analysis
- 3.4. Planning for manufacture
- 3.5. Planning for distribution and use
- 1.4. Planning for Retirement

4. Problem Solving and Decision Making (4 hours)
- 4.1. The Problem Solving Process
- 4.2. Creative Problem Solving
- 4.3. Invention
- 4.4. Brainstorming
- 4.5. Problem Statement; Needs, goals, constraints, compromises, conditions, criteria for evaluation
- 4.6. Problem Solving; Preparation, incubation, inspiration and verification
- 4.7. Decision Matrix
- 4.8. Decision Tree
- 4.9. Relevant Problems

5. Design of shafts (8 hours)
- 5.1. Design for static load
- 5.2. Reversed bending and steady torsion
- 5.3. The solderberg approach
- 5.4. Design for alternating bending and torsional stress
- 5.5. The kimmelmann load approach
- 5.6. Basic graphical approach
- 5.7. A general approach
- 5.8. The sine approach

6. Rolling contact bearing (4 hours)
- 6.1. Types of roller bearing
- 6.2. Bearing life
- 6.3. Bearing load
- 6.4. Selection of ball and straight roller bearing
- 6.5. Selection of tapered bearing

7. Lubrication and journal bearings (6 hours)
- 7.1. Types of lubrication, viscosity and charts
- 7.2. Petroff law, stable lubrication, thick film lupr
- 7.3. Hydrodynamic theory
- 7.4. Design consideration for journal bearing
- 7.5. Minimum film thickness
- 7.6. Coefficient of friction, lubricant flow, film pressure and temperature rise, temp and viscosity consideration
- 7.7. Optimization techniques
- 7.8. Pressure fed bearing, heat balance
- 7.9. Bearing design and bearing alloys
- 7.10. Thrust bearing, boundary lubricated bearing
- 7.11. Bearing material

8. Design of belts (4 hours)
- 8.1. Flat belt design open cross belt
- 8.2. V-belt design
- 8.3. Choice of chain and sprocket drive

9. Gear design (12 hours)
- 9.1. Spur gear
  - 9.1.1. Gear train

9.1.2. Force analysis and tooth stresses
9.1.3. Stress concentration and geometry factor
9.1.4. Dynamics effects
9.1.5. Estimating gear size
9.1.6. Fatigue strength design
9.1.7. Factor of safety and surface durability
9.1.8. Surface fatigue strength
9.1.9. Gear blank design

9.2. Helical bevel and worm gear
9.2.1. Helical gears tooth proportion and force analysis
9.2.2. Strength analysis and design
9.2.3. Worm gearing – kinematics and force analysis
9.2.4. Power rating of worm gears
9.2.5. Bevel gears- kinematics and force analysis
9.2.6. Bevel gearing design – bending stress and strength surface durability
9.2.7. Spiral bevel gears

Practical:

1. Assigned Problems;

Chosen to relate to course material; the design process, decision making and new product design

2. Assignment on: Design of shafts
3. Assignment on: Rolling contact bearing
4. Assignment on: journal bearings
5. Assignment on: Belt design
6. Assignment on: Gear design

References:

1. G.E. Dieter, "Engineering Design- a Materials Processing Approach", McGraw Hill, First Metric Edition.
2. M. F. Spotts,"Design of Machine Elements" , Prentice Hall.
3. J.E. Shigley, "Machine Design", McGraw Hill.

Evaluation Schemes:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below.

Unit	Chapter	Topics	Marks
1	1, 2 & 3	all	**16**
	9	9.2	
2	4 & 6	all	**16**
3	5	all	**16**
4	7 & 8	all	**16**
5	9	9.1	**16**
Total			**80**

THEORY OF MECHANISM AND MACHINE I
ME653

Lecture : 3 **Year : III**
Tutorial : 3/2 **Part : II**
Practical : 0

Course Objectives:
To make students understand about different mechanism used in devices or machines and make them able to do complete analysis of mechanism (including linkages, gears, gear trains, cams and followers).

1. Introduction (2 hours)
- 1.1. Introduction to the study of mechanisms
- 1.2. Basic definitions & descriptions
- 1.3. Mechanism configurations, links, chains, inversions
- 1.4. Transmission of motion
- 1.5. Mobility, Degree of freedom

2. Linkages and Mechanisms (4 hours)
- 2.1. Position Analysis of the four-bar mechanism
- 2.2. Four-bar linkage motion and Grashoff's law
- 2.3. Linkage position analysis; loop closure equations & iterative methods
- 2.4. Introduction to different mechanism : Slider crank, Scotch Yoke, Quick return, toggle, Oldham coupling & Hooke's Coupling, Straight line, Chamber wheel, constant velocity universal joint, intermittent motion, mechanical computing, etc. mechanisms.
- 2.5. Synthesis concepts

3. Cams and Followers (6 hours)
- 3.1. Classification of cams and nomenclature
- 3.2. Graphical cam layout;
- 3.3. Disk cam with flat-faced follower
- 3.4. Disk cam with Radial or Offset follower
- 3.5. Standardized Follower Displacement or Lift curves
- 3.6. Analytical Cam Design; Disk cam with flat-faced follower: Disk cam with Radial or Offset follower: Disc cam with Oscillating Roller follower
- 3.7. Other cam layouts
- 3.8. Cam production methods

4. Spur Gears (6 hours)
- 4.1. Introduction to Involute spur gears
- 4.2. Geometry of Involutes
- 4.3. Characteristics of Involute Tooth Action
- 4.4. Standardization of Gears; Metric system
- 4.5. Interference of Involute Gears
- 4.6. Numbers of teeth to avoid interference
- 4.7. Determining backlash in Involute gears
- 4.8. Non-standard Spur gears; extended center distance system
- 4.9. Methods of gear production

5. Bevel, Helical and Worm Gears (5 hours)
- 5.1. Theory of straight Bevel gears
- 5.2. Bevel Gear tooth proportions and geometrical details
- 5.3. Spiral and Hypoid gears
- 5.4. Theory of helical gears & tooth geometry
- 5.5. Parallel and crossed shafts for helical gears
- 5.6. Worm gearing

6. Simple and Planetary gear trains (5 hours)
- 6.1. Theory of Planetary Gear Trains
- 6.2. Speed Ratios; Formula and Tabular Methods
- 6.3. Applications
- 6.4. Assembly of Planetary gear trains

7. Kinematic Analysis of Mechanisms (9 hours)
- 7.1. General Plane Motion Representation
- 7.2. Relative Motion Velocity Analysis; Velocity Polygons; Graphical or Vector algebra solutions
- 7.3. Instantaneous centers of velocity
- 7.4. Kennedy's theorem
- 7.5. Velocities by Instantaneous centers
- 7.6. Relative motion acceleration analysis; Acceleration Polygons; Graphical or Vector algebra solutions; Corilis acceleration applications
- 7.7. Motion analysis by vector mathematics; Velocity analysis, Acceleration Analysis, Coriolis Acceleration Application
- 7.8. Analysis by Complex Numbers; Loop Closure Equation for Geometrical Layout, Kinematic Analysis by Complex Numbers Application

8. Force Analysis of Mechanisms (8 hours)
- 8.1. Centrifugal Force, Inertia Force and Inertia Torque

8.2. Methods of Force Analysis – Introduction
8.3. Forces on Gear Teeth- spur/bevel & helical gears
8.4. Force analysis on cams & followers
8.5. Superposition Force Analysis Methods, Graphical or Analytical
8.6. Linkage Force by Matrix Methods
8.7. Linkage Force by Method of Virtual Work
8.8. Linkage Force by Complex Number Method
8.9. Applications and Examples

References:

1. H.H. Mabie and C. F. Reinholtz, "Mechanism and Dynamics of Machinery", Wiley.
2. J.S. Rao & R.V. Dukkipati Mechanisms and Machine Theory, New Age International (P) Limited..
3. J.E. Shigley and J.J. Uicker, Jr., " Theory of Machines and Mechanisms", McGraw Hill.
4. B. Paul, "Kinematics and Dynamics of Planar Machinery", Prentice Hall.
5. C. E. Wilson, J.P. Sadler and W.J. Michels, "Kinematics and Dynamics of Machinery", Harper Row.

