HYDROPOWER ENGINEERING

Year	**Third**	Teaching Schedule (Hours/week)	Lecture (Theory)	Practical	Tutorial
Semester	**Sixth**	Credit Hour	**3**	**-**	**-**
Course Code	BEG353CI	Lecture Hour	**3**	**3/2**	**1**

Examination System	Final		Internal Assessment		Total Marks	Remarks
	Theory	Practical	Theory	Practical		
Full Marks	**80**	**-**	**20**	**25**	**125**	
Pass Marks	**32**	**-**	**8**	**10**	**50**	
Duration	**3 Hours**	**-**	**3 Hours**	**-**	**-**	

Course Objective:

To familiarize the basic concepts of Fluid flow and hydraulics and their application in the context of hydropower development. To make students acquainted with component of hydropower systems and their design principles.

1. Introduction to Basic Fluid Mechanics and Hydraulics (14 hours)

1.1. Classification of Fluid Flows: Compressible versus incompressible flow, Laminar versus Turbulent flow, steady versus unsteady flow, One-, Two-, and Three-Dimensional flow

1.2. Properties of fluid: Concept of Continuum, density and specific gravity, vapor pressure and cavitation, energy and specific heats, compressibility, viscosity, surface tension and capillary effect.

1.3. Pressure and fluid statics: pressure at a point, variation of pressure with depth

1.4. Pressure measurement devices; barometer, manometer and other devices.

1.5. Hydrostatic forces on submerged plane surfaces and curved surfaces

1.6. Mass, Bernoulli and Energy Equations: Conservation of Mass, Mechanical Energy and Efficiency

1.7. The Bernoulli's Equation: Static, Dynamic and Stagnation Pressures; Limitation on the use of the Bernoulli's Equation; HGL and EGL, Applications of the Bernoulli's equation.

1.8. Pipe Hydraulics: Laminar flow in pipes(pressure drop and head loss), turbulent flow in pipes (shear stress, velocity profile , The Moody's chart), Types of fluid flow problems in pipes, Minor losses, Series and parallel pipes, piping systems with pumps and Turbines.

1.9. Unsteady flow in pipes: Water hammer and its effects, Hydraulic hammer and hydrodynamic pressure calculations.

1.10. Open channel hydraulics: classification, Froude number, specific energy, uniform flow in channels, best hydraulic cross section.

2. Introduction to Hydrology (5 hours)

2.1. Descriptive Hydrology: Hydrological Cycle, Types of precipitation, Measurement of rainfall, Intensity duration curves

2.2. Stream gauging: selection of stream gauging site, river stage measurement, measurement of water depth, measurement of discharge, Area- velocity method, Current meter, Slope-area method, Salt concentration method, Stage discharge relationship

2.3. Estimation of peak flow: Empirical methods, Rational methods, Probability plotting method, gumbel's distribution

3. Planning of Hydropower projects (5 hours)

3.1. Introduction to Hydropower: Comparison of hydropower and thermal power, combined power system and grids, basic terms and definitions

3.2. Investigation and planning: Planning parameters, power market, hydrology, topography, geology, soils and materials, Environmental issues, project appraisal and socio-economic considerations

3.3. Hydropower Development cycle: Reconnaissance studies, Prefeasibility Studies and Feasibility Studies.

3.4. Assessment of available Hydropower, necessity of storage and poundage, essential stream flow data, flow duration and power duration curve and their uses, Firm power and secondary power, Environmental flow.

3.5. Types of Hydropower plants, General arrangement of a hydropower project (sketch also) ; intakes, conveyance systems, forebay, surge tanks, power house, tailrace,

4. Dam Engineering (5 hours)

4.1. Classification of dams, gravity, arch, earth or rock fill and buttress dams(with sketches), Relative advantages and disadvantages of one type of dam over another. Investigation of dam site, Engineering surveys

4.2. Gravity dam: Force acting on gravity dams (water pressure, uplift, wave pressure, silt pressure, wind pressure, earthquake forces), primary load combinations for the numerical problems (Water, uplift and self weight only)

4.3. Stability requirements: Failure due to overturning and sliding, Elementary profile of gravity dam, Middle- third rule.

