ELECTRIC MACHINES-II

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

Course Objectives:
To impart knowledge on constructional details, operating principle and performance of 3-phase Synchronous Machines and Fractional Kilowatt Motors.

1. Three Phase Synchronous Generator (8 hours)
- 1.1 Constructional Details, Armature Windings, Types of Rotor, Exciter
- 1.2 Working Principle, Rotating Magnetic Field
- 1.3 EMF equation, distribution factor, pitch factor
- 1.4 Armature Reaction and its effects
- 1.5 Alternator with load and its phasor diagram
- 1.6 Voltage Regulations
- 1.7 Parallel Operation and Synchronization
- 1.8 Operation on infinite bus

2. Three Phase Synchronous Motor (7 hours)
- 2.1 Principle of operation
- 2.2 Starting methods
- 2.3 No load and Load operation, Phasor Diagram
- 2.4 Effect of Excitation and power factor control, V and Inverted V Curves
- 2.5 Hunting
- 2.6 Power angle Characteristics of Cylindrical Rotor Machine
- 2.7 Two reaction Model of Salient pole machine
- 2.8 Power Angle Characteristics of Salient Pole Machine

3. Fractional Kilowatt Motors (12 hours)
- 3.1 Single phase Induction Motors: Construction and Characteristics
- 3.2 Double Field Revolving Theory
- 3.3 Split phase Induction Motor
  - 1.1.1 Capacitor start motor
  - 1.1.2 Capacitors start and run motor
  - 1.1.3 Shaded pole motor
  - 1.1.4 Reluctance start motor
- 3.4 Single phase Synchronous Motor
  - 1.1.5 Reluctance motor
  - 1.1.6 Hysteresis motor
- 3.5 Universal motors
- 3.6 Special Purpose Machines: Stepper motor, Schrage motor and Servo motor

References:

1 I.J. Nagrath&D.P.Kothari," Electrical Machines", Tata McGraw Hill
2 S. K. Bhattacharya, "Electrical Machines", Tata McGraw Hill
3 Husain Ashfaq ," Electrical Machines", DhanpatRai& Sons
4 A.E. Fitzgerald, C.KingsleyJr and Stephen D. Umans,"Electric Machinery", Tata McGraw Hill
5 P. S. Bhimbra, "Electrical Machines"' Khanna Publishers
6 Irving L.Kosow, "Electric Machine and Tranformers", Prentice Hall of India.
7 M.G. Say, "The Performance and Design of AC machines", Pit man & Sons.
8 Bhag S. Guru and Huseyin R. Hizirogulu, "Electric Machinery and Transformers" OxfordUniversity Press, 2001.

Practical:
1. To study No-load characteristics of a 3-phase synchronous generator
2. To study load characteristics of synchronous generator with (a) resistive load (b) inductive load and (c) capacitive load
3. To study the effect of excitation on performance of a synchronous motor and to plot V- curve
4. To study the effect of a capacitor on the starting and running of a single-phaseinduction motor
5. To study the operating characteristics of universal motors

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

Chapter	Hours	Marks Distribution*
1	8	14
2	7	12
3	12	14
Total	27	40

* There could be a minor deviation in the marks distribution.

COMMUNICATION ENGLISH
SH….

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

Course Objectives

- To make the students capable of producing professional writings such as research articles, technical proposals, reports and project work.
- To familiarize the students with the native speakers' pronunciation with the use of audio-visual aids.

Unit I: Reading (15 hours)

1. **Intensive Reading** 8 hours
   - 1.1. Comprehension
   - 1.2. Note-taking
   - 1.3. Summary writing
   - 1.4. Contextual questions based on facts and imagination
   - 1.5. Interpreting text

2. **Extensive Reading** **5** hours
   - 2.1. Title/Topic Speculation
   - 2.2. Finding theme
   - 2.3. Sketching character

3. **Contextual Grammar** **2** hours
   - 3.1. Sequence of tense
   - 3.2. Voice
   - 3.3. Subject-Verb agreement
   - 3.4. Conditional Sentences
   - 3.5. Preposition

Unit II: Writing **(30** hours**)**

1. **Introduction to technical writing process** **2** hours
   - 1.1. Composing and editing strategies
   - 1.2. MLA and APA comparison

2. **Writing notices with agenda and minutes** **2** hours
   - 2.1. Introduction
   - 2.2. Purpose
   - 2.3. Process