Evaluation Scheme:

There will be questions covering all the chapters of the syllabus. The evaluation scheme for the questions will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	all	**16**
	3	3.1 & 3.10	
2	3	3.2 to 3.9	**16**
	4	all	
3	5 & 6	all	**16**
4	7	all	**16**
5	8	all	**16**
Total			**80**

INTERNAL COMBUSTION ENGINES
ME654

Lectures : 3 **Year : III**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:
To make student able to understand construction and operation of IC engine, fuels and combustion of fuels in SI and CI engine performance test procedure and formation of exhaust emissions and their controlling measures.

1. Overview of Thermodynamics of Fuel-air Cycles and Real Cycles (5 hours)
- 1.1 Otto cycle, Diesel cycle, Atkinson cycle, Stirling cycle, Brayton cycle.
- 1.2 Assumptions in fuel air cycle analysis
- 1.3 Composition of cylinder gases

2. Engine Construction and operation (4 hours)
- 2.1 Construction and working principle of SI, CI engines and gas turbines
- 2.2 Major engine components
- 2.3 Four stroke and two stroke engines

3. Engine Fuels (6 hours)
- 3.1 Basic requirements of engine fuels:
- 3.2 Chemical structure of petroleum
- 3.3 Heat value of fuels.
- 3.4 Rating of SI Engine fuels,
- 3.5 Rating of CI engine fuels
- 3.6 Combustion equation for hydrocarbon fuels
- 3.7 Properties and ratings of petrol and diesel fuels
- 3.8 Fuel supply systems of SI and CI engines
- 3.9 Non-conventional fuels for IC engines; LPG, CNG, Methanol, Ethanol, Non-edible vegetable oils, Hydrogen.

4. Carburetor & Fuel Injection Systems (6 hours)
- 4.1 Construction and working of carburettor
- 4.2 Inlet and exhaust valve timings
- 4.3 Fuel feed and fuel injection pumps
- 4.4 Petrol injection
- 4.5 Electronic Fuel Injection systems (EFI)
- 4.6 Multi-point fuel injection system (MPFI)

5. Combustion in SI and CI Engines (6 hours)
- 5.1 Ignition systems
- 5.2 Stages of combustion in engines
- 5.3 Flame propagation and factors affecting it
- 5.4 Knocking a nd pre-ignition
- 5.5 Factors affecting knocking and Control of knocking
- 5.6 Combustion chamber requirements
- 5.7 Turbo charging and super charging
- 5.8 Engine emissions
- 5.9 Engine emissions and emission standards

6 Engine lubrication systems (4 hours)
- 6.1 Engine lubrication systems
- 6.2 Hydrodynamic theory of lubrication
- 6.3 Properties of lubricants
- 6.4 Types of lubricants and additives
- 6.5 Grading of lubricating oils

7 Engine cooling (6 hours)
- 7.1 Air and water cooling systems
- 7.2 Working principles of air and water cooling systems
- 7.3 Variation of gas temperatures
- 7.4 Components of water cooling system

8 Engine Performance and Testing of Engines (8 hours)
- 8.1 Performance parameters
- 8.2 Engine power, BHP, Fuel consumption, Air consumption
- 8.3 Engine heat balance sheet
- 8.4 Mechanical efficiency
- 8.5 Engine efficiencies
- 8.6 Testing of engines and related numerical problems

Practical:
1. Engine dismantling and engine assembly: SI and CI engines.
2. Identification of engine components and checking them for defects.
3. Performance testing of SI/CI engine
4. Tailpipe emission testing of given engine

References:

1. Heywood, J. B, “Internal Combustion Engine Fundamentals”, McGraw Hill Publishing Co., New York.
2. Sharma, S. P, Chandramohan, “Fuels and Combustion”, Tata McGraw Hill Publishing Co.
3. Mathur and Sharma, “A course on Internal combustion Engines”, Dhanpat Rai & Sons.
4. Pulkrabek, W. W., “Engineering Fundamentals of the Internal Combustion Engine”, Prentice-Hall of India Private Limited.
5. Prof. P.L. Ballaney, “Internal Combustion Engines”, Khanna Publications, Delhi, India.
6. R.K. Mohanty, “A Text Book of Internal Combustion Engines”, Standard Book House, Delhi, India.

Evaluation Scheme:

There will be questions covering all the chapters of the syllabus. The evaluation scheme for the questions will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	all	**16**
2	3	all	**16**
	4	4.1 to 4.4	
3	4	4.5 & 4.6	**16**
	5	all	
4	6 & 7	all	**16**
5	8	all	**16**
Total			**80**

ENERGY RESOURCES
ME655

Lecture : 3 **Year : III**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:
To make student able to understand different types of conventional energy resources, different types of renewable energy resources and energy conversion technologies.

1. Fossil fuels and their characteristics (4 hours)
- 1.1. Classification of traditional fuels
- 1.2. Refining of crude oil
- 1.3. Properties of gasoline and diesel

2. Solar energy (6 hours)
- 2.1. Movement of earth and Solar radiation, solar radiation measuring devices.
- 2.2. Solar radiation fundamentals and solar angles
- 2.3. Flat plate collectors, solar water heaters, Solar Concentrators
- 2.4. Photovoltaic materials; Materials in bulk and thin film forms
- 2.5. Role of microstructure (single crystal, multicrystalline, polycrystalline, amorphous and nanocrystalline) in electrical and optical properties of the materials
- 2.6. Applications of Photovoltaic for power generation

3. Bio energy (3 hours)
- 3.1. Biogas generation and factors affecting bio digestion or generation of gas
- 3.2. Biomass and biochemical conversion to fuels
- 3.3. Biogas plants

4. Wind energy (4 hours)
- 4.1. Principles of wind energy conversion
- 4.2. Types and characteristics of Horizontal & vertical axis wind turbines
- 4.3. Wind farming

5. Micro and small hydro power systems (6 hours)
- 5.1. Micro/Mini hydropower systems, principles and related technologies
- 5.2. Site investigation
- 5.3. Determination of flow
- 5.4. Construction and operation of the different types of water turbines within the range of micro and small hydro power systems
- 5.5. Characteristics of turbines used for micro and small hydro power plants

6. Non conventional forms of energy and batteries (6 hours)
- 6.1. Introduction to fuel cells and Hydrogen fuel system
- 6.2. Hydrogen production processes
- 6.3. General introduction to infrastructure requirement for hydrogen production, storage, and utilization
- 6.4. Battery fundamentals
- 6.5. Different types of batteries

7. **Nuclear energy (6 hours)**
- 7.1. Introduction
- 7.2. Nuclear fusion and reactions
- 7.3. Requirements for nuclear fusion
- 7.4. Health hazards
- 7.5. Radiation protection & shielding

8. Responsible development practices (4 hours)
- 8.1. World energy resources
- 8.2. Energy consumption pattern of different countries
- 8.3. Environment, Development and Society-comparative approaches to natural resource management:
- 8.4. Indigenous system of natural resource management-land, water, forest, air etc:
- 8.5. Environmental ethics.
- 8.6. Urbanization and Sustainability,
- 8.7. Environmentally responsible consumption.