5. Component of Hydropower System (6 hours)

5.1. Intake: Types, importance, location, Layout, Design Criteria only

5.2. Hydraulic Tunnels: Lay out, Design Criteria

5.3. Settling Basin: Layout and Design Criteria

5.4. Forebay and surge tanks: Layout and Design criteria

5.5. Penstock Liners: Layout and Design criteria

5.6. Valves: Types and suitability

6. Spillways (3 hours)

6.1. Design of spillways, definition, purpose, types

6.2. Gates: types and their location

6.3. Occurrence of cavitation and cavitation erosion.

7. Hydro-Electric Machines (7 hours)

7.1. Hydro-Mechanical installations: turbines- Pelton, Francis, Kaplan and their performance characteristics, selection of Turbines and their specific speed, draft tube and its importance

7.2. Pumps: Centrifugal, Reciprocating and their performance characteristics, selection and starting speed

7.3. Electro-mechanical installations: generators and their types, purpose and working principle of governors

7.4. Power House: Classification and dimensions of Power House.

Practical:

1. Hydrostatics force on a submerged body
2. Verification of Bernoulli's equation
3. Head loss in a pipe
4. Performance characteristics of a pelton turbine
5. Performance characteristics of Francis turbine
6. Characteristics of a centrifugal pump.

References:

1. P.N.Modi and S. Seth " Fluid Mechanics and Hydraulics" Standard book house.
2. Subramanya K. " Engineering Hydrology " Tata Mc graw hill publication
3. Dandekar M.M. and Sharma K.N. " Water power Engineering"
4. Hydraulic machines ,G. I Krivchenko, Mir publishers Moscow

POWER SYSTEM PROTECTION

Year	**Third**	Teaching Schedule (Hours/week)	Lecture (Theory)	Practical	Tutorial
Semester	**Sixth**	Credit Hour	**4**	**-**	**-**
Course Code	BEG327EL	Lecture Hour	**4**	**3/2**	**1**

Examination System	Final		Internal Assessment		Total Marks	Remarks
	Theory	Practical	Theory	Practical		
Full Marks	**80**	**-**	**20**	**25**	**125**	
Pass Marks	**32**	**-**	**8**	**10**	**50**	
Duration	**3 Hours**	**-**	**3 Hours**	**-**	**-**	

Course Objective:
To present fundamental knowledge on protection system and its associated components in power system

1. **Principle of power system protection** **(4 hours)**
   - 1.1. Protection system components and its terminologies
   - 1.2. Basic requirement of protection scheme
   - 1.3. Need of protection scheme in power system
   - 1.4. Back up protection, coordination, protection zone

2. **Current and Potential Transformers** **(4 hours)**
   - 2.1. Potential transformer: Operation, standard ratios, errors, application
   - 2.2. Current transformer: Wound and bar types, operation, standard ratios
   - 2.3. Accuracy classification, typical knee point voltage, applications

3. **Fuses** **(4 hours)**
   - 3.1. Types of fuses: Construction, operating characteristic and application
   - 3.2. Fuse element, rated fuse current, minimum fusing factor, fusing factor, pre arcing and arcing time
   - 3.3. Merits and demerits of various types of fuse

4. **Isolators and Contactors** **(4 hours)**
   - 4.1. Isolators: Construction, operation and uses
   - 4.2. Contactors: Construction and operation, normally open (NO) and Normally Close (NC), auxiliary contacts of contactors and application of contactors

5. System Earthing (6 hours)

5.1. Earthing: Definition, purpose, system earthing and body earthing, methods of earthing, substation earthing, measurement of soil resistivity

5.2. Causes of over voltages: Internal cause and external cause

5.3. Over voltage protection: Overhead earth wire, angle of protection, horn gap and rod gap lightning arrestor, surge absorbers

5.4. Isolated neutral, solid neutral, resistance earthing, reactance earthing, Peterson coil earthing

6. Circuit Breaker (12 hours)

6.1. Circuit breaking process: Arc phenomena, arc extinction and its methods, pre-arcing and arcing time, restricting voltage and recovery voltage

6.2. Duties of circuit breaker

6.3. Classification of circuit breaker:

6.3.1. Miniature circuit breaker: Construction, operating principle and application and various types of MCB such as ELCB