3. **Writing Proposal** **6** hours
   - 3.1. Introduction
   - 3.2. Parts of the proposal
     - 3.2.1. Title page
     - 3.2.2. Abstract/Summary
     - 3.2.3. Statement of Problem
     - 3.2.4. Rationale
     - 3.2.5. Objectives
     - 3.2.6. Procedure/Methodology
     - 3.2.7. Cost estimate or Budget
     - 3.2.8. Time management/Schedule
     - 3.2.9. Summary
     - 3.2.10. Conclusion
     - 3.2.11. Evaluation or follow-up
     - 3.2.12. Works cited

4. **Reports**
   - 4.1. Informal Reports 6 hours
     - 4.1.1. Memo Report
       - 4.1.1.1. Introduction
       - 4.1.1.2. Parts
     - 4.1.2. Letter Report
       - 4.1.2.1. Introduction
       - 4.1.2.2. Parts
   - 4.2. Project/Field Report 3 hours
     - 4.2.1. Introduction
     - 4.2.2. Parts
   - 4.3. Formal report 9 hours
     - 4.3.1. Introduction
     - 4.3.2. Types of Formal Reports
       - 4.3.2.1. Progress Report
       - 4.3.2.2. Feasibility Report
       - 4.3.2.3. Empirical/ Research Report
       - 4.3.2.4. Technical Report
     - 4.3.3. Parts and Components of Formal Report
       - 4.3.3.1. Preliminary section
         - 4.3.3.1.1. Cover page
         - 4.3.3.1.2. Letter of transmittal/Preface
         - 4.3.3.1.3. Title page

4.3.3.1.4. Acknowledgements
4.3.3.1.5. Table of Contents
4.3.3.1.6. List of figures and tables
4.3.3.1.7. Abstract/Executive summary

4.3.3.2. Main Section
4.3.3.2.1. Introduction
4.3.3.2.2. Discussion/Body
4.3.3.2.3. Summary/Conclusion
4.3.3.2.4. Recommendations

4.3.3.3. 4.3.3.3 Documentation
4.3.3.3.1. Notes (Contextual/foot notes)
4.3.3.3.2. Bibliography
4.3.3.3.3. Appendix

5. **Writing Research Articles** 2 hours
   5.1. Introduction
   5.2. Procedures

References

1. Adhikari, Usha : Yadv, Rajkumar : Shrestha, Rup Narayan ; (2000) Communicative Skills in english,Research Training Unit, IOE, Pulchowk Campus
2. Khanal, Ramnath, (2008) Need-based Language Teaching (Analysis in Relation to Teaching of English for Profession Oriented Learners) Kathmandu : D, Khanal.
3. Konar, Nira (2010), Communication Skills for Professional PHI Learning Private Limited, New Delhi.
4. Kumar, Ranjit (2006), Research Methodology, Pearson Education.
5. Laxminarayan, K.R (2001), English for Technical Communication. Chennai; Scitech publications (India) Pvt. Ltd.
6. Mishra, Sunita et. al. (2004), Communication Skills for Engineers, Pearson Education First Indian print.
7. Prasad, P. et. al (2007), The functional Aspects of Communication Skills S.K. Kataria & sons.
8. Rutherfoord, Andrea J. Ph.D (2001), Basic Communication Skills for Technology, Pearson Education Asia.
9. Rizvi, M. Ashraf (2008), Effective Technical Communication. Tata Mc Graw Hill.
10. Reinking A James et. al (1999), Strategies for Successful Writing: A rhetoric, research guide, reader and handbook, Prentice Hall Upper Saddle River, New Jersey.
11. Sharma R.C. et al. (2009), Business Correspondence and Report Writing: A Practical Approach to Business and Technical communication. Tata Mc Graw Hill.
12. Sharma, Sangeeta et. al (2010) Communication skills for Engineers and Scientists, PHI Learning Private Limited, New Delhi.
13. Taylor, Shirley et. al. (2009), Model Business letters, E-mails & other Business documents, Pearson Education.

