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**

INDUSTRIAL ATTACHMENT
ME 706

Attachment: One month **Year : IV**
Part : I

Course Objective:
To visit and work in different kinds of industries in the country. To study the existing management system and technology of that industry.

General Procedures:
Students in groups will be placed in different industries for the duration of two weeks during vacation. They will be assigned to perform available work in the industry supervised by the assigned engineer/technician from the industry.

After the completion of their attachment each group has to submit the report in writing and give presentation to the committee formed by the department.

The report should include technical as well as managerial part of the industry.

Evaluation Scheme:
The evaluation scheme will be indicated in the table below:

	Marks
Evaluation by supervisor from industry	**50**
Evaluation of written report	**20**
Presentation	**30**
Total	**100**

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**