6.3.2. Moulded Case circuit Breaker: Construction, operating principle and application

6.3.3. Air circuit breaker: Construction, operating merits and demerits, arc extinction phenomena and application.

6.3.4. Oil circuit breaker: Construction, operating merits and demerits, arc extinction phenomena and application

6.3.5. Vacuum circuit breaker: Construction, operating merits and demerits, arc extinction phenomena and application.

6.3.6. SF6 circuit breaker: Construction, operating merits and demerits, arc extinction phenomena and application

6.4. Circuit breaker rating: Rated voltage, rated current, rated frequency, operating duty, making capacity, short time rating

6.5. HVDC circuit breaker

6.6. Auto reclosure

6.7. Testing of circuit breaker

7. Protective relays (14 hours)

7.1. Introduction

7.2. Classification of relays

7.3. Method of earth fault detection

7.4. Restricted and unrestricted earth fault protection

7.5. Electromagnet attraction relays

7.6. Electro magnet induction relays

7.7. Buchholz relay

7.8. Over current relays

7.8.1. Inverse definite minimum time (IDMT) relay, TDS,PSM

7.8.2. Application of IDMT relay in sectionalized HV feeder, Time-Graded protection/Current Graded protection

7.9. Directional relay (induction type

7.10. Over current and earth fault relay

7.11. Unit protection scheme/Differential protection

7.11.1. Advantage of unit protection scheme over non unit protection

7.11.2. Application of unit protection/differential protection scheme to HV feeders,

7.11.3. Transformers and generators
7.11.4. Biased or percentage relay and its application to transformers and generators
7.11.5. Voltage balance relay
7.11.6. Universal relay torque equation

7.12. Distance protection
7.13. Impedance, reactance and mho relay
7.14. Application of distance protection relay in sectionalized feeder
7.15. Carrier current protection
7.16. Bus bar protection

8. Static and digital relays (12 hours)

8.1. Need for static relays
8.2. Essential components of static relays
8.3. Comparison of static and electromagnet relays
8.4. Classification of static relays
8.5. A review of Electronic Circuit Commonly used in static relays: Auxiliary DC Voltage Supply,
8.6. Time Delay Circuit, Level Detectors, Multivibrator, logic circuit, use of operational Amplifier in static relay,
8.7. Static Over current relays and over voltage/under voltage relay
8.8. Directional static over current relays
8.9. Static differential relays
8.10. Static differential protection scheme applied to transformer
8.11. Static distance relays such as impedance relay, reactance relay and mho relay
8.12. Static differential protection applied to the generator
8.13. Block diagram and Component of digital relay
8.14. Block diagram of microprocessor based protective scheme for protection of transformer, generator and transmission line
8.15. Block diagram of microprocessor based over voltage /under voltage relay

Practical

1. Draw magnetizing curve for a protective CT. Check Knee point voltage
2. Test over current device in an Air Circuit Breaker for operation using primary injection
3. Test an induction disc relay in over current in over current protection scheme for operating characteristics using secondary injection.
4. Test an induction disc relay in residual earth fault protection scheme for operating characteristics and setting using secondary injection.
5. Check connections on a biased differential protection scheme of transformer. Test the scheme for operation and setting values on internal faults using primary injection
6. Measurement of soil resistivity

References

1. Sunil S. Rao “Switchgear and protection” Khanna Publishers
2. G. Mason “The art and science of protective relaying”
3. J.B Gupta “Switchgear and protection” Kataria and Sons

DIGITAL CONTROL SYSTEM

Year	**Third**	Teaching Schedule (Hours/week)	Lecture (Theory)	Practical	Tutorial
Semester	**Sixth**	Credit Hour	**3**	**-**	**-**
Course Code	BEG328EL	Lecture Hour	**3**	**3/2**	**1**

Examination System	Final		Internal Assessment		Total Marks	Remarks
	Theory	Practical	Theory	Practical		
Full Marks	**80**	**-**	**20**	**25**	**125**	
Pass Marks	**32**	**-**	**8**	**10**	**50**	
Duration	**3 Hours**	**-**	**3 Hours**	**-**	**-**	

Course Objectives:
To present the basic concepts on analysis and design of sampled data control system and to apply these concepts to typical physical processes.

