

**Mgm-321 BUSINESS COMMUNICATION**

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**Total contact hours**

Theory 32 Hrs.

**Prerequisites:** The students shall already be familiar with the language concerned.

**AIMS** The course has been designed to enable the students to.

1. Develop communication skills.
2. Understand basic principles of good and effective business writing in commercial and industrial fields.
3. Develop knowledge and skill to write technical report with confidence and accuracy.

**COURSE CONTENTS**

- 1. COMMUNICATION PROCESS. 6 Hours**
  - 1.1 Purposes of communication
  - 1.2 Communication process
  - 1.3 Distortions in communication
  - 1.4 Consolidation of communique
  - 1.5 Communication flow
  - 1.6 Communication for self development
- 2. ORAL COMMUNICATION SKILLS. 6 Hours**
  - 2.1 Significance of speaking.
  - 2.2 Verbal and non-verbal messages.
  - 2.3 Strategic steps of speaking.
  - 2.4 Characteristics of effective oral messages.
  - 2.5 Communication Trafficking.
  - 2.6 Oral presentation.
- 3. QUESTIONING SKILLS. 3 Hours**
  - 3.1 Nature of question.
  - 3.2 Types of questions.
  - 3.3 Characteristics of a good question.
  - 3.4 Questioning strategy
- 4. LISTENING SKILLS. 5 Hours**
  - 4.1 Principles of active listening.
  - 4.2 Skills of active listening.
  - 4.3 Barriers to listening.
  - 4.4 Reasons of poor listening.

- 4.5 Giving Feedback.
- 5. INTERVIEWING SKILLS. 3 Hours**
- 5.1 Significance of interviews.
- 5.2 Characteristics of interviews.
- 5.3 Activities in an interviewing situation
- 5.4 Types of interviews.
- 5.5 Interviewing strategy.
- 6. REPORT WRITING. 3 Hours**
- 6.1 Goals of report writing
- 6.2 Report format.
- 6.3 Types of reports.
- 6.4 Report writing strategy.
- 7. READING COMPREHENSION. 2 Hours**
- 7.1 Reading problems.
- 7.2 Four Reading skills.
- 8. GROUP COMMUNICATION. 4 Hours**
- 8.1 Purposes of conducting meetings.
- 8.2 Planning a meeting.
- 8.3 Types of meetings.
- 8.4 Selection f a group for meeting.
- 8.5 Group leadership skills.
- 8.6 Running a successful meeting.
- 8.7 Active participation techniques.

### **RECOMMENDED BOOKS**

1. Sh. Ata-ur-Rehman Effective Business Communication & Report Writing.
2. Ulman J.N. Could JR. Technical Reporting.

**Mgm-321 BUSINESS COMMUNICATION.**

**INSTRUCTIONAL OBJECTIVES**

1. **UNDERSTAND THE COMMUNICATION PROCESS.**
  - 1.1 State the benefits of two way communication.
  - 1.2 Describe a model of communication process.
  - 1.3 Explain the major communication methods used in organization.
  - 1.4 Identify the barriers to communication and methods of overcoming these barriers.
  - 1.5 Identify misconceptions about communication.
  
2. **UNDERSTAND THE PROCESS OF ORAL.**
  - 2.1 Identify speaking situations with other peoples.
  - 2.2 Identify the strategy steps of speaking.
  - 2.3 Identify the characteristics of effective speaking.
  - 2.4 State the principles of one-way communication.
  - 2.5 State the principles of two-way communication.
  - 2.6 Identify the elements of oral presentation skills.
  - 2.7 Determine the impact of non-verbal communication on oral communication.
  
3. **DETERMINE THE USES OF QUESTIONING SKILLS TO GATHER AND CLARIFY INFORMATION IN THE ORAL COMMUNICATION PROCESS.**
  - 3.1 Identify different types of questions.
  - 3.2 Determine the purpose of each type of question and its application.
  - 3.3 Identify the hazards to be avoided when asking questions.
  - 3.4 Demonstrate questioning skills.
  
4. **DEMONSTRATE THE USE OF ACTIVE LISTENING SKILL IN THE ORAL COMMUNICATION PROCESS.**
  - 4.1 State the principles of active listening.
  - 4.2 Identify skills of active listening.
  - 4.3 Identify barriers to active listening.
  - 4.4 State the benefits of active listening.
  - 4.5 Demonstrate listening skills.
  - 4.6 Explain the importance of giving and receiving feed back.
  
5. **Determine the appropriate interview type for the specific work-related situation and conduct a work-related interview.**
  - 5.1 State the significance of interviews.
  - 5.2 State the characteristics of interviews.
  - 5.3 Explain the activities in an interviewing situation.
  - 5.4 Describe the types of interviews.
  - 5.5 Explain the interviewing strategy.

5.6 Prepare instrument for a structured interview.

**6. PREPARE A REPORT OUT-LINE, BASED ON SUBJECT MATTER AND AUDIENCE.**

- 6.1 Identify the different types of reports.
- 6.2 Determine when to use an informal or formal report presentation.
- 6.3 Identify the stages of planning a report.
- 6.4 Identify the parts of a report and choose the parts appropriate for each type of report.
- 6.5 Draft a report outline.