9. Energy audit (6 hours)
- 9.1. Energy audit concepts
- 9.2. Basic elements and measurements
- 9.3. Preparation and presentation of energy audit reports
- 9.4. Case study and potential energy savings

Practical:
1. Measurement of Solar Radiation with Pyranometer
2. Determine the performance of liquid heating solar collector from open -loop through flow test setup
3. Determination of the performance of Study of Solar Water Heater

4. Study the construction and operation of wind turbine
5. Study of Bio gas plant and its principle of operation
6. Study of Micro/Small hydro power systems

References:

1. H.P. Garg & J. Prakash, “Solar Energy Fundamentals and Applications”, Tata McGraw Hill Education Private Limited, new Delhi, India.
2. S.N. Bhadra, D. Kastha, S. Banerjee, “Wind Electrical Systems”, Oxford University Press, New Delhi, India.
3. G. D. Rai, “Non-Conventional Sources of Energy”, Khanna Publishers, India
4. J.A.Duffie, W.A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & sons.

Evaluation Scheme:

There will be questions covering all the chapters of the syllabus. The evaluation scheme for the questions will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	all	**16**
2	3 & 4	all	**16**
3	5	all	**16**
	6	6.1 to 6.3	
4	6	6.4 & 6.5	**16**
	7	all	
5	8 & 9	all	**16**
Total			**80**

MACHINE DESIGN II
ME701

Lectures : 3 **Year : IV**
Tutorial : 0 **Part : I**
Practical : 3

Course Objective:
To provide fundamental knowledge and skills to the students that are needed to design the most commonly used machine elements.

1. Modeling and Simulation (4 hours)
- 1.1. The role of Models in Engineering Design
- 1.2. Mathematical Modeling
- 1.3. Similitude and Scale Models
- 1.4. Computer Simulation and Parameter Variation
- 1.5. Computer Generated Geometric Models
- 1.6. Finite Element Modeling and Analysis

2. Optimization Techniques (4 hour)
- 2.1. Optimization by Differential Calculus
- 2.2. Search Methods
- 2.3. Multivariable Search Methods
- 2.4. Linear and Geometric Programming
- 2.5. Multifactor Objective Functions

3. Interaction of Materials, Processing and Design (2 hour)
- 3.1. Role of Processing in Design
- 3.2. Overviews of Manufacturing Processes and Relation to Design: Casting, forging, sheet metal forming, machining, powder metallurgy, welding, heat treatment, assembly
- 3.3. Other factors Affecting the Design Process Material properties, type of loading, stress concentrations, corrosion resistance, wear and abrasion resistance

4. Risk and Reliability of Design (4 hours)
- 4.1. Risk and Society; Regulations, standards, risk assessment
- 4.2. Probabilistic Approach to Design
- 4.3. Reliability Theory;
  - 4.3.1. Failure Rates
  - 4.3.2. System Reliability
  - 4.3.3. Maintenance and repair
- 4.4. Design for reliability
- 4.5. Hazard Analysis
- 4.6. Fault Tree Analysis

5. System Design (10 hours)
Power Transmission System Design such as Machine Tools, Automobile, Air craft etc.

6. Spring design (8 hours)
- 6.1. Stresses in helical spring
- 6.2. Deflection of helical spring
- 6.3. Extension and compression springs
- 6.4. Spring materials: estimation of tensile and torsion yield strength
- 6.5. Design of helical spring: critical frequency
- 6.6. Fatigue loading
- 6.7. Belleville spring
- 6.8. Helical torsion spring
- 6.9. Leaf spring
- 6.10. Energy store capacity of spring

7. Clutches and brakes (8 hours)
- 7.1. Internal expanding rim clutches and brakes
- 7.2. External expanding rim clutches and brakes
- 7.3. Band type clutches and brakes
- 7.4. Frictional contact axial clutches
- 7.5. Cone clutches and brakes
- 7.6. Energy consideration and temperature rise
- 7.7. Frictional material

8. Power screw (5 hours)
- 8.1. Screw thread for power transmission, types and standard
- 8.2. Relationship between applied torque and axial force
- 8.3. Friction effects; self locking thread
- 8.4. Stress concentration in threads
- 8.5. Effects of material

Practical:
1. **Machine Drawing Practice;**
   One or two drawing assignments that utilize the student's experience in previous drawing courses, but requires more depth of exposure to the production of working drawings including limit dimensioning, surface finish, welds, threads, fasteners, bearings, couplings and other hardware.
2. **Design Project I;**
   Introductory design project which may be the same for all students. It should be selected to combine the ideas of the design process with any analysis required, as well as the drawing process for communication of results. Students should be asked to outline and justify the logic behind the process of decision- making involved in the development of the design.
3. **Design Project II;**

More advanced project requiring a team approach say 4 students per group. The work of the project must be planned by the students as a group, the work divided and deadlines set for completion. Progress should be monitored and evaluated by the instructor at intervals to ensure success of the design effort. Again, detailed drawings are required and, if appropriate, oral presentations may be required for communication and justification of the project.

References:

4. G.E. Dieter, "Engineering Design- a Materials Processing Approach", McGraw Hill, First Metric Edition.
5. M. F. Spotts,"Design of Machine Elements" , Prentice Hall.
6. J.E. Shigley, "Machine Design", McGraw Hill.

Evaluation Schemes:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 2 & 3	all	**16**
2	4 & 8	all	**16**
3	5	all	**16**
4	6	all	**16**
5	7	all	**16**
Total			**80**

THEORY OF MECHANISM AND MACHINE II
ME702

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objective:

To provide basic concept for the dynamics response analysis of common machines and machine components. To model a given system for a vibratory response. To develop computer simulation and program for the dynamic response

1. Engine Force Analysis (2hours)
- 1.1. Analytical Method for Velocity and Acceleration of the Piston and the Connecting Rod
- 1.2. Equivalent Dynamical System
- 1.3. Analytical Method for Inertia Torque
- 1.4. Graphical Method for Velocity and Acceleration of the Piston and the Connecting Rod

2. Turning Moment Diagram and Flywheel (2hours)
- 2.1. Turning Moment Diagram
- 2.2. Fluctuation of Energy and Coefficient of Fluctuation of Energy
- 2.3. Flywheel
- 2.4. Coefficient of Fluctuation of Speed
- 2.5. Energy Stored in a Flywheel and Flywheel Sizing