1. **Introduction to discrete time control system** **(8 hours)**
   - 1.1 Principle features of discrete time control system
   - 1.2 Signal sampling, quantizing and coding
   - 1.3 Data acquisition, conversion and distribution system
   - 1.4 Reconstruction of original signal from sampled signal

2. **The Z-Transform** **(9 hours)**
   - 2.1 Fundamentals of Z-transform
   - 2.2 Important properties and theorems of the Z-transform
   - 2.3 Z-transform from the convolution integral
   - 2.4 Inverse Z-transform
     - 2.4.1 Direct Division
     - 2.4.2 Partial Fraction
     - 2.4.3 Inversion Integral
   - 2.5 Z-transform method for solving difference equation

3. **Analysis of discrete time control system** **(10 hours)**
   - 3.1 S-plane to Z-plane mapping and Vice-versa.
   - 3.2 Stability analysis of closed loop systems in the Z-plane
   - 3.3 Discrete time equivalents of continuous time systems
   - 3.4 Discrete time equivalents of analog controllers
   - 3.5 Transient and steady state response analysis

4. Design and compensation of discrete time control system (10 hours)

4.1 Digital filters: structure, implementation, frequency response, applications

4.2 Control system controllers: structure, hardware/software features, responses to control signals, use of root locus and frequency domain concepts

4.3 Phase lead and phase lag compensator design for discrete time system

4.4 PID controller design and selection of parameters for discrete time system

5. Discrete time state equations (8 hours)

5.1 State space representation of discrete time systems

5.2 Discretization of the continuous time state space equation

5.3 Pulse transfer function matrix

5.4 Stability assessment from the discretized state space equations

Practical:

1. Study of relay type "ON-OFF" control system To familiarize the student about the feedback control system with an ON/OFF control
2. Z - transform using MATLAB To learn the application of MATLAB to convert the s-domain transfer function into z-domain
3. To study the affects in transient response and frequency response of different methods and sampling time used in z- Transfer function.
4. Stability analysis of closed –loop system in z-plane to learn the application of MATLAB to test the stability of a system in z-domain
5. Simulation study using Simulink of MATLAB To Familiarize with MATLAB Simulation To study simulation of discrete time control system
6. Position control system through analog interfacing To learn the use of analog interfacing technique to control the position of motor in the DC Motor module

References:

1. K. Ogata, "Discrete Time Control Systems", Prentice Hall, Englewood Cliffs, New Jersey.
2. Charles L. Phillips, "Digital Control System: Analysis and Design", Prentice Hall, Englewood Cliffs, New Jersey.bg

INDUSTRIAL ELECTRIFICATION

Year	**Third**	Teaching Schedule (Hours/week)	Lecture (Theory)	Practical	Tutorial
Semester	**Sixth**	Credit Hour	**4**	**-**	**-**
Course Code	BEG329EL	Lecture Hour	**4**	**2**	**0**

Examination System	Final		Internal Assessment		Total Marks	Remarks
	Theory	Practical	Theory	Practical		
Full Marks	**80**	**-**	**20**	**25**	**125**	
Pass Marks	**32**	**-**	**8**	**10**	**50**	
Duration	**3 Hours**	**-**	**3 Hours**	**-**	**-**	

Course Objective:
To provide detailed knowledge in design electrical distribution and illumination system, to understand relevant standards, rules and regulation system and to apply appropriate measures to evaluate and improve energy efficiency

1. Introduction **(6 hours)**
- 1.1 Electric Load Estimate
- 1.2 Load Centre
- 1.3 Supply System for Industrial Plant
- 1.4 Classification of Electrical Installation
- 1.5 Reading and Interpretation of Building Drawing
- 1.6 Electrical Rules related to Electrical Installation & Testing.