Language lab		30 hours
Listening		12 hours
Activity I	General instruction on effective listening, factors influencing listening, and note-taking to ensure ttention. (Equipment Required: Laptop, multimedia, laser pointer, overhead projector, power point, DVD, video set, screen)	2 hours
Activity II :	Listening to recorded authentic instruction followed by exercises. (Equipment Required: Cassette player or laptop)	2 hours
Activity III	Listening to recorded authentic description followed by exercises. (Equipment Required: Cassette player or laptop)	4 hours
Activity IV	Listening to recorded authentic conversation followed by exercises (Equipment Required: Cassette player or laptop)	4 hours
Speaking		18 hours
Activity I	General instruction on effective speaking ensuring audience's attention, comprehension and efficient use of Audio-visual aids. (Equipment Required: Laptop, multimedia, laser pointer, DVD, video, overhead projector, power point, screen)	2 hours
Activity II	Making students express their individual views on the assigned topics (Equipment Required: Microphone, movie camera)	2 hours
Activity III	Getting students to participate in group discussion on the assigned topics	4 hours
Activity IV	Making students deliver talk either individually or in group on the assigned topics (Equipment Required: Overhead projector,	8 hours

	microphone, power point, laser pointer multimedia, video camera, screen)	
Activity V	Getting students to present their brief oral reports individually on the topics of their choice. (Equipment Required: Overhead projector, microphone, power point, laser pointer multimedia, video camera, screen)	2 hours

Evaluation Scheme:

Unit	Testing Items	Number of Questions	Marks Distribution*
I	Reading Passages	3	15
	Novel	1	5
	Novel	1	5
	Grammar	10 or 5	5
II	Composing & Editing strategies	1	5
	MLA and APA Comparison	1	4
	Writing Research Articles	1	10
	Writing notice, Agenda and minutes	1	5
	Writing Proposal	1	8
	I Writing Reports (Formal Report)	1	10
	II Writing short reports or Project Report	1	8
		Total	80

- **There may be minor Variation in marks distribution**

Language Lab

Title	Testing Items	Number of Questions	Marks Distribution
Language Lab	**Listening** - Instruction - Description - Conversation	3	10
	Speaking - Expressing Individual views - Group/Round Table discussion - Talk delivery - Presenting brief oral report	3	15

PROBABILITY AND STATISTICS

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

Course Objective:
To provide the students with particle knowledge of the principles and concept of probability and statistics and their application in engineering field.

1. Descriptive statistics and Basic probability (6 hours)
- 1.1. Introduction to statistics and its importance in engineering
- 1.2. Describing data with graphs (bar, pie, line diagram, box plot)
- 1.3. Describing data with numerical measure(Measuring center, Measuring variability)
- 1.4. Basic probability, additive Law, Multiplicative law, Baye's theorem.

2. Discrete Probability Distributions (6 hours)
- 2.1. Discrete random variable
- 2.2. Binomial Probability distribution
- 2.3. Negative Binomial distribution
- 2.4. Poison distribution
- 2.5. Hyper geometric distribution

3. Continuous Probability Distributions (6 hours)
- 3.1. Continuous random variable and probability densities
- 3.2. Normal distribution
- 3.3. Gama distribution
- 3.4. Chi square distribution

4. Sampling Distribution (5 hours)
- 4.1. Population and sample
- 4.2. Central limit theorem
- 4.3. Sampling distribution of sample mean
- 4.4. Sampling distribution of sampling proportion

5. Correlation and Regression (6 hours)
- 5.1. Least square method
- 5.2. An analysis of variance of Linear Regression model
- 5.3. Inference concerning Least square method
- 5.4. Multiple correlation and regression

6. Inference Concerning Mean (6 hours)
- 6.1. Point estimation and interval estimation
- 6.2. Test of Hypothesis
- 6.3. Hypothesis test concerning One mean
- 6.4. Hypothesis test concerning two mean
- 6.5. One way ANOVA

7. Inference concerning Proportion (6 hours)
- 7.1. Estimation of Proportions
- 7.2. Hypothesis concerning one proportion
- 7.3. Hypothesis concerning two proportion
- 7.4. Chi square test of Independence

9. Application of computer on statistical data computing (4 hours)
- 8.1 Application of computer in computing statistical problem. *eq* scientific calculator, EXCEL, SPSS , Matlab etc

References:

1. Richard A. Johnson, "Probability and Statistics for Engineers 7th edition", Miller and Freund's publication
2. Jay L. Devore, " Probability and Statistics for Engineering and the Sciences" ,Brooks/Cole publishing Company, Monterey, California,1982
3. Richard I. Levin, David S Rubin, " Statistics For Management", Prentice Hall publication
4. Mendenhall Beaver Beaver, " Introduction Probability and statistics 12th edition ", Thomson Brooks/Cole

Evaluation scheme:

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

Chapters	Hours	Mark distribution *
1	6	12
2	6	10
3	6	10
4	5	10
5	6	10
6	6	10
7	6	10
8	4	8
Total	**45**	**80**

*There may be minor deviation in marks distribution.