3. Gyroscopic Couple (3 hours)
- 3.1. Precessional Angular Motion
- 3.2. Gyroscopic Couple
- 3.3. Effect of Gyroscopic Couple on Aeroplane
- 3.4. Stability of a Four Wheel and Two Wheel Vehicles
- 3.5. Effect of Gyroscopic Couple on a Disc Fixed Rigidly at a Certain Angle to a Rotating Shaft

4. Governors (4 hours)
- 4.1. Function of a Governer
- 4.2. Terms Used in Governer
- 4.3. Types of Governers
- 4.4. Sensitiveness and Stability of Governors

5. Balance of Machinery (6 hours)
- 5.1. Balancing of a Single Rotating Mass by a Single Mass Rotating in the Same Plane
- 5.2. Balancing of a Single Rotating Mass by Two Masses Rotating in Different Planes
- 5.3. Balancing of Several Masses Rotating in the Same Plane
- 5.4. Balancing of Several Masses Rotating in the Different Planes
- 5.5. Types of Balancing Machines
- 5.6. Balancing of Reciprocating Masses
- 5.7. Balancing of Multicylinder Engines, In-line, V-type, Opposed and Radial Configurations
- 5.8. Balance of Four Bar Linkages

6. Vibration of Single Degree of Freedom Systems[(10 hours)
- 6.1. Definition and Effects of Vibration, Terms Used in Vibration
- 6.2. Elements of a Vibrating System
- 6.3. Undamped Vibration of Single Degree of Freedom System
- 6.4. Damped Vibration of Single Degree of Freedom System
- 6.5. Forced Harmonic Response of Single Degree of Freedom System with Viscous Damping
- 6.6. Systems with Coulomb Damping
- 6.7. Rotating Unbalance
- 6.8. Whirling of Rotor-Shaft Systems
- 6.9. Vibration Isolation and Force Transmissibility
- 6.10. Response of Harmonic Excitation of Support
- 6.11. Vibration Measuring Instruments
- 6.12. Energy Dissipated by Damping
- 6.13. Convolution Integral and General Force Excitation

7. Vibration of Two Degree of Freedom Systems (4hours)
- 7.1. Undamped Vibration of Two Degrees of Freedom System, Natural Frequencies and Mode Shapes
- 7.2. Damped Vibration of Two Degrees of Freedom System
- 7.3. Forced Harmonic Vibration of Two Degrees of Freedom System
- 7.4. Vibration Absorber

8. Vibration of Multi Degree of Freedom Systems (6hours)
- 8.1. Equations of Motion in Matrix Form
- 8.2. Flexibility and Stiffness Matrices, Reciprocity Theorem
- 8.3. Eigenvalues and Eigenvectors, Orthogonal Properties of Eigenvectors
- 8.4. Modal Analysis
- 8.5. General Forced Response

9. Approximate Numerical Methods (4hours)
- 9.1. Rayleigh Method
- 9.2. Rayleigh-Ritz Method
- 9.3. Dunkerley Method
- 9.4. Matrix Iteration Methods
- 9.5. Finite Difference Method

10. Vibration of Continuous Systems (4 hours)
- 10.1. Lateral Vibration of a String

10.2. Longitudinal Vibration in Rods
10.3. Torsional Oscillation in Circular Shafts
10.4. Lateral Vibration in Beams

Practical:

1. Response of Governors
2. Experiment on Gyroscope
3. Balancing of Rotating Masses
4. Response of a Spring Mass System
5. Whirling of a Rotating Shaft

References:

2. H. Mabie and C.F. Reinholtz, "Mechanisms and Dynamics of Machinery", H, Wiely.
3. W. T. Thomson, "Theory of Vibration with Applications", Prentice Hall.
4. S.S. Rao, "Mechanical Vibrations", Addison Wesley.
5. S. G. Kelly, "Fundamentals of Mechanical Vibrations", Mc Graw Hill.
6. A. Gilat, "MATLAB An Introduction with Applications", Wiley India.

Evaluation Scheme:

There will be questions covering all the chapters of the syllabus. The evaluation scheme will be indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 2 & 3	all	**16**
2	4 & 5	all	**16**
3	6	all	**16**
4	7 & 8	all	**16**
5	9 & 10	all	**16**
Total			**80**

ENGINEERING ECONOMICS
ME703

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 0

Course Objectives:

To provide sound and comprehensive coverage of engineering economics especially. To explain how the business operates, how engineering project decisions are made within the business, and how engineering decisions can affect the bottom line (profit) of the firm. To build a thorough understanding of the theoretical and conceptual basis upon which the practice of financial project analysis is built. To satisfy the very practical needs of the engineer toward making informed financial decisions when acting as a team member or project manager for an engineering project. To incorporate all critical decision-making tools – including the most contemporary, computer –oriented ones such as simulation techniques in risk analysis so that engineers can make informed decision making under uncertainty.

1. Introduction to Engineering Economics (1 hour)
- 1.1. Engineering economics
- 1.2. Engineering economic decisions

2. Cost Concepts and Behavior (5 hours)
- 2.1. Direct material costs
- 2.2. Direct Labor costs
- 2.3. Manufacturing overheads
- 2.4. Non-manufacturing overheads
- 2.5. Cost-volume analysis

3. Understanding Financial Statements (6 hours)
- 3.1. Balance Sheet
- 3.2. Income Statement
- 3.3. Cash-flow Statements
- 3.4. Financial Ratio Analysis of Companies

4. Time value of Money (6 hours)
- 4.1. Compound interest
- 4.2. Types of cash flows
- 4.3. Single cash-flow
- 4.4. Uniform cash-flows, annuity
- 4.5. Linear gradient series
- 4.6. Geometric Gradient series
- 4.7. Irregular cash-flows

5. Project Evaluation Techniques (12 hours)
- 5.1. Project cash flows
- 5.2. Payback period Method
- 5.3. Net present Value Method (NPV)
- 5.4. Future Value Method
- 5.5. Annual Equivalent Method
- 5.6. Internal Rate of Return Method (IRR)

6. Depreciation (3 hours)
- 6.1. Straight-line method
- 6.2. Declining Balance Method
- 6.3. Sum of the digits Method

7. Income Tax & Discounted Cash-flow models (3 hours)
- 7.1. Effect of income tax on cash-flows
- 7.2. Development of discounted cash-flows models on EXCEL

8. Project Risk Analysis (3 hours)
- 8.1. Sensitivity analysis
- 8.2. Breakeven analysis
- 8.3. Probability concepts and
- 8.4. Probability distributions on Excel

9. Economic Analysis in Public Sector (6 hours)
- 9.1. Social costs & social Benefits
- 9.2. Benefit-cost analysis

References:

1. Chan S. Park, "Contemporary Engineering Economics", Prentice Hall of India Pvt. Ltd., New Delhi.

Evaluation Scheme:

There will be questions covering all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	all	**16**
	5	5.1 & 5.2	
2	3 & 6	all	**16**
3	4 & 7	all	**16**

4	5	5.3 to 5.6	**16**
5	8 & 9	all	**16**
Total			**80**

TURBO MACHINES
ME704

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objective:

To provide fundamental knowledge of turbo machines and their application. Also make them able to describe the working principles and applications of gas turbines and their components.