**7. DEMONSTRATE READING COMPREHENSION.**

- 7.1 Identify major reading problems.
- 7.2 Identify basic reading skills.
- 7.3 State methods of previewing written material.
- 7.4 Identify methods of concentration when reading.
- 7.5 Demonstrate reading comprehension.

**8. UNDERSTAND THE PRINCIPLES OF GROUP COMMUNICATIONS.**

- 8.1 State the purpose and characteristics of major types of meeting.
- 8.2 Explain responsibilities of a meeting/committee.
- 8.3 Identify problems likely to be faced at meeting and means to overcome these problems.
- 8.4 Distinguish between content and process at meetings.
- 8.5 Explain the key characteristics of a good group facilitator.

**Mgm-311 INDUSTRIAL MANAGEMENT AND HUMAN RELATIONS.**

**Total Contact Hours**

Theory	32	T P C
Practical	0	1 0 1

**AIMS** The study of this subject will enable the student to develop the management skill, acquaint him with the principles of management and human relations and develop psychological approach to solve the labour problems.

**COURSE CONTENTS**

- 1. INDUSTRIAL PSYCHOLOGY. 2 Hours**
  - 1.1 History and definition.
  - 1.2 Nature and scope.
  
- 2. LEADERSHIP 1 Hour**
  - 2.1 Definition and types.
  - 2.3 Qualities of a good leader.
  
- 3. MOTIVATION 2 Hours**
  - 3.1 Definition.
  - 3.2 Types (Financial and non financial motives).
  - 3.3 Conflict of motives.
  
- 4. MORALE 1 Hour**
  - 4.1 Importance.
  - 4.2 Development.
  - 4.3 Measurement.
  
- 5. HUMAN ENGINEERING. 1 Hour**
  - 5.1 Importance of human factor in industry.
  - 5.2 Man-machine system.
  - 5.3 Strategy for making allocation decisions.
  
- 6. INDUSTRIAL FATIGUE AND BOREDOM. 2 Hours**
  - 6.1 Definition and distinction.
  - 6.2 Psychological causes.
  - 6.3 Objective causes.
  - 6.4 Prevention
  
- 7. INDUSTRIAL ACCIDENTS 2 Hours**
  - 7.1 Psychological causes.

7.2	Objective causes.	
7.3	Prevention	
<b>8.</b>	<b>INDUSTRIAL PREJUDICE</b>	<b>2 Hours</b>
8.1	Causes	
8.2	Remedies	
<b>9.</b>	<b>PUBLIC RELATIONS.</b>	<b>2 Hours</b>
9.1	Importance	
9.2	Functions	
<b>10.</b>	<b>GUIDANCE AND COUNSELLING</b>	<b>2 Hours</b>
10.1	Importance	
10.2	Choice of job.	
10.3	During service.	
<b>11.</b>	<b>JOB EVALUATION</b>	<b>2 Hours</b>
11.1	Importance	
11.2	Methods	
11.3	Job satisfaction	
11.4	Work simplification.	
<b>12.</b>	<b>INDUSTRIAL MANAGEMENT</b>	<b>2 Hours</b>
12.1	Introduction	
12.2	Functions of management.	
12.3	Subdivisions of management	
12.4	Objectives of industrial management.	
<b>13.</b>	<b>PERSONNEL SELECTION.</b>	<b>2 Hours</b>
13.1	Recruitment of employees.	
13.2	Training.	
13.3	Effects of training on production and product cost.	
<b>14.</b>	<b>WORKING CONDITIONS.</b>	<b>2 Hours</b>
14.1	Importance and consideration.	
14.2	Effects on efficiency and per unit cost.	
<b>15.</b>	<b>TIME AND MOTION STUDY.</b>	<b>3 Hours</b>
15.1	Concept and importance.	
15.2	Sequence of motion study.	
15.3	Principles of motion study.	
15.4	Steps to time study.	
15.5	Determination of operations time.	

- 16. QUALITY CONTROL. 2 Hours**  
16.1 Concept and advantages  
16.2 Methods.
- 17. ROLE OF FOREMAN IN MANAGEMENT. 2 Hours**  
17.1 Foreman's abilities.  
17.2 Duties and functions.

**BOOKS RECOMMENDED:**

- 1 C.S. Meyers, Industrial Psychology, Oxford University Press, London.
2. Smith Wakley, Psychology of Industrial Behaviors, Mc-Graw Hill, New York.
3. Ghulam Hussain, Nizamat-e-Sanaat Aur Insani Rawabat, Ilmi Kitab Khana, Urdu Bazar, Lahore.
4. Andrew R. Megill, The Process of Management William M New Man.
5. Richard N Omen, Management of Industrial Enterprises.