CONTROL SYSTEM
EG……

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

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

1. Control System Background (2 hours)
- 1.1. History of control system and its importance
- 1.2. Control system: Characteristics and Basic features
- 1.3. Types of control system and their comparison

2. Component Modeling (6 hours)
- 2.1. Differential equation and transfer function notations
- 2.2. Modeling of Mechanical Components: Mass, spring and damper
- 2.3. Modeling of Electrical components: Inductance, Capacitance, Resistance, DC and AC motor, Transducers and operational amplifiers
- 2.4. Electric circuit analogies (force-voltage analogy and force- current analogy)
- 2.5. Linearized approximations of non-linear characteristics

3. System Transfer Function and Responses (6 hours)
- 3.1. Combinations of components to physical systems
- 3.2. Block diagram algebra and system reduction
- 3.3. Signal flow graphs
- 3.4. Time response analysis:
  - 3.4.1. Types of test signals (Impulse, step, ramp, parabolic)
  - 3.4.2. Time response analysis of first order system
  - 3.4.3. Time response analysis of second order system
  - 3.4.4. Transient response characteristics
- 3.5. Effect of feedback on steady state gain, bandwidth, error magnitude and system dynamics

4. Stability (4 hours)
- 4.1. Introduction of stability and causes of instability
- 4.2. Characteristic equation, root location and stability
- 4.3. Setting loop gain using Routh-Hurwitz criterion
- 4.4. R-H stability criterion
- 4.5. Relative stability from complex plane axis shifting

5. Root Locus Technique (6 hours)
- 5.1. Introduction of root locus
- 5.2. Relationship between root loci and time response of systems
- 5.3. Rules for manual calculation and construction of root locus
- 5.4. Analysis and design using root locus concept
- 5.5. Stability analysis using R-H criteria

6. Frequency Response Techniques (6 hours)
- 6.1. Frequency domain characterization of the system
- 6.2. Relationship between real and complex frequency response
- 6.3. Bode Plots: Magnitude and phase
- 6.4. Effects of gain and time constant on Bode diagram
- 6.5. Stability from Bode diagram (gain margin and phase margin)
- 6.6. Polar Plot and Nyquist Plot
- 6.7. Stability analysis from Polar and Nyquist plot

7. Performance Specifications and Compensation Design (10 hours)
- 7.1. Time domain specification
  - 7.1.1. Rise time, Peak time, Delay time, settling time and maximum overshoot
  - 7.1.2. Static error co-efficient
- 7.2. Frequency domain specification
  - 1.1.1 Gain margin and phase margin
- 7.3. Application of Root locus and frequency response on control system design
- 7.4. Lead, Lag cascade compensation design by Root locus method.
- 7.5. Lead, Lag cascade compensation design by Bode plot method.
- 7.6. PID controllers

8. State Space Analysis (4 hours)
- 8.1. Definition of state -space

8.2. State space representation of electrical and mechanical system
8.3. Conversion from state space to a transfer function.
8.4. Conversion from transfer function to state space.
8.5. State-transition matrix.

Practical:

1. To study open loop and closed mode for d.c motor and familiarization with different components in D.C motor control module.
2. To determine gain and transfer function of different control system components.
3. To study effects of feedback on gain and time constant for closed loop speed control system and position control system.
4. To determine frequency response of first order and second order system and to get transfer function.
5. Simulation of closed loop speed control system and position control system and verification

References:

1. Ogata, K., "Modern Control Engineering", Prentice Hall, Latest Edition
2. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, Latest Edition.
3. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition.
4. Nagrath & Gopal, "Modern Control Engineering", New Ages International, Latest Edition

Evaluation Scheme:

Chapter	Hours	Marks Distribution*
1	2	4
2	6	12
3	6	10
4	4	8
5	6	12
6	6	10
7	10	16
8	4	8
Total	44	80

* There could be minor deviation in the marks distribution.

INSTRUMENTATION II

EX

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

Course Objective:

- Continuation of INSTRUMENTATION I with emphasis on advance system design and case studies.
- To introduce and apply the knowledge of microprocessor, A/D, D/A converter to design Instrumentation system.
- To provide the concept on interfacing with microprocessor based system and circuit design techniques.