1. Introduction **(8 hours)**
- 1.1. Definition of a Turbo machine
- 1.2. Parts of a Turbo machine
- 1.3. General Classification of Turbines
- 1.4. Application of First and Second Laws of Thermodynamics
- 1.5. Efficiencies
- 1.6. Dimensionless Parameters and Their Physical Significance
- 1.7. Effect of Reynolds Number and Specific Speed

2. Velocity Vector Diagram **(8 hours)**
- 2.1. Typical Turbine Blade Profile
- 2.2. Analysis of Work Done
- 2.3. Stage Efficiency in
  - 2.3.1. Impulse Turbine
  - 2.3.2. Reaction Turbine
- 2.4. Related problems

3. Gas Turbine **(7 hours)**
- 3.1. Gas Turbine Engine: Schematic
- 3.2. The Theoretical Cycle: The Brayton Cycle
- 3.3. Compressor Inlet and Compressor Performance
- 3.4. Combustion Chamber
- 3.5. Turbine Performance

4. Gas Turbine Nozzles **(8 hours)**
- 4.1. Principle of Operation
- 4.2. Types of Nozzles
- 4.3. Nozzle Performance
- 4.4. Total Temperature and Pressure
- 4.5. Nozzle Energy Equation
- 4.6. The Nozzle Efficiency

5. Theoretical Jet Engine **(8 hours)**
- 5.1. Types of Jet Engines
  - 5.1.1. Turbine powered
  - 5.1.2. Ram Powered
  - 5.1.3. Non-continuous Combustion
- 5.2. Rocket Engine
- 5.3. Hybrid Engines

6. Gas Turbine Cycles of Aircraft Propulsion **(6 hours)**
- 6.1. Turbojet Engines
- 6.2. Turbofan Engines
- 6.3. Turboprop Engines
- 6.4. Overall Performance and Comparison
- 6.5. The Propulsion Efficiency
- 6.6. Variation of the Basic Gas Turbine Engine Cycle

Practicals:
1. Familiarization with Different Types of Turbo Machines
   a. Demonstration of Turbine Parts and Components
   b. Demonstration of Gas Turbine Engine System
2. Familiarization with Different Equipments and Components used in Turbo Machines
3. Gas Turbine Engine Study using Software (Computer Lab)
4. Demonstration of Aircraft Engine and Familiarization with Engine Parameters and Control
5. Familiarization with Tools used in Maintenance Operation of Gas Turbines

References:

1. Csanady , G.T., “Theory of Turbo machines”, McGraw Hill Book Co., New York.
2. Sorensen, H.A., “Gas Turbines”, The Ronald Press co., New York.
3. William W Perg, “Fundamentals of Turbomachinery”, John Wiley & Sons, Inc.

Evaluation Schemes:
The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below.

Unit	Chapter	Topics	Marks
1	1	all	**16**
2	2	all	**16**
3	3 & 6	all	**16**
4	4	all	**16**
5	5	all	**16**
Total			**80**

ENVIRONMENT AND POLLUTION CONTROL
ME705

Lectures : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objectives
To make student able to understand sources, nature, and health effects of air pollutants and basic control strategies and equipment; fundamentals of water pollution; nature of sound and quantification, noise control strategies and solid waste, and basic strategies for proper handling of solid waste.

1. Air pollution (8 hours)
- 1.1. Introduction to the different aspects of air pollution
- 1.2. Sources and effects of particulate and gaseous air pollutants
- 1.3. Photochemical reactions
- 1.4. Air pollution sampling and measurement
- 1.5. Measurement of Total suspended particulate, PM_{10} and $PM_{2.5}$
- 1.6. Industrial dust control methods and equipment
- 1.7. Selection of particulate control device
- 1.8. Air quality standards of Nepal

2. Metrological aspects of air pollution dispersion (6 hours)
- 2.1. Temperature lapse rates, atmospheric stability and inversions
- 2.2. Dispersion of air pollutants
- 2.3. The Gaussian plume model

3. Indoor Air Quality (6 hours)
- 3.1. Indoor Air Pollutants
- 3.2. Sources of Indoor Pollutants
- 3.3. Control strategies
- 3.4. Ventilation standards
- 3.5. Household smoke pollution and its effects to the residents

4. Water pollution (6 hours)
- 4.1. Introduction to various aspects of water pollution and water quality standards
- 4.2. BOD, COD, Oxygen sag curve
- 4.3. Water quality standards of Nepal
- 4.4. Municipal waste water treatment systems

5. Solid waste (6 hours)
- 5.1. Characteristics of solid waste
- 5.2. Overview of solid waste generation and management techniques
- 5.3. Hazardous wastes; definition and classification
- 5.4. Hazardous waste management techniques

6. Noise pollution (6 hours)
- 6.1. Nature of sound
- 6.2. Human ear
- 6.3. Quantification of sound in terms of SPL and PWL
- 6.4. Typical noise levels at different places and effects of noise
- 6.5. Noise control methods

7. Global issues and responsible development practices (7 hours)
- 7.1. Brief history of human civilization and development
- 7.2. Ozone depletion
- 7.3. Montreal protocol and controlling of CFC's and HCFCs
- 7.4. Control of ozone depleting substances in Nepal
- 7.5. Causes and effects of greenhouse gases
- 7.6. Indigenous system of natural resource management-land, water, forest, air etc
- 7.7. Sustainability of eco systems and the need for responsible development practices.
- 7.8. Environmentally responsible construction
- 7.9. Education in Human Values (EHV)
- 7.10. Introduction to Clean Development Mechanism (CDM) and carbon trading

Practical:
1. Measurement of TSP by High Volume Sampler
2. Measurement of PM_{10}
3. Measurement of particulate level in different rooms by low volume air sampler
4. Measurement of Noise levels at different surroundings
5. Study visits to municipal solid waste management stations

References:

1. Mackenzie L. Davis & David A. Cornwell, "Introduction to Environmental Engineering", McGraw Hill.
2. Gilbert M. Masters, Standford University, "Introduction to Environmental Engineering and Science", Printice Hall.
3. Stephan Konz, Kansas State University, "Work design", Grid Publishing Inc., Colombus, Ohio
3. C. S. Rao, "Environmental Pollution Control Engineering", New age International (P) Limited, Publishers, India.

Evaluation Scheme
There will be questions covering all the chapters of the syllabus. The evaluation scheme will be indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	all	**16**
2	2 & 3	all	**16**

3	4	all	**16**
4	5 & 6	all	**16**
5	7	all	**16**
Total			**80**

ELECTIVE-I

BASIC AIRCRAFT & AIR FRAME
ME72506

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objective:

To develops basic idea about different types of aircraft. To become familiar with different types of aircraft structure, construction & materials and to develop basic idea about the airframe maintenance.