**Mgm-311 INDUSTRIAL MANAGEMENT AND HUMAN RELATIONS.**

**INSTRUCTIONAL OBJECTIVES**

At the completion of this course, the students will be able to:

- 1. KNOW INDUSTRIAL PSYCHOLOGY.**
  - 1.1 Describe brief history of industrial psychology.
  - 1.2 Describe in detail definition of industrial psychology.
  - 1.3 State nature and scope of industrial psychology.
  
- 2. KNOW LEADERSHIP.**
  - 2.1 Define leadership.
  - 2.2 Describe types of leadership.
  - 2.3 State qualities of a good leader.
  
- 3. UNDERSTAND MOTIVATION.**
  - 3.1 Define motivation.
  - 3.2 Describe financial and non financial motives.
  - 3.3 Explain conflict of motives.
  
- 4. KNOW MORALE.**
  - 4.1 State importance of morale.
  - 4.2 Describe development of morale.
  - 4.3 State the method of measurement of morale.
  
- 5. UNDERSTAND HUMAN ENGINEERING.**
  - 5.1 Explain importance of human engineering in the industry.
  - 5.2 Explain man-machine system.
  - 5.3 Explain strategy for making allocation decisions.
  
- 6. UNDERSTAND INDUSTRIAL FATIGUE AND BOREDOM.**
  - 6.1 Define fatigue and boredom.
  - 6.2 Describe psychological causes of fatigue and boredom.
  - 6.3 Describe objective causes of fatigue and boredom.
  - 6.4 Explain measures to prevent fatigue and boredom.
  
- 7. UNDERSTAND INDUSTRIAL ACCIDENTS.**
  - 7.1 Explain psychological causes of industrial accidents.
  - 7.2 Explain objective causes of industrial accidents.
  - 7.3 Explain measures to prevent industrial accidents.
  
- 8. UNDERSTAND INDUSTRIAL PREJUDICE.**

- 8.1 Define prejudice
  - 8.2 Explain causes of industrial prejudice.
  - 8.3 Explain remedies of industrial prejudice.
- 9. UNDERSTAND THE SIGNIFICANCE OF PUBLIC RELATIONS.**
- 9.1 Explain importance of public relations.
  - 9.2 Explain functions of public relations.
- 10. UNDERSTAND THE NEED FOR GUIDANCE AND COUNSELLING.**
- 10.1 State importance of guidance and counselling.
  - 10.2 Explain the role of guidance and counselling in choosing the job.
  - 10.3 Describe help of guidance and counselling during service.
- 11. UNDERSTAND JOB EVALUATION.**
- 11.1 Explain importance of job evaluation.
  - 11.2 Explain methods of job evaluation.
  - 11.3 Explain job satisfaction.
  - 11.4 Explain work simplification.
- 12. UNDERSTAND INDUSTRIAL MANAGEMENT.**
- 12.1 Define management.
  - 12.2 State functions of management.
  - 12.3 Enlist subdivision of management.
  - 12.4 Explain objectives of industrial management.
- 13. UNDERSTAND TRAINING AND ITS EFFECTS.**
- 13.1 Describe the recruitment procedure of employees in an industrial concern.
  - 13.2 Explain training.
  - 13.3 Identify the kinds of training.
  - 13.4 Explain the effects of training on production and product cost.
- 14. UNDERSTAND THE EFFECT OF WORKING CONDITION ON EFFICIENCY.**
- 15.1 Explain importance of working condition.
  - 15.2 Describe air-conditioning, ventilation, lighting and noise.
  - 15.3 State the effects of good working conditions on efficiency and per unit cost.
- 15. UNDERSTAND TIME AND MOTION STUDY.**
- 15.1 Explain the concept.
  - 15.2 Describe the importance of work study.
  - 15.3 Explain the sequence of motion study.
  - 15.4 State the principles of motion study.
  - 15.5 Describe the steps for carrying out time study.

15.6 Explain the method of determination of operations time.

**16. UNDERSTAND THE METHODS OF QUALITY CONTROL.**

16.1 Define quality control

16.2 State the advantages of quality control.

16.2 Explain methods of quality control.

**17. UNDERSTAND THE ROLE OF FOREMAN IN AN INDUSTRIAL UNDERTAKING.**

17.1 Explain ability of the foreman.

17.2 Enlist duties of foreman.

17.3 Describe functions of foreman as middle management.

## ET-316      A.C. MACHINES

### Total Contact Hours

Theory	128	T	P	C
Practical	192	4	6	6

**AIM** At the end of this course the student will be able to have an insight into the construction, working principles and behaviour of machines under different operating conditions and an awareness of their losses and efficiency. The knowledge gained will form basis for carrying out repair and maintenance of these machines, an area covered in the programme concurrently.