2. Earthing **(4 hours)**
- 2.1 Introduction
- 2.2 System & Equipment Earthing
  - 2.2.1 Point to be earthed
  - 2.2.2 Factors influencing the earth resistance
  - 2.2.3 Method of reducing earth resistance
- 2.3 Methods of Earthing
- 2.4 Lightning Protection Earthing

3. Power Carrying Devices **(6 hours)**
- 3.1 Cables
  - 3.1.1 Cable Construction
  - 3.1.2 Types of cables

3.1.3 Cable Ratings: voltage rating & Conductor size
3.1.4 Installation of cable
3.1.5 Locating cable faults
3.2 Connectors and Terminations
3.2.1 Types of connectors and Applications
3.2.2 Types of terminations and Methods
3.2.3 Splicing Devices and Techniques:
3.3 Bus-way
3.3.1 Bus-way Construction and Standards,
3.3.2 Types of Bus-way
3.3.3 Applications
3.3.4 Installation

4. Distribution Substation of Industrial Plant (6 hours)

4.1 Introduction
4.2 Classification
4.3 Indoor Substations
4.4 Out-door Substations
4.5 Selection and Location of site
4.6 Schematic Diagram of Distribution Substation
4.7 Equipment and Measuring Accessories for Substations and Switch gear Installation

5. Electrification of Industrial Building (5 hours)

5.1 Concept of Industrial Installation
5.2 General rules guidelines for wiring of Industry
5.3 Installation and positioning of equipments.
5.4 Principles of circuit design in power circuits.
5.5 Energy and power requirement for Lift, Conveyor-belt and HVAC
5.6 Procedures for designing the circuits and deciding the number of circuits.
5.7 Method of drawing single line diagram.
5.8 Selection of type of wiring and rating of wires & cables.
5.9 Load calculations and selection of size of conductor.
5.10 Selection of rating of main Panel Board and distributions board,
5.11 Protective switchgear Fuse, MCCB , MCB and accessories.

6. System Components for Industrial Illumination (6 hours)

6.1 Light Sources
6.1.1 Incandescent Filament Lamps
6.1.2 Fluorescent Lamps
6.1.3 High Intensity Discharge Lamps
6.1.4 LED Lamps
6.1.5 Types Luminaries
6.2 Types of Industrial Lighting Systems
6.2.1 Factory Lighting for Visual Tasks
6.2.2 Security Lighting
6.2.3 Emergency Lighting

7. Illuminating Design Principle (8 hours)

7.1 Basic Consideration for Illuminating Design
- 7.1.1 Space Function
- 7.1.2 Provision of Quality and Quantity of illumination
- 7.1.3 Selection of Lighting Systems, Sources, Luminaries, and Controls
- 7.1.4 Definitions of Terminology

7.2 Lumen Method of Lighting Computations
7.3 Point-to-point Lighting Computation
7.4 Design Procedures

8. Out-door Lighting Design (6 hours)

8.1 Introduction
8.2 Selection of Street Light Sources
8.3 Selection of Luminaries
8.4 Design Procedure of Street Lighting Scheme
8.5 Basic Floodlighting Effects
8.6 Selection of Floodlight Sources
8.7 Selection of Luminaries
8.8 Design Procedures
8.9 Application Guide: Buildings, color, Examples of flood lighting Installation.

9. Emergency and back-up Supply System for Industrial Plant (6 hours)

9.1 Battery Supply System
9.1.1 Battery Installation
9.1.2 Charging and Maintenance
9.2 Emergency Supply System
9.3 Uninterrupted Supply for Critical Load

10. Electrical Energy Audit in Industry (6 hours)

10.1 Introduction
10.2 Energy Audit Technique
10.3 Electricity Conservation Program
10.4 Distribution system
10.5 Load Management
10.6 Energy efficient motors
10.7 Energy efficient lighting system
10.8 Energy Saving Opportunity

Practical:

1. Introduction to wiring accessories such as – switches, socket, distribution board etc , protective devices such as – fuse, MCB, MCCB etc their construction, function and application.
2. Preparing Electrical Lay-out and details for commercial Complex or Industrial Building
3. Conducting Market Study and Collecting, informative brochures and Specification on various product available about electrical lamp, appliances and equipments
4. Design electrical Installation scheme for commercial complex or Industry. Draw detail wiring diagrams. Prepare report and Drawing sheets (Light circuit Design, Power circuit Design and Detail Design of Distribution System)

5. Study of different types of sources of light and make connections, and to measure intensity of light with lux-meter:
   a. Fluorescent lamp
   b. HP mercury vapor lamp
   c. HP sodium vapor lamp
   d. Compact Fluorescent lamp (CFL)
6. Using Power Analyzer measure electric parameters for energy auditing propose