1. Introduction to Aircraft (2 hours)
- 1.1. History of aircraft
- 1.2. Development trends of aircraft on the aspect of design and scale
- 1.3. Classification of Aircraft on the basis of engine, Commercial application and manufacturer
- 1.4. Modern era of Aircraft
- 1.5. Introduction of Aircraft use in Nepal

2. Main component of Air Frame (18 hours)
- 2.1. Fuselage
  - 2.1.1. Construction and pressurisation sealing;
  - 2.1.2. Wing, stabiliser, pylon and undercarriage attachments
  - 2.1.3. Seat installation and cargo loading system
  - 2.1.4. Doors and emergency exits: construction, mechanisms
  - 2.1.5. Operation and safety devices
  - **2.1.6.** Windows and windscreen construction and mechanisms.
- 2.2. Wings
  - 2.2.1. Construction;
  - 2.2.2. Fuel storage;
  - 2.2.3. Landing gear, pylon, control surface and high lift/drag attachments
- 2.3. Landing Gear
  - 2.3.1. Construction, shock absorbing;
  - 2.3.2. Extension and retraction systems: normal and emergency;
  - 2.3.3. Indications and warning;
  - 2.3.4. Wheels, brakes, antiskid and auto braking;
  - 2.3.5. Tyres;
  - 2.3.6. Steering.
- 2.4. Empennage
  - 2.4.1. Construction;
  - 2.4.2. Control surface attachment.
  - 2.4.3. Tail functions and arrangement
  - 2.4.4. Horizontal Stabilizer
  - 2.4.5. Vertical Stabilizer
  - 2.4.6. Rudder and Elevator

3. Flight Control Surfaces (3 hours)
- 3.1. Primary controls: aileron, elevator, rudder, spoiler;
- 3.2. Trim control;
- 3.3. Active load control;
- 3.4. High lift devices;
- 3.5. Lift dump, speed brakes;
- 3.6. System operation: manual, hydraulic, pneumatic, electrical
- 3.7. Artificial feel, Yaw damper, Mach trim, rudder limiter, gust
- 3.8. Locks systems;
- 3.9. Balancing and rigging

4. Hydraulic & Pneumatic System (3 hours)
- 4.1. Hydraulic systems and its components
- 4.2. Pneumatic system and its components

5. Equipment and Furnishings (3 hours)
- 5.1. Emergency equipment requirements; Seats, harnesses and belts.
- 5.2. Cabin lay-out; Equipment lay-out;
- 5.3. Cabin Furnishing Installation;
- 5.4. Cabin entertainment equipment;
- 5.5. Galley installation;
- 5.6. Cargo handling and retention equipment;
- 5.7. Air stairs.

6. Fuel Systems (5 hours)
- 6.1. System Layout
- 6.2. Fuel Tanks
- 6.3. Supply system
- 6.4. Dumping, Venting & Draining
- 6.5. Cross feed & Transfer
- 6.6. Indication & warning
- 6.7. Refuelling & Defueling

7. Other equipments & Components (9 hours)
- 7.1. Fire Protection system
- 7.2. Lighting System
- 7.3. Waste and Water system
- 7.4. Oxygen supply
- 7.5. Ice & Rain Protection system
- 7.6. Air conditioning systems & distribution

7.7. Cabin Pressurisation
7.8. Safety & Warning Device

8. Maintenance of Airframe (2 hours)

8.1. Maintenance work of airframe
8.2. Maintenance equipments & tools
8.3. Spare parts management

Practical:

Practical means project work and report have to be submitted at the end of the course. The report should be around 20-30 pages plus appendix in the context of different types of piston and jet engines aircraft , corresponding airframe constructions, layout and their maintenance practice in Nepal.

1. Case study
2. Site visit

References:

1. Michael Chun-Yung Niu, "Airframe Structural Design", Hong Kong Conmilit Press Ltd.
2. "Airframe & Power plant Mechanics", U.S. Department of Transportation, Federal Aviation Administration (FAA), AC65-12A & 15A
3. Daniel P. Raymer, "Aircraft Design: A conceptual Approach", American Institute of Aeronautics & Astronautics (AIAA) Education.
4. Bandu N. Pamadi, "Performance, Stability, Dynamics, and Control of Airplanes", AIAA Education Series.
5. R.S.shevell, "Fundamentals of Flight", Pearson Education, Second Edition.
6. John J. Bertin , "Aerodynamics for Engineers", Pearson Education.
7. Aircraft Manual of different manufactures

Evaluation Scheme:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 3 & 4	all	**16**
2	2	2.1 & 2.2	**16**
3	2	2.3 & 2.4	**16**
4	5, 6 & 8	all	**16**
5	7	all	**16**
Total			**80**

PROJECT ENGINEERING
CE 751

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : II**
Practical : 0

Course Objective:

- To introduce the basic knowledge on project and project environment
- To make the students able to prepare feasibility study report and project proposal.
- To provide the sound knowledge of project planning, implementation and controlling.
- To provide knowledge on risk associated with the project
- To provide the knowledge of project finance and
- To provide the concept of modern trends and techniques of project management.

1. Introduction of Project and Project Management (6 hours)

1.1. Definition of Project, its characteristics, and example of project.
1.2. Classification of Project
1.3. Project Objective and Goal
1.4. Project Life Cycle Phases
1.5. Project Environment
1.6. Introduction to Project Management

2. Project Appraisal and Project Formulation (8 hours)

2.1. Concept of Project Appraisal
2.2. Project Proposal (technical and financial)
2.3. Procedure for Developing Project Proposal
2.4. Techniques of Project Formulation
- Feasibility analysis
- Cost Benefit analysis
- Input analysis
- Environmental analysis

3. Project Planning and Scheduling (12 hours)

3.1. Concept of Project Planning and its Importance
3.2. Project Planning Process
3.3. Work Breakdown Structure (WBS)
3.4. Project Scheduling with Bar Chart, CPM & PERT
3.5. Project Scheduling with Limited Resources (Resource Leveling and Smoothing)
3.6. Introduction to Planning Software - MS Project

4. Project Implementation and Controlling. (7 hours)

4.1. Introduction to Monitoring, Evaluation and Controlling
4.2. Project Control
4.3. Project Control Cycle
4.4. Elements of Project Control (time, cost and quality)
4.5. Project Schedule Control
4.6. Project Cost Control: Methods and procedure (Earned value analysis)
4.7. Project Quality Control
4.8. Introduction to Project Management Information System (PMIS)

5. Project Risk Analysis and Management (7 hours)

5.1. Introduction to Project Risk
5.2. Types of Project Risk
5.3. Analysis of Major Sources of Risk
5.4. Effective Management of Project Risk
- Risk Management planning
- Risk Identification
- Qualitative and Quantitative Risk Analysis
- Risk Response Planning
- Risk Monitoring and Controlling

6. Introduction to Project Financing (5 hours)

6.1. Project finance
6.2. Capital Structure Planning
6.3. Capital Budgeting Decision

Tutorial:

1.	Writing project Proposal	(2 hours)
2.	Scheduling Using Bar chart & CPM	(4 hours)
3.	Scheduling Using Planning Software	(4 hours)
4.	Project Control Method (EVA)	(1 hour)
5.	Capital Structure Planning Exercise	(2 hours)
6.	Capital Budgeting Exercise	(2 hours)

References:

1 IshwarAdhikari and Santosh Kr. Shrestha, "A text book of Project Engineering", Chandeshwori Publication, First Editn.
2 DhurbaP.Rizal, "Project Management" , Ratnapustakbhandar.
3 E.R. Yescombe, "Principles of Project Finance" Yescombe-Consulting Limited.
4 K. Nagarajan, "Project Management", ISBN: 81-224-1340-4, New Age International (P) Limited, New Delhi, India.
5 Dr. Govinda Ram Agrawal, "Project Management in Nepal" Edition: 2006, M.K. Publishers and Distributors, Kathmandu, Nepal.