### COURSE CONTENTS

- 1      **SINGLE PHASE TRANSFORMER** 36 Hrs.
  - 1.1    Definition, principle, basic parts.
  - 1.2    EMF equation, transformation ratio.
  - 1.3    Classification of transformer - core, mode of operation, use and cooling.
  - 1.4    Transformer operation (ideal) - On No load, on load, with resistive load, phasor diagram, with inductive, phasor diagram, with Capacitive load, phasor diagram.
  - 1.5    Transformer operation (Practical) - parameters, primary resistance, secondary resistance, primary leakage reactance, secondary leakage reactance, secondary, equivalent resistance, equivalent reactance referred to secondary, referred to primary, Exciting conductance and susceptance, equivalent circuit diagrams referred to primary & secondary, operation of practical transformer on load of different power factor, phasor diagram, approximate and exact voltage drop in transformer, regulation, percent resistance, reactance and impedance.
  - 1.6    Transformer losses & efficiency - Iron and copper losses. Ordinary and all day efficiencies, maximum efficiency, cooling of transformers.
  - 1.7    Transformer tests and specifications - Insulation test, Ratio test, Polarity test, Open circuit test. Short circuit test, Back to back test.
  - 1.8    Parallel operation of 1 phase transformer
  - 1.9    Special transformers, construction, principle and use - Instrument transformer, Auto transformer, Constant current transformer, Rotating core transformer.
  
2.      **3 PHASE TRANSFORMER.** 11 Hrs.
  - 2.1    Construction and working of 3 phase transformer.
  - 2.2    Connection groups of 3 phase transformer, name-plate rating.
  - 2.3    Connection of single phase transformers for 3 phase & 2 phase transformation - Star-Star, Star-Delta, Delta-Star, Delta-Delta, open Delta, Scott, Transformation of 3 phase to 6 phase & vice versa.

- 3 A.C MOTORS.** 1 Hr.
- 3.1. General.
- 3.2. Preference of A.C motors over DC motors.
- 3.3. Classifications.
- 4. THREE PHASE INDUCTION MOTORS.** 24 Hrs.
- 4.1 Production of rotating magnetic field by 3 phase & 2 phase EMFs.
- 4.2 Construction of squirrel cage & wound rotor induction motor.
- 4.3 Principle of rotation of S.C. rotor, synchronous speed, rotor speed, slip, frequency of rotor induced current.
- 4.4 Motor parameters (stator resistance, reactance, rotor resistance, rotor reactance in starting & running condition. Condition for maximum starting & running torque.
- 4.5 Power stages in induction motor, Resistance measurement, No load & blocked rotor tests to determine losses, efficiency & parameters of motor. Equivalent circuit & circle diagram of induction motor.
- 4.6 Starting of 3 ph induction motor.
- 4.7 Speed control of induction motor.
- 4.8 Motor control circuit diagrams, design & reading.
- 5. SINGLE PHASE MOTOR.** 10 Hrs.
- 5.1 Classification.
- 5.2 Split phase motor.
- 5.3 Shaded pole motor.
- 5.4 Repulsion motor.
- 5.5 Series motor.
- 6. EXTERNAL ROTOR MOTOR.** 1 Hr.
- 6.1 Servo Motor: Construction, Working and Applications. 1 Hr.
- 7. SYNCHRONOUS GENERATOR.** 32 Hrs.
- 7.1. Construction - Stator, Rotor, Armature winding (single layer, two layer, chain), Hydrogen cooling for large machines
- 7.2 Principle. EMF equation.
- 7.3. Performance of Synchronous Generator on Load.
- 7.4 Voltage variation on load
- 7.5 Armature Reaction
- 7.6 Synchronous impedance
- 7.7. Phasor Diagram of Loaded Synchronous Generator on different power factors.
- 7.8. Regulation & its Determination by Synchronous Impedance Method.
- 7.9 O.C. and S.C. tests
- 7.10 Calculation of voltage regulation
- 7.11 Synchronizing Generator by different methods (lamp bright, lamp dark, synchroscope).

- 7.12 Single phase.
- 7.13 Three phase.
- 7.14 Load sharing.
- 7.15 Brushless A.C. Generator: Construction, Working & Uses.

**8 SYNCHRONOUS MOTOR. 8 Hrs.**

- 8.1. Principle, construction, operation & uses of 3 phase synchronous motor
- 8.2. Principle, construction operation, characteristics & uses of unexcited single phase synchronous motor.

**9 CONVERTERS 6 Hrs.**

- 9.1. Motor Generator set.
- 9.2. Motor converter.

**ET-316: A.C MACHINES****INSTRUCTIONAL OBJECTIVES****TIME SCHEDULE**

S.No.	Major Topics	No. of Periods	No. of Questions in Q. Paper
1.	Transformer single phase	36	
	a. Construction, no load, off load regulation, open circuit & short circuit		2
	b. Efficiency, parallel operation, auto transformer etc.		1
2.	Three phase transformer	10	1
3.	A.C. motors three phase	25	2
4.	A.C. motors single phase	11	1
5.	Synchronous generator	32	
	a. Types of rotors, winding, EMF of generator		1
	b. Generator on load and voltage regulation		1
	c. Synchronizing etc. etc.		1
6.	Synchronous motors	8	1
7.	Converter	6	1
	Total:	128	12

**1. UNDERSTAND CONSTRUCTION & PRINCIPLE OF TRANSFORMER.**

- 1.1. Define transformer as step up and step down.
- 1.2. Describe parts of transformer.
- 1.3. Explain principle of transformer.
- 1.4.
  - a) Describe classification of transformer.
  - b) Differentiate core type & shell type transformer.
- 1.5. Derive EMF equation of transformer.
- 1.6. Solve problems related to above.