1. Microprocessor Based Instrumentation System (4 hours)

1.1. Basic Features of Microprocessor Based System
1.2. Open Loop and Closed Loop Microprocessor Based System
1.3. Benefits of Microprocessor Based System
1.4. Microcomputer on Instrumentation Design
1.5. Interfacing With Microprocessor
  1.5.1. PC Interfacing Techniques
  1.5.2. Review of Address Decoding
  1.5.3. Memory Interfacing
  1.5.4. Programmed I/O, Interrupt Driven I/O and Direct Memory Access (DMA)

2. Parallel Interfacing With Microprocessor Based System (4 hours)

2.1. Methods of Parallel Data Transfer : Simple Input and Output, Strobe I/O, Single Handshake I/O, & Double Handshake I/O
2.2. 8255 as General Purpose Programmable I/O Device and its interfacing examples
2.3. Parallel Interfacing with ISA and PCI bus

3. Serial Interfacing With Microprocessor Based System (6 hours)

3.1. Advantages of Serial Data Transfer Over Parallel
3.2. Synchronous and Asynchronous Data Transfer
3.3. Errors in Serial Data Transfer
3.4. Simplex, Half Duplex and Full Duplex Data Communication
3.5. Parity and Baud Rates
3.6. Introduction Serial Standards RS232, RS423, RS422
3.7. Universal Serial Bus
  3.7.1. The Standards: - USB 1.1 and USB 2.0
  3.7.2. Signals, Throughput & Protocol
  3.7.3. Devices, Hosts And On-The-Go
  3.7.4. Interface Chips:- USB Device And USB Host

4. Interfacing A/D And D/A Converters (4 hours)

4.1. Introduction
4.2. General Terms Involved in A/D and D/A Converters
4.3. Examples of A/D and D/A Interfacing
4.4. Selection of A/D and D/A Converters Based on Design Requirements

5. Data Acquisition And Transmission (5 hours)

5.1. Analog and Digital Transmission
5.2. Transmission Schemes
  5.2.1. Fiber Optics
  5.2.2. Satellite
  5.2.3. Bluetooth Devices
5.3. Data Acquisition System
  5.3.1. Data Loggers
  5.3.2. Data Archiving and Storage

6. Grounding And Shielding (3 hours)

6.1. Outline for Grounding and Shielding
6.2. Noise, Noise Coupling Mechanism and Prevention
6.3. Single Point Grounding and Ground Loop
6.4. Filtering and Smoothing
6.5. Decoupling Capacitors and Ferrite Beads
6.6. Line Filters, Isolators and Transient Suppressors
6.7. Different Kinds of Shielding Mechanism
6.8. Protecting Against Electrostatic Discharge
6.9. General Rules For Design

7. Circuit Design (3 hours)

7.1. Converting Requirements into Design
7.2. Reliability and Fault Tolerance
7.3. High Speed Design
  7.3.1. Bandwidth, Decoupling, Ground Bounce, Crosstalk, Impedance Matching, and Timing
7.4. Low Power Design
7.5. Reset and Power Failure Detection and interface Unit

8. Circuit Layout (3 hours)

8.1. Circuits Boards and PCBs
8.2. Component Placement
8.3. Routing Signal Tracks
8.3.1. Trace Density, Common Impedance, Distribution of Signals and Return, Transmission Line Concerns, Trace Impedance and Matching, and Avoiding Crosstalk.
8.4. Ground ,Returns and Shields
8.5. Cables and Connectors
8.6. Testing and Maintenance

9. Software For Instrumentation And Control Applications (4 hours)

9.1. Types of Software, Selection and Purchase
9.2. Software Models and Their Limitations
9.3. Software Reliability
9.4. Fault Tolerance
9.5. Software Bugs and Testing
9.6. Good Programming Practice
9.7. User Interface
9.8. Embedded and Real Time Software

10. Case Study (9 hours)

Examples chosen from local industrial situations with particular attention paid to the basic measurement requirements, accuracy, and specific hardware employed environmental conditions under which the instruments must operate, signal processing and transmission, output devices:

a) Instrumentation for a power station including all electrical and non-electrical parameters.
b) Instrumentation for a wire and cable manufacturing and bottling plant.
c) Instrumentation for a beverage manufacturing and bottling plant.
d) Instrumentation for a complete textile plant; for example, a cotton mill from raw cotton through to finished dyed fabric.
e) Instrumentation for a process; for example, an oil seed processing plant from raw seeds through to packaged edible oil product.
f) Instruments required for a biomedical application such as a medical clinic or hospital.
g) Other industries can be selected with the consent of the Subject teacher.