References:

1. J.B. Gupta " Electrical Installation Estimating and Costing" S.K. Kataria& Sons, New Delhi
2. G.L. Wadhwa " Generation, Distribution and Utilization of Electrical Energy", New Age International (P) Limited, India
3. H.Pratab " Art & Science of Utilisation of Electrical Energy" Dhanpat Rai& Sons, New Delhi

SIGNAL ANALYSIS

Year	**Third**	Teaching Schedule (Hours/week)	Lecture (Theory)	Practical	Tutorial
Semester	**Sixth**	Credit Hour	**3**	**-**	**-**
Course Code	BEG332EC	Lecture Hour	**3**	**3/2**	**1**

Examination System	Final		Internal Assessment		Total Marks	Remarks
	Theory	Practical	Theory	Practical		
Full Marks	**80**	**-**	**20**	**25**	**125**	
Pass Marks	**32**	**-**	**8**	**10**	**50**	
Duration	**3 Hours**	**-**	**3 Hours**	**-**	**-**	

Course Objectives:
To provide understanding of basic concepts in signals and systems.

1. **Signal** **(4 hours)**
   Signal definition, continuous time signal, discrete time signal, basic signal types, energy signal, power signal, periodicity of continuous time signal, periodicity of discrete time signal, transformation of independent variable.

2. **Fourier series** **(9 hours)**
   Continuous time Fourier series representation, properties of continuous time Fourier series (linearity, time shift, frequency shift, time reversal, time scaling, conjugation conjugate symmetry, multiplication, convolution), Parseval's relation. Discrete time Fourier series representation, Properties of discrete time Fourier series (linearity, time shift, frequency shift, time reversal, conjugation and conjugate symmetry, multiplication, convolution), Parseval's relation.

3. **Fourier transform** **(12 hours)**
   Continuous time Fourier transform representation, properties of continuous time Fourier transform (linearity, time shift, frequency shift, time reversal, time scaling, duality, conjugation and conjugate symmetry, multiplication, convolution), Parseval's relation, Fourier transform of square wave function, impulse function, unit step function, rectangular function, signum function, cosine function, periodic function etc, energy spectral density, power spectral density. Discrete time Fourier transform representation, properties of discrete time Fourier transform (linearity, time shift, frequency shift, time reversal, conjugation and

conjugate symmetry, multiplication, convolution), Parseval's relation, Fourier transform of rectangular sequence, unit sample sequence, periodic sequence etc, discrete Fourier transform, properties of discrete Fourier transform.

4. Sampling (2 hours)

Ideal sampling, practical considerations in sampling, reconstruction of signal from its samples, aliasing.

5. Continuous time system (9 hours)

System definition, properties of system, Linear time invariant (LTI) system, convolution integral, properties of LTI system, frequency response of LTI system, bode plot, conditions for distortion less transmission, ideal low pass filter, impulse response and step response of ideal low pass filter, impulse response and frequency response of first order system and second order system.

6. Discrete time system (9 hours)

System definition, properties of system, Linear time invariant (LTI) system, convolution sum, properties of LTI system, difference equation, transfer function, frequency response of LTI system, bode plot, conditions for distortion less transmission, impulse response and frequency response of first order system and second order system.

References

1. Alan V. Oppenheim, Alan S. Willsky, S. Hamid "Signals and Systems", Prentice Hall
2. B. P. Lathi, "Linear systems and signals", Oxford University Press.

ENGINEERING ECONOMICS

Year	**Third**	Teaching Schedule (Hours/week)	Lecture (Theory)	Practical	Tutorial
Semester	**Sixth**	Credit Hour	**3**	**-**	**-**
Course Code	BEG395MS	Lecture Hour	**3**	**-**	**1**

Examination System	Final		Internal Assessment		Total Marks	Remarks
	Theory	Practical	Theory	Practical		
Full Marks	**80**	**-**	**20**	**-**	**100**	
Pass Marks	**32**	**-**	**8**	**-**	**40**	
Duration	**3 Hours**	**-**	**3 Hours**	**-**	**-**	

Course Objectives:

To provide concept and knowledge of economic studies that will be useful for the evaluation engineering projects and make decisions related to investment.