2. **UNDERSTAND OPERATION OF TRANSFORMER ON NO LOAD AND LOAD.**
  - 2.1 Differentiate between ideal & practical transformer.
  - 2.2 Draw the phasor diagram of transformer on no load and load
  - 2.3 Explain components of no load primary current.
  - 2.4 Calculate energy component & magnetizing component of no load current.
  - 2.5 Explain the transient changes in current when load is connected.
  - 2.6 Distinguish between primary leakage flux, & secondary leakage flux.
  - 2.7 State methods of reducing leakage flux.
  - 2.8 State the relation of current & transformation ratio rating it to KVA.
  
3. **UNDERSTAND EQUIVALENT CIRCUIT OF TRANSFORMER.**
  - 3.1 Identify the primary resistance, secondary resistance, primary reactance, secondary reactance and magnetizing - branch components
  - 3.2 Convert the parameters of primary side onto secondary and vice versa, calculating equivalent values
  - 3.3 Draw the equivalent circuit of transformer.
  - 3.4 Draw the phasor diagram of transformer loaded with resistive, inductive, capacitive load with parameters referred to (a) both sides (b) primary (c) secondary.
  - 3.5 Solve problems on equivalent circuit of transformers under different loading conditions.
  
4. **CALCULATE REGULATION OF TRANSFORMER.**
  - 4.1 Define regulation.
  - 4.2 State factors on which regulation depend.
  - 4.3 Explain the voltage drop in transformer.
  - 4.4 Derive expression for approximate voltage drop & exact voltage drop.
  - 4.5 Define % Resistance, % Reactance & % Impedance.
  - 4.6 State formula for % impedance.
  - 4.6 Calculate regulation for various loading conditions.
  
5. **CALCULATE EFFICIENCY OF TRANSFORMER.**
  - 5.1 List the losses in transformer.
  - 5.2 Identify the parts in which these losses occur and the causes for the losses to occur.
  - 5.3 Define efficiency.
  - 5.4 Differentiate between commercial efficiency & all day efficiency.
  - 5.5 Calculate all day efficiency.
  - 5.6 Solve numericals on Losses & Efficiency
  - 5.7 Derive conditions for maximum efficiency and hence calculate maximum efficiency.

- 6. UNDERSTAND TESTS OF TRANSFORMER.**
  - 6.1 List transformer tests.
  - 6.2 Describe various tests.
  - 6.3 Interpret the results of tests as parameters of equivalent circuit and components of losses.
  - 6.4 Solve numerical problems, related to open circuit test & short circuit test.
  
- 7. OPERATE TRANSFORMER IN PARALLEL.**
  - 7.1 State the need of parallel operation.
  - 7.2 Describe the conditions for parallel operation and how these are fulfilled.
  - 7.3 Explain parallel operation under various conditions
  - 7.4 Solve problems on parallel operation of transformers, related to load-sharing.
  
- 8. UNDERSTAND CONSTRUCTION AND WORKING OF SPECIAL PURPOSE TRANSFORMER.**
  - 8.1 Describe construction & working of special purpose transformers (such as auto-transformer, instrument transformers, constant current transformers, rotating core transformers).
  - 8.2 State the uses of special purpose transformer.
  
- 9. UNDERSTAND CONSTRUCTION & WORKING OF 3 PHASE TRANSFORMER.**
  - 9.1 State advantages & disadvantages of 3 phase transformer over 1 phase transformer and 3-phase transformer over a bank of three phase transformers.
  - 9.2 Describe the construction of 3 phase transformer (insulation, winding arrangement, core, cooling, terminals).
  
- 10. UNDERSTAND THE CONNECTION GROUPS OF 3 PHASE TRANSFORMER.**
  - 10.1 Enlist connection groups of 3 phase transformer.
  - 10.2 Explain the voltage relationships & phasor diagrams of different groups along with their application
  - 10.3 Explain the vector groups: Dd0, Yy0, Dd6, Dy11.
  