Practical:

The laboratory exercises deal interfacing techniques using microprocessor or microcontrollers. There will be about six lab sessions which should cover at least following:

1. Simple and Handshake data transfer using PPI.
2. Basic I/O device interfacing like keyboard, seven segments, motors etc
3. Analog to Digital interfacing
4. Digital to Analog interfacing
5. Design exercise (small group project)

Study in detail the instrumentation requirements of a particular proposed or existing industrial plant and design an instrumentation and data collection system for that particular industrial plant. The final report should present the instrumentation requirements in terms of engineering specifications, the hardware solution suggested, a listing of the particular devices chosen to satisfy the requirements, appropriate system flow diagrams, wiring diagrams, etc. to show how the system would be connected and operated.

References:

- D. V. Hall, "*Microprocessor and Interfacing, Programming and Hardware*" Revised 2nd Edition 2006, Tata McGraw Hill
- K.R. Fowler, "*Electronic Instrument Design: Architecting for the Life Cycle*", Oxford University Press, Inc. 1996
- Ramesh S. Gaonkar, "*Microprocessor Architecture, Programming and Application with 8085*", 5th Edition 2002, Prentice Hall
- A.K. Ray & K.M. Bhurchandi, **"***Advanced Microprocessors And Peripherals*", 2nd Edition 2006, Tata McGraw Hill
- E.O. Duebelin, "*Measurement System Application And Design*",5th Edition, Tata McGraw Hills
- John Hyde, "*USB Design By Example*", Intel Press
- PCI bus, USB, 8255,Bluetooth datasheets
- D. M. Consodine, "*Process Instruments and Controls Handbook*", 3rd Edition, McGraw-Hill,New York, 1985.
- S. Wolf and R. F. Smith, "*Student Reference Manual for Electronic Instrumentation Laboratories*", Prentice Hall, Englewood Cliffs, New Jersey, 1990.
- S. E. Derenzo, "*Interfacing: A Laboratory Approach Using the Microcomputer for Instrumentation, Data Analysis, and Control*", Prentice Hall, Englewood Cliffs, New Jersey, 1990.

Evaluation Scheme:

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

Chapter	Hour	Marks Distribution*
1	4	6
2	4	6
3	6	12
4	4	8
5	5	8
6	3	6
7	3	6
8	3	4
9	4	8
10	9	16
Total	45	80

* There could be minor deviation in the marks distribution.

POWER SYSTEM ANALYSIS -II

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

Course Objective:
The course aim to deliver the advance analysis of the interconnected power system including load flow, short circuit studies and stability analysis.

1. Interconnected Power System [6 hours]
- 1.1. Introduction
- 1.2. Real power/ frequency balance
- 1.3. Reactive power/ voltage balance
- 1.4. Node equations
- 1.5. Bus admittance matrixes
- 1.6. Applications of Bus admittance matrixes in Network analysis
- 1.7. Basic concept of Bus impedance Matrixes

2. Load Flow Analysis [8 hours]
- 2.1. Basic complex power flow equations for a power system networks
- 2.2. Data for Load flow studies
- 2.3. Iterative approaches for solving power flow equations
  - 2.3.1. Gauss-Seidal method
  - 2.3.2. Newton- Rapshon methods
- 2.4. Introduction to advance techniques e.g. decoupled load flow
- 2.5. Voltage profile and var compensation

3. Power system fault calculation [4 hours]
- 3.1. Definition and purpose of fault calculation
- 3.2. Types of faults in power system
- 3.3. Symmetrical fault calculations
- 3.4. Calculation of short circuit MVA

4. Unbalance System Analysis [6 hours]
- 4.1. Symmetrical components
- 4.2. Sequence impedances
- 4.3. Sequence components of the voltages and currents
- 4.4. Expression for power in terms of symmetrical components
- 4.5. Transformer voltages and currents

5. Unsymmetrical faults on Power Systems [10 hours]
- 5.1. Sequence networks of synchronous generators
- 5.2. Fault calculations of a single synchronous generator
  - 5.2.1. Line to ground faults
  - 5.2.2. Line to line faults
  - 5.2.3. Double line to ground faults
- 5.3. Path for zero sequence currents in Transformers
- 5.4. Fault calculations on a power system networks
  - 5.4.1. Line to ground faults
  - 5.4.2. Line to line faults
  - 5.4.3. Double line to ground faults

6. Power System Stability [10 hours]
- 6.1. Operational power balance in a synchronous generator
- 6.2. Classification of power system stability
- 6.3. Swing equation & swing curve for a single machine infinite bus system
- 6.4. Rotor angle stability; steady state, dynamic & transient stability
- 6.5. Equal area criterion
- 6.6. Stability enhancement techniques
- 6.7. Step by step method for solving swing equations by computer methods
- 6.8. Basic concept of voltage stability

References:

1. Power System Analysis by W.D. Stevension, Tata McGraw Hill Publications
2. Power System Stability and Control by P. Kundur
3. Modern Power System Analysis by I.J Nagrath and D.P Kothari, Tata McGraw Hill Publications

Evaluation Scheme:

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

Chapter	Hour	Marks Distribution *
1	6	10
2	8	16
3	4	8
4	6	10
5	10	16
6	10	20
Total	42	80

*There could be a minor deviation in Marks distribution

ELECTRIC MACHINE DESIGN
……EE

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

Course Objective:
To impart knowledge on the principle of design of electrical machines like transformers, induction machines and DC machine

1. **Materials used in electrical equipment** **(5 hours)**
   - 1.1. Review of electrical conducting materials
     - 1.1.1 Various characteristics and comparison between conducting materials
     - 1.1.2 Materials of high conductivity and high resistivity
   - 1.2 Magnetic materials
     - 1.2.1 Classification ,characteristics and application of magnetic materials
     - 1.2.2 Materials for steady flux (solid core materials), materials for pulsating fluxes (laminated core materials sheet)
     - 1.2.3 Special purpose alloys ,hot rolled and cold rolled steel sheets, sintered power core
     - 1.2.4 Magnetic materials used in transformers, dc machines and ac machines
   - 1.3 Insulating materials
     - 1.3.1 Classification ,characteristics ,application
     - 1.3.2 Insulating materials for transformers, dc machines and ac machines, ceramics

2. Heating and cooling of electric machine **(7 hours)**
- 2.1 Review of heat transfer: Conduction, convection and radiation
- 2.2 Internal temperature (hot spots and their calculations)
- 2.3 Temperature gradients in iron core
- 2.4 Temperature gradients in conductors placed in slots
- 2.5 Ventilation of electrical machine
  - 2.5.1 Types of enclosure, methods of cooling, schemes of ventilation
  - 2.5.2 Cooling of totally enclosed machines ,cooling circuits ,cooling systems
- 2.6 Temperature rise, heating time constant, final steady temperature rise, cooling time constant
- 2.7 Rating of electric machine based on temperature rise
- 2.8 Calculation of temperature rise in armature, field coils and commutators

3. Transformer Design **(13 hours)**
- 3.1 Review of transformer theory
- 3.2 Types of transformer : Power transformer, distribution transformer, core type and shell type
- 3.3 Design approach
  - 3.3.1 Output equations (single and three phase), Volt per turn
  - 3.3.2 Design of core(square core, stepped and cruciform core)
  - 3.3.3 Choice of flux density
  - 3.3.4 Design of winding and choice of current density
  - 3.3.5 Design of insulation
  - 3.3.6 Design of window and window space factor
  - 3.3.7 Design of yoke
- 3.4 Calculation of operating characteristics from design data
  - 3.4.1 Resistance of winding, leakage reactance of winding in core type transformer, iron loss, copper loss, efficiency, regulation.
- 3.5 Design of cooling system
  - 3.5.1 Temperature rise in plain walled tank, design of tank and tubes

4. Three phase induction motor design **(10 hours)**
- 4.1 Review of three phase induction motor theory
  - 4.1.1 Construction and principle of three phase induction motor
  - 4.1.2 Various types of three phase stator winding
- 4.2 Design approach:
  - 4.2.1 Output equation, choice of magnetic and electric loading
  - 4.2.2 Choice of stator winding. stator slots and insulation, stator teeth , stator teeth, stator core and stator stamping dimension
  - 4.2.3 Air gap length, rotor design (squirrel cage and slip ring type)
  - 4.2.4 Leakage inductance, evaluation of equivalent circuit parameters and operating characteristics from design data.

5. DC Machine Design **(9 hours)**
- 5.1 Armature Winding
  - 5.1.1 Lap and wave winding

5.2 Design Approach :

5.2.1 Output equation, choice of average gap density, choice of ampere conductors per meter

5.2.2 Choice of no of poles in DC machine, pole proportions

5.2.3 Selection of length of air gap

5.2.4 Choice of armature windings, no of armature conductors, no of coils, no of armature slots, armature conductor selection

5.2.5 Design of commutator , design of brushes, design of compensating winding

5.2.6 Evaluation of operating characteristics from design data

Practical

1. A detail design of core type power and distribution transformer
   - orthographic drawing of transformer including winding, tank and tubes
2. A detail design of three phase induction motor
   - Drawing of three phase stator winding (Mush winding, Lap winding and Wave winding)
3. A detail design of DC armature winding
   - Drawing of Lap and wave winding used in DC machine armature