1. Introduction **(3 hours)**

1.1 Origin of Engineering Economy
1.2 Principles of Engineering Economy
1.3 Role of Engineers in Decision Making
1.4 Cash Flow Diagram

2. Interest and Time Value of Money **(6 hours)**

2.1 Introduction to Time Value of Money
2.2 Simple Interest
2.3 Compound Interest
    2.3.1 Nominal Interest Rate
    2.3.2 Effective Interest Rate
    2.3.3 Continuous Compounding
2.4 Economic Equivalence
2.5 Development of Interest Formulas
    2.5.1 The Five Types of Cash Flows
    2.5.2 Single Cash Flow Formulas
    2.5.3 Uneven Payment Series
    2.5.4 Equal Payment Series
    2.5.5 Linear Gradient Series.
    2.5.6 Geometric Gradient Series.

3. Basic Methodologies of Engineering Economic Analysis (8 hours)

3.1 Determining Minimum Attractive (Acceptable) Rate of Return (MARR).
3.2 Payback Period Method
3.3 Equivalent worth Methods
  3.3.1 Present worth Method
  3.3.2 Future worth Method
  3.3.3 Annual worth Method
3.4 Rate of Return Methods
  3.4.1 Internal Rate of Return Method.
  3.4.2 External/Modified Rate of Return Method
3.5 Public Sector Economic Analysis (Benefit Cost Ratio Method)
3.6 Introduction to Lifecycle Costing
3.7 Introduction to Financial and Economic Analysis

4. Comparative Analysis of Alternatives (6 hours)

4.1 Comparing Mutually Exclusive Alternatives having Same Useful Life by
  4.1.1 Payback Period Method and Equivalent Worth Method
  4.1.2 Rate of Return Methods and Benefit Cost Ratio Method
4.2 Comparing Mutually Exclusive Alternatives having Different Useful Lives by
  4.2.1 Repeatability Assumption
  4.2.2 Co-terminated Assumption
  4.2.3 Capitalized Worth Method
4.3 Comparing Mutually Exclusive, Contingent and Independent Projects in Combination

5. Replacement Analysis (6 hours)

5.1 Fundamentals of Replacement Analysis
  5.1.1 Basic Concepts and Terminology
  5.1.2 Approaches for Comparing Defender and Challenger
5.2 Economic Service Life of Challenger and Defender
5.3 Replacement Analysis When Required Service Life is long
  5.3.1 Required Assumptions and Decision Framework
  5.3.2 Replacement Analysis under the Infinite Planning Horizon
  5.3.3 Replacement Analysis under the Finite Planning Horizon

6. Risk Analysis (6 hours)

6.1 Origin/Sources of Project Risks
6.2 Methods of Describing Project Risks
  6.2.1 Sensitivity Analysis
  6.2.2 Breakeven Analysis
  6.2.3 Scenario Analysis
6.3 Probability Concept of Economic Analysis
6.4 Decision Tree and Sequential Investment Decisions

7. Depreciation and Corporate Income Taxes (6 hours)

7.1 Concept and Terminology of Depreciation
7.2 Basic Methods of Depreciation
  7.2.1 Straight line method
  7.2.2 Declining Balance Method

7.2.3 Sinking Fund Method
7.2.4 Sum of the Year Digit Method
7.2.5 Modified Accelerated Cost Recovery System (MACRS)
7.3 Introduction to Corporate Income Tax
7.4 After Tax Cash Flow Estimate
7.5 General Procedure for Making after Tax Economic Analysis

8. Inflation and its Impact on Project Cash Flows (4 hours)
8.1 Concept of Inflation
8.2 Measuring Inflation
8.3 Equivalence Calculation under Inflation
8.4 Impact of Inflation on Economic Evaluation

Tutorial:
1. Assignments
2. Quizzes and Case study

References:

1. Chan S.Park,"Contemporary Engineering Economics",,Prentice Hall, Inc.
2. E. Paul De Garmo, William G. Sullivan and James A. Bontadelli, "Engineering Economy", MC Milan Publishing Company.
3. James L. Riggs, David D. Bedworth and Sabah U. Randhawa,