Evaluation Scheme:

The questions will cover all the chapters in the Syllabus. The evaluation scheme will be as indicated in the table below.

Unit	Chapters	Topics	Marks
1	1& 6	all	**16**
2	2	all	**16**
3	3	all	**16**
4	4	all	**16**
5	5	all	**16**
Total			**80**

FINITE ELEMENT METHOD

ME751

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:

To understand the basic steps of finite element methods, its applications and advantages. To develop the finite element model for discrete structural and non structural problems and continuum problems specially heat transfer, plane elasticity. To develop computer program and use commercial software for above mentioned problems.

1. Overview (2 hours)
- 1.1. Introduction
- 1.2. Brief history
- 1.3. Mathematical modeling of the physical system
- 1.4. FEM Analysis Process
- 1.5. FEM Steps
- 1.6. Applications of the Finite Element Method
- 1.7. Advantages of the Finite Element Method

2. Mathematical Background (2 hours)
- 2.1. Vector analysis
- 2.2. Matrix theory
- 2.3. Differential Equations

3. Direct Stiffness Method: Discrete Finite Elements (8 hours)
- 3.1. Spring/Bar Element
- 3.2. Truss Element
- 3.3. Beam Element
- 3.4. Frame Element
- 3.5. Analogous problems in one dimension

4. Continuum Problems (8 hours)
- 4.1. Ritz Method
- 4.2. Method of Weighted residuals
- 4.3. Strong and Weak formulation

5. Interpolation Functions (10 hours)
- 5.1. Piecewise defined functions
- 5.2. One dimensional element
- 5.3. Two dimensional element
  - 5.3.1. Triangular element
  - 5.3.2. Rectangular element
- 5.4. Variation approach

6. Applications in Solid Mechanics (10 hours)
- 6.1. Plane stress
- 6.2. Plane strain
- 6.3. 3 dimensional element
- 6.4. Axisymmetric stress analysis
- 6.5. Thermal stress analysis

7. Higher order Elements (5 hours)
- 7.1. Lagrange elements
- 7.2. Serendipity elements
- 7.3. Parametric Mapping

Practical:

1. Development of Computer programs for discrete structural problems (Bar, Truss, Beam and Frame).
2. Development of Computer program for discrete non-structural problems (Heat Transfer, Fluid Flow).
3. Development of Computer program for one dimensional continuum problems.
4. Development of Computer program for two dimensional continuum problems with one dependent variable.
5. Development of Computer program for two dimensional continuum problems with two dependent variables.
6. Development FEM model using parametric mapping.
7. Use of commercial software for heat transfer and stress analysis.

References:

1. D. L. Logan, “A First Course in the Finite Element Method”, Thomson India Edition.
2. D. V. Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw Hill Publishing Company Limited.
3. J. N. Reddy, “An Introduction to the Finite Element Method”, Tata McGraw Hill Publishing Company Limited.
4. A. Gilat, “MATLAB An Introduction with Applications”, Wiley India.

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the questions will be indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 2 & 7	all	**16**
2	3	all	**16**
3	4	all	**16**
4	5	all	**16**
5	6	all	**16**
Total			**80**

ENGINEERING PROFESSIONAL PRACTICE
CE 752

Lecture : 2 **Year : IV**
Tutorial : 0 **Part : II**
Practical : 0

Course Objective:
To familiarize the students with their roles in the society, ethical and legal environment in which engineering is practiced, contract administration, regulatory environment and contemporary issues in Engineering.

1. **History of Engineering Practices** (3 **hours)**
   - 1.1. Man and Society
   - 1.2. Technology and Society
   - 1.3. History of Engineering Practice in Eastern Society
   - 1.4. History of Engineering Practice in Western society
   - 1.5. Engineering Practices in Nepal

2. **Profession and Ethics** **(6 hours)**
   - 2.1. Profession: Definition and Characteristics
   - 2.2. Professional Institutions
   - 2.3. Relation of an Engineer with Client, Contractor and Fellow Engineers
   - 2.4. Ethics, Code of Ethics and Engineering Ethics
   - 2.5. Moral Dilemma and Ethical Decision Making
   - 2.6. Detailed Duties of an Engineer and Architect
   - 2.7. Liability and Negligence

3. **Professional Practices in Nepal** **(3 hours)**
   - 3.1. Public Sector Practices
   - 3.2. Private Sector Practices
   - 3.3. General Job Descriptions of Fresh Graduates in both Public and Private Sector

4. **Contract Management** **(6 hours)**
   - 4.1. Methods of Work Execution/Contracting
   - 4.2. Types of Contracts
   - 4.3. Tendering Procedure
   - 4.4. Contract Agreement

5. **Regulatory Environment** **(5 hours)**
   - 5.1. Nepal Engineering Council Act
   - 5.2. Labor Law
   - 5.3. Intellectual Property Right
   - 5.4. Building Codes and Bylaws
   - 5.5. Company Registration

6. **Contemporary Issues in Engineering** **(3 hours)**
   - 6.1. Globalization and Cross Cultural Issues
   - 6.2. Public Private Partnership
   - 6.3. Safety, Risk and Benefit Analysis
   - 6.4. Development and Environment
   - 6.5. Conflict and Dispute Management

7. **Case Studies Based on Engineering Practices** **(4 hours)**

References:

1. Carson Morrison and Philip Hughes "Professional engineering Practice – Ethical Aspects", McGraw-Hill Ryerson Ltd.' Toronto 1982
2. DrRajendraAdhikari, "Engineering Professional Practice – Nepalese and international Perspectives" Pashupati Publishing House, Kathmandu Nepal 2010
3. M. Govindarajan; S Natarajan and V.S. Senthikumar., " Engineering Ethics" – PHI Learning Pvt. Ltd. New Delhi 2009
4. Nepal Engineering Council Act
5. Contract Act
6. Labor Act
7. Company Act
8. Copyright Act
9. Public Procurement Act
10. Building By-Laws

Evaluation Scheme:
The questions will cover all the chapters in the Syllabus. The evaluation scheme will be as indicated in the table below.

Unit	Chapter	Topics	Marks
1	1 & 3	all	8
2	2	all	8
3	4	all	8
4	5 & 6	all	8
5	7	all	8
Total			**40**

ELECTIVE II

Aircraft Dynamics

EG 76508ME

Lecture : 3
Year : IV
Tutorial : 1
Part : II

Practical: 1.5

COURSE OBJECTIVES:

- To introduce students with basic aircraft design and manufacturing techniques.
- To provide insights on how the design and analysis of aircrafts are carried out in phases and iteratively.
- To provide students with the basic knowledge about flight dynamics, aircraft performance measures and analysis methods.

PREREQUISITES

All students taking this course must have taken previous course on Aircraft and Airframe.