References

1. A.K. Sawhney " A course in Electrical Machine Design"
2. M.G. Say " Performance and design of AC Machines"
3. M.G. Say "Performance and design of DC Machines"

Evaluation Scheme:

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

Chapters	Hours	Marks distribution*
1	5	10
2	7	12
3	13	24
4	10	18
5	9	16
Total	44	80

* There could be minor deviation in marks distribution

ENGINEERING ECONOMICS
CE

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

Course Objective:
After completing this course, students will be able to conduct simple economic studies. They will also be able to make evaluation of 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 Cashflows. [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

Tutorials:

1. Assignments,
2. Quizzes and 1 Case study.

References:

1. Chan S. Park, *Contemporary Engineering Economics,* Prentice Hall, Inc.
2. E. Paul De Garmo, William G. Sullivan and James A. Bonta delli, *Engineering Economy,* MC Milan Publishing Company.
3. James L. Riggs, David D. Bedworth and Sabah U. Randhawa, *Engineering Economics,* Tata MCGraw Hill Education Private Limited.

Evaluation Scheme:

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

Chapters	Hours	Marks Distribution *
1	4	4
2	8	8
3	12	16
4	8	12
5	8	12
6	8	12
7	8	12
8	4	4
Total	60	80

*There may be minor variation in marks distribution.

DIGITAL CONTROL SYSTEM
EG……

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

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 [8 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 MATLB
   - To learn the application of MATLAB to convert the s-domain transfer function into z-domain
   - To study the affects in transient response and frequency response of different methods and sampling time used in z- Transfer function.
3. 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
4. Simulation study using simulink of MATLAB
   - To Familiarize with MATLAB Simulation
   - To study simulation of discrete time control system
5. 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.

Evaluation Scheme:

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

Chapter	Hours	Mark distribution*
1	8	12
2	8	16
3	10	20
4	10	20
5	8	12
Total	44	80

* There could be minor deviation in the marks distribution.

Signal Analysis

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

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), Parsevals 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.

Evaluation Scheme
Marks distribution for all the chapters in the syllabus is shown in the table below.

Chapters	Hours	Mark distribution*
1	4	8
2	9	14
3	12	22
4	2	6
5	9	15
6	9	15
Total	45	80

* There could be minor deviation in the marks distribution.

Switchgear and Protection
……EE

Lecture : 4 **Year : III**
Tutorial : 1 **Part : II**
Practical : 3/2

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

1. Principle of power system protection (3 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 (3 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 (12hours)
- 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
7.12. Universal relay torque equation
7.13. Distance protection
  7.13.1. Impedance, reactance and mho relay
  7.13.2. Application of distance protection relay in sectionalized feeder
7.14. Carrier current protection
7.15. 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 volatge/under voltage realy
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 realying”
3. J.B Gupta “Switchgear and protection” Kataria and Sons

Evaluation Scheme:

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

Chapters	Hours	Marks distribution*
1	3	4
2	3	4
3	4	6
4	4	6
5	6	8
6	12	16
7	14	20
8	12	16
Total	58	80

* There could be minor deviation in marks distribution

INDUSTRIAL POWER DISTRIBUTION AND ILLUMINATION
EE …..

Lecture : 4 **Year : III**
Tutorial : 0 **Part : II**
Practical : 2

Course Objective:
After completion of the course, the student will be able to:
- Have detailed knowledge in design electrical distribution and illumination system
- Understand relevant standards, rules and regulation system
- 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. Introducton
- 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 Lumineries
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 vapour lamp
   c. HP sodium vapour 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

Evaluation Scheme:

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

Chapter	Hours	Marks Distribution*
1	6	8
2	4	4
3	6	8
4	6	8
5	6	8
6	6	8
7	8	12
8	6	8
9	6	8
10	6	8
Total	60	80

*There may be minor deviation in marks distribution.

HYDROPOWER
EG……CE-

Lecture : 3 **Year : III**
Tutorial : 1 **Part : II**
Practical : 1.5

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 flows

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 pondage, 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 : Lay out and Design Criteria

5.4. Forebay and surge tanks: Layout and Design criteria

5.5. Penstock Liners: Lay out 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. Occurance 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 governers
7.4. Power House: Classification and dimensions of Power House.

Praticals

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, 2009
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

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	Mark distribution*
1	14	28
2	5	6
3	5	8
4	5	8
5	6	10
6	3	6
7	7	14
Total	45	80

* There may be minor variation in marks distribution