- 11. A) UNDERSTAND TRANSFORMATION FROM 1 PHASE TO 2 PHASE & 3 PHASE & VICE VERSA USING SINGLE PHASE TRANSFORMERS.**  
**B) UNDERSTAND TRANSFORMATION OF 3 PHASE TO SIX PHASE.**
  - 11.1 Explain with phasor diagram transformation of 1 phase to 3 phase & 2 phase by using 3/2 single phase transformer (Star-star, Delta-Delta, Star-Delta, Delta-Star, open delta, scott.)
  - 11.2 Compare different connection as mentioned above
  - 11.3 Draw diagram of different methods for obtaining 6 phase from 3- phase (Double star, double delta, diametrical)

11.4 Explain the 6 phase to 3 phase transformation.

**12. UNDERSTAND THE COOLING METHODS OF TRANSFORMER.**

12.1 State necessity of cooling of transformer

12.2 List cooling methods.

12.3 Explain methods of cooling

12.4 State the location & of function of (a) Breather (b) explosion vent (c) conservator (d) oil level indicator.

12.5 Explain the construction and operation of Buchholz's Relay.

**A.C. MOTORS.**

**1. COMPREHEND CONSTRUCTION AND WORKING OF A.C. SYNCHRONOUS MOTORS.**

1.1 List parts of synchronous motor.

1.2 Explain principle of production of rotating magnetic field

1.3 Explain principle of working of synchronous motor

1.4 Explain the performance of synchronous motor on load with phasor diagram

1.5 Explain the effect of varying excitation on the AC line current (magnitude and phase) in synchronous Motors.

1.6 Explain the significance and use of V-curves of synchronous motor

1.7 Solve simple problems related to induced e.w.f., line current and PF.

1.8 Explain the phenomenon of hunting

1.9 State how hunting is prevented

1.10 State starting methods of Synchronous motor

1.11 State the field of application of synchronous motor

1.12 Describe the construction & principle of unexcited synchronous motor

**2. COMPREHEND THE CONSTRUCTION AND WORKING OF 3 PHASE INDUCTION MOTORS.**

2.1 State the function of different parts of 3 phase induction motor

2.2 State the principle of working of 3-phase induction motor

2.3 Derive the equation relating torque, power and slip, and for the pull out torque

2.4 Solve problem on the performance of induction motor relating torque, slip and power.

2.5 Explain the relationship between slip and torque using slip-torque curve.

2.6 Explain losses in an induction motor

2.7 Calculate efficiency of induction motor for given slip and torque/power conditions.

2.8 Explain blocked rotor and no-load tests.

2.9 Derive parameters of equivalent circuit from tests.

2.10 Draw circle diagrams & compute the performance data from No load test, blocked rotor test

- 2.11 Explain general principles of 3 phase stator winding
- 2.12 Define terms related to winding
- 2.13 Classify the windings as short and full-pitched, single and double-layer, progressive and retrogressive
- 2.14 Draw winding diagrams of typical slot pole combinations
- 2.15 State the methods of starting of induction motor
- 2.16 Sketch the circuit diagram of induction motor & explain its working with D.O.L. starter, Y-delta starter, Auto transformer starter
- 2.17 Describe speed control methods

**3. COMPREHEND WORKING OF 1 PHASE INDUCTION MOTOR.**

- 3.1 State the types of 1 phase Induction motor
- 3.2 Explain principle of working of split phase, capacitor & shaded pole motor
- 3.3 State speed control methods of 1 phase induction motor

**4. COMPREHEND WORKING OF COMMUTATOR MOTOR.**

- 4.1 State different type of AC commutator motors
- 4.2 Explain the principle of repulsion motor, a.c, series motor, universal motor and schrage motor
- 4.3 Describe speed control methods of commutator motor
- 4.4 State the methods of speed & phase control of schrage motor

**5. UNDERSTAND BRAKING OF AC MOTORS.**

- 5.1 Define braking
- 5.2 Describe methods of braking of induction motor
- 5.3 Explain the principle of braking as applied to induction motor

**SYNCHRONOUS GENERATOR**

**1. UNDERSTAND THE CONSTRUCTION & CLASSIFICATION OF SYNCHRONOUS GENERATOR.**

- 1.1 Describe the construction of alternator
- 1.2 Classify alternators based on speed and poles (salient, smooth cylindrical).
- 1.3 Compare rotating field type with rotating armature type
- 1.4 List the parts with materials used
- 1.5 State the function of each part
- 1.6 Describe salient pole construction
- 1.7 List types armature winding used in synchronous generator
- 1.8 Define terms related to armature winding: pitch and pitch factors, distribution factor, single and double layer, overhang etc.
- 1.9 Compare different armature windings
- 1.10 Draw the winding diagrams

**2. UNDERSTAND THE PRINCIPLE OF SYNCHRONOUS GENERATOR**

- 2.1 Explain the principle of alternator
- 2.2 Derive the emf equation of synchronous generator
- 2.3 State advantages of rotating field construction
- 2.4 State need of exciter
- 2.5 List various types of exciters (main, pilot & static)
- 2.6 Explain the static excitation in synchronous generator (brush less excitation)
- 2.7 Solve problems on equation (emf of alternator)
- 2.8 Describe measures of wave-form improvement

**3. COMPREHEND THE PERFORMANCE, TESTING OF ALTERNATORS (SYNCHRONOUS GENERATOR).**

- 3.1 State reasons for voltage variation on load
- 3.2 State importance of voltage regulation
- 3.3 Define regulation of synchronous generator
- 3.4 Define synchronous impedance
- 3.5 State the effect of synchronous impedance on terminal voltage
- 3.6 Draw the phasor diagram for loads at different power factors
- 3.7 Describe O.C & S.C test on alternator
- 3.8 Calculate regulation of 1-phase and 3-phase alternator by synchronous impedance method
- 3.9 State the importance & drawbacks of synchronous impedance method
- 3.10 Explain phasing of 3-ph alternator in star, delta
- 3.11 Describe hunting
- 3.12 Calculate regulation for different load power-factors, using synch. impedance.

**4. COMPREHEND THE PROCEDURE FOR VOLTAGE CONTROL & SYNCHRONIZATION.**

- 4.1 State the necessity of parallel operation
- 4.2 State conditions for synchronism
- 4.3 Explain the synchronization procedure for 3-ph and 1-ph alternators using bright lamp method, dark lamp method, synchronoscope
- 4.4 Explain method for adjusting the loads shared by two alternators or one alternator with infinite bus bar
- 4.5 Explain the voltage control of alternators using carbon pile regulator
- 4.6 Calculate the load sharing by two alternators in parallel.

**CONVERTERS**

**1. UNDERSTAND CONVERSION MACHINES**

- 1.1 Explain working of motor generator set as converting A.C to D.C
- 1.2 List merits & demerits of motor generator converting set
- 1.3 Explain motor convertor
- 1.4 Draw circuit diagram of motor converter
- 1.5 Explain the working of a half-wave and full wave-solid state rectifier bridge, with the help of circuit diagrams.
- 1.6 Describe construction and working by Mercury-Arc rectifiers.

**LIST OF PRACTICALS**

**TRANSFORMERS**

- 1 Study various transformers.
- 2 Determination of transformation ratio.
- 3 Determination of polarity of 1 phase transformer.
- 4 Transformer winding Project I.
- 5 Transformer winding Project I (Contd).
- 6 Open circuit test.
- 7 Short circuit test.
- 8 Determination of regulation of 1 phase transformer.
- 9 Determination of efficiency by direct loading.
- 10 Determination of efficiency by back to back test.
- 11 Parallel operation 1 phase transformer.
- 12 Study and connection of auto transformer.
- 13 Verification of current & voltage ratio of an auto transformer.
- 14 Study of 3 phase transformer & its connection.
- 15 Transformer winding project I (Contd).
- 16 Connecting 3 single phase transformer in Star-Star, & Star-Delta.
- 17 Connecting 3 single phase transformer in Delta-Delta & Delta-Star.
- 18 Connecting two 1 phase transformers in open delta & in scott.
- 19 Transformer project I (Contd).
- 20 Transformer project I (Contd).
- 21 Parallel operation, 3 phase transformers.
- 22 Connect 3-phase transformers as per given vector groups (Yy0, Dd0, Dy11, Dd6)

**A.C MOTORS.**

- 1 Verification of rotating magnetic field.
- 2 Study 3 phase motors.
- 3 Measuring starting & running currents of induction motor.
- 4 Study slip torque curves.
- 5 Determination of slip of stroboscope.
- 6 Connecting 3 phase motor with (a) D.O.L. (b) Auto Transformer, starters.
- 7 Connecting 3 phase motor with (a) Star-Delta starter & (b) 3 position push button starter.
- 8 Determination of efficiency of 3 phase motor.
- 9 Speed control by primary voltage control method & rotor resistance control method.
- 10 Cascade control of motor.
- 11 Starting of wound rotor motor.
- 12 Study of connection of split phase motor.
- 13 Study & connection of shaded pole motor.
- 14 Project II induction motor winding session I.
- 15 Study of repulsion motor.
- 16 Work on project II. Session II
- 17 Work on project II. Session III
- 18 Work on project II. Session IV
- 19 Work on project II. Session V
- 20 Work on project II. Session VI
- 21 Work on project II. Session VII

22 Work on project II. Session VIII

### **SYNCHRONOUS GENERATORS**

- 1 Study of alternator & its operation.
- 2 Study effect of speed on frequency.
- 3 Practice alternator winding.
- 4 Practice alternator winding.
- 5 Open circuit test.
- 6 Short circuit test.
- 7 Determination of voltage regulation (synchronous impedance method).
- 8 Parallel operation of alternators by dark lamp method.
- 9 Parallel operation of alternators by bright lamp method.
- 10 Study sharing of WATTS and VARS load of two parallel-operating alternators.
- 11 Study power angle with change of load.

### **SYNCHRONOUS MOTORS**

- 1 Study of operation as Synchronous motor.
- 2 Starting of synchronous motor using various methods.
- 3 Study effect of excitation on armature current & power factor.
- 4 Study of Torque angle with change of load.

### **CONVERTERS AND RECTIFIERS**

- 1 Study & operate motor generator set.
- 2 Study & operate motor converter set.
- 3 Study of brushless converter.
- 4 Study of brushless A.C generator.
- 5 Study of servomotor.

Note: Students must prepare theory and practical note books and get these checked weekly by the concerned teacher. They should produce it to external examiner for sessional work/marking check up at the time of final exam.

### **RECOMMENDED BOOKS:**

1. B.L Theraja. Electrical Technology
2. Philips Kemp. Alternating Current Electrical Engineering
3. C.L. Dawes. Electrical Engineering Vol II
4. Drinkall Hadik Grant. Alternator Current Motors
5. M.G. Say. A.C Machine Theory
6. Kates-Stafford. Electrical Generator
7. Coral H-Dunlop. Transformers

## ET-322 POWER PLANTS AND ENERGY CONSERVATION

### Total Contact Hours:

Theory (only): 64

T	P	C
	2	0
		2

**AIMS** Power Generator is essential area of electrical technology. Familiarization of the types, construction, working and operation of different types of power plants is aimed at. The student should be able to see the power station as a unit, with need and working of each component integrated into the unit.

An area of growing concern covered is the energy conservation, as also an introduction to the economic aspects of electricity supply as an Industry, showing concern for investments and returns.

- 1. SOURCES OF POWER.** 6 Hrs.
  - 1.1 Introduction to different sources of power.
  - 1.2 Salient features of systems of power sources.
  - 1.3 Comparison of different sources, Thermal, Hydel, Nuclear Solar, Tidal, Wind Magneto Dynamic and Geothermal.
  
- 2. THERMAL POWER STATION.** 14 Hrs.
  - 2.1 Introduction to thermal power station.
  - 2.2 Selection of fuels and site.
  - 2.3 Type of thermal power stations and their working.
  - 2.4 Parts of thermal power station and their working.
  - 2.5 Boilers and their types, under tube, fire tube etc.
  - 2.6 Steam turbines and their types, Impulse and Reaction.
  - 2.7 Construction and working principle of steam turbine.
  - 2.8 Selection and capacity of steam turbine.
  - 2.9 Construction of turbo generators.
  - 2.10 Function and application of condenser in a steam turbine power station.
  - 2.11 Water circulation system in a thermal power station.
  - 2.12 Introduction to diesel engine power station.
  - 2.13 Working of a diesel surface, two stroke, four stroke and their comparison.
  - 2.14 Cooling system of diesel engine.
  - 2.15 Site and schematic of diesel power station.
  
- 3. NUCLEAR POWER STATIONS.** 8 Hrs.
  - 3.1 Introduction to Nuclear power station.
  - 3.2 Main parts of nuclear power station.
  - 3.3 Principle of nuclear energy, atomic structure, atomic, number (For materials mostly used for nuclear energy).
  - 3.4 Kinetic energy and isotopes, fuel (Nuclear).
  - 3.5 Fission and fusion.
  - 3.6 Heavy water and its importance.
  - 3.7 Nuclear reactor, its types.
  - 3.8 Line diagram of a nuclear reactor.
  - 3.9 Nuclear power stations in Pakistan.
  
- 4. HYDEL POWER STATION.** 12 Hrs.

- 4.1 Introduction to Hydel Power station.
  - 4.2 Classification of Hydel Power Station.
  - 4.3 Merits & demerits of Hydel Power Station.
  - 4.4 Selection of site for Hydel Power Station.
  - 4.5 General arrangement and operation of Hydel Power Station.
  - 4.6 Types of Hydel turbines and their characteristic.
  - 4.7 Governing of Turbines.
  - 4.8 Comparison between turbines.
  - 4.9 Hydro electric generation in Pakistan.
- 5. GAS TURBINE POWER STATION. 8 Hrs.**
- 5.1 Introduction to Gas Power station.
  - 5.2 construction & working of simple gas turbine.
  - 5.3 Layout of a gas turbine station.
  - 5.4 Gas power station in Pakistan.
  - 5.5 Introduction to combined cycle Power station.
  - 5.6 Combined cycle power stations in Pakistan.
- 6. TARIFFS AND ECONOMICS. 8 Hrs.**
- 6.1 Introduction to economics consideration(cost of generation).
  - 6.2 Factors influencing cost of generation, load factor, demand factor, diversity factor.
  - 6.3 Different load curves.
  - 6.4 Depreciation of plant cost and method of charging.
  - 6.5 Types of Tariffs.
  - 6.6 Calculations on tariffs (simple problems).
  - 6.7 Fundamentals of load management.
- 7. CONSERVATION OF ENERGY. 8 Hrs.**
- 7.1 Introduction & necessity of energy conservation.
  - 7.2 Source of energy loss.
  - 7.3 Effect of factors on energy loss.
  - 7.4 Methods to limit losses effect of over-sized drives on losses.
  - 7.5 Methods to improve power factor in the context of energy conservation.
  - 7.6 Economical limits of PF improvement

#### **TEXT AND REFERENCE BOOKS**

1. Generation, Transmission & Utilization of Electrical Power by A.T. Starr.
2. Diesel Electric Power Plants by Kates.
3. A Course in Electrical Power by M.L. Soni Gupta and Bhatnagar.
4. Electrical Power by S.L Opal.
5. Elements of Power Station Design M.V. Deshpande
6. Heat Engines by K.P. Roy.
7. Applied Thermodynamics by R.S. Khurmi.