COURSE OUTLINE:

1. **Basic Aerodynamic Principles (6 hrs)**
   - 1.1. Fluid Flow over Wings and Bodies
   - 1.2. Aerodynamic Forces and Aerodynamic Coefficients
   - 1.3. Lift and Drag of Bodies
   - 1.4. Aerodynamic Characteristics of Wing Sections
   - 1.5. Aerodynamic Characteristics of Finite Wings
   - 1.6. Flow of Compressible Fluids
   - 1.7. Application of CFD
2. **Aircraft Performance (8 hrs)**
   - 2.1. Equations of Motion for Flight in Vertical Plane
   - 2.2. Gliding Flight
   - 2.3. Level Flight
   - 2.4. Climbing Flight
   - 2.5. Range and Endurance
   - 2.6. Turning Flight
   - 2.7. Take-off and Landing
   - 2.8. Hazards during Take-off and Landing: Wind Shear and Microbrust
3. **Static Stability and Control (16 hrs)**
   - 3.1. Concept of Equilibrium and Stability
   - 3.2. Static Longitudinal Stability
   - 3.3. Stability in Maneuvering Flights
   - 3.4. Static Directional Stability
   - 3.5. Lateral Stability
   - 3.6. Stick-Free Stability
   - 3.7. Dynamic Stability
   - 3.8. Inertia Coupling
   - 3.9. Handling Qualities
4. **Introduction to Aircraft Design Principles (3 hrs)**
   - 1.1. Aircraft Configuration and Functional Studies
   - 1.2. Overview of Design Process
   - 1.3. Conceptual Design Parameters
   - 1.4. Introduction to Modern Design Tools and Techniques
5. **Design of Unique Aircraft Concepts (6 hrs)**
   - 4.1. Flying wing, Lifting Fuselage, BWB
   - 4.2. Delta and Double-Delta Wing
   - 4.3. Forward-Swept Wing
   - 4.4. Canard-Pusher
   - 4.5. Multi-Fuselage
   - 4.6. Unmanned High-Altitude Vehicles
6. **Aircraft Manufacturing Techniques (6 hrs)**
   - 5.1. Modern Manufacturing Industries
   - 5.2. Composite Materials in Aerospace Applications
   - 5.3. Mock-Up and Prototyping

PRACTICALS:

1. Design Exercises

2. Practice work on XFLR5 Open Source Software

An assigned project work and an accompanying report will be needed to be submitted by students by end of the course. The report should be written in a LaTeX platform.

REFERENCES:

1. Raymer, Daniel P., "Aircraft Design: A Conceptual Approach", Fourth Edition, AIAA Education Series, 2006.
2. Luling An (compiled by),"An Introduction to Aircraft Manufacturing Technology", College of Mechanical and Electrical Engineering, Nanjing University of Aeronautics and Astronautics, 2010.
3. Bandu N. Pamadi, "Performance, Stability and Dynamics, and Control of Airplanes", AIAA Education Series, 1998.

EVALUATION SCHEME:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks Distribution*
1 & 2	14	16
3	8	16
3 & 4	11	16
5	6	16
6	6	16
Total	45	80

*** There may be minor deviation in marks distribution.**

AUTOMOBILE ENGINEERING ENTERPRISES
ME76509

Lecture : 3 **Year : IV**

Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:

To prepare students for the automobile engineering enterprises in the country and abroad.

1. Fundamentals of Automobile Overhaul (15 hours)

1.1 Introduction. Scope and importance
1.2 Overhauling of engines. Machines and equipment for overhauling. Lifting and handling equipment, measuring and quality control equipment, their operation. Overhauling by over sizing and under sizing of components. Overhauling by rebuilding of components. Overhauling by replacement of components.
1.3 Diesel pump overhauling
1.4 Quality control. Post-overhaul running and testing of engines
1.5 Overhauling of electrical components. Motors and generators. Overhauling by replacement of parts.

2. Service Stations and Maintenance /Repair Shops (10 hours)

2.1 Introduction. Differentiation. Scope. Types
2.2 Service station. Functions. Equipment
2.3 Maintenance/Repair Shop
  2.3.1 Function. Equipment and Process.
  2.3.2 Lifting and transportation equipment
  2.3.3 Cleaning and lubricating equipment
  2.3.4 Measuring and calibrating equipment
  2.3.5 Diagnostic equipment
2.4 Types and scopes of maintenances
2.5 Specialized maintenance shops
  2.5.1 Electricals
  2.5.2 Aircons
  2.5.3 Battery
  2.5.4 Chassis and body
  2.5.5 Engine
  2.5.6 Tyres
2.6 Dynamometric testing
  2.6.1 Engine
  2.6.2 Brake
2.7 Planning and designing of Service stations and maintenance shops

3. Gas station, Petrol Pump and Charging Stations (4 hours)

3.1 Introduction. Role. Queueing theory
3.2 Fuel dispensing station. Equipment. Safety.
  3.2.1 Economics of enterprise

ELECTIVE III

AVIONICS
ME78506

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives

To familiarize the students on the basic application of electronics & control system in aircraft. To introduce the basic concepts of navigation & communication systems of aircraft.

Course Outlines:

1. Introduction to Avionics (4 hours)
- 1.1. Needs of Avionics
- 1.2. Different components of avionics
- 1.3. System & integration of avionics

2. Digital Avionics (10 hours)
- 2.1. Introduction to digital system
  - 2.1.1.Needs of digital system in aircraft
  - 2.1.2.Digital computers, Microprocessors & Memories
- 2.2. Introduction to digital avionics
  - 2.2.1.Avionics system architecture & data buses
  - 2.2.2.Introduction of flight deck & cockpit
  - 2.2.3.Control and display technologies CRT, LED, LCD, EL
  - 2.2.4.Plasma panel - Touch screen - Direct voice input (DVI)

3. Introduction to Avionics System (10 hours)
- 3.1. Flight control system
- 3.2. Auto Flight
- 3.3. Communication System
- 3.4. Navigation System
- 3.5. Utility System

4. Electrical & Control System (9 hours)
- 4.1. Batteries & Charger
- 4.2. Electrical Power (AC/DC) Generation
- 4.3. Emergency Power Generator
- 4.4. Power Distribution
- 4.5. Voltage regulation, Circuit protection, Surge Protection & Lighting Arrestor
- 4.6. External/ Ground Power
- 4.7. External & Internal Light used in aircraft

5. Instruments in Aircraft (9 hours)
- 5.1. Pitot static: altimeter,
- 5.2. Air speed indicator, vertical speed indicator;
- 5.3. Gyroscopic: artificial horizon, attitude director, direction indicator, horizontal situation indicator, turns and slip indicator, turn coordinator
- 5.4. Compasses: direct reading, remote reading;
- 5.5. Vibration indicating systems — HUMS
- 5.6. Ground Proximity Warning Systems;
- 5.7. Other indication and warning indicator

6. On Board Maintenance System (3 hours)
- 6.1. Central maintenance computers
- 6.2. Data loading system
- 6.3. Electronic library system & Printing
- **6.4.** Monitoring & Control system

Laboratory/ Project Works:
Practical means project work and report have to be submitted at the end of the course. The report should be around 20-30 pages plus appendix.
- Case study
- Site visit

References:

1. Middleton, D.H., Ed., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd., England.
2. Spitzer, C.R., "Digital Avionic Systems", Prentice Hall, Englewood Cliffs, N.J., USA.
3. . Brain Kendal, "Manual of Avionics", The English Book House, , New Delhi.
4. Aircraft Manufacturer's Manuals & Handbooks

Evaluation Scheme:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 6	all	**16**
2	2	all	**16**
3	3	all	**16**
4	4	all	**16**
5	5	all	**16**
Total			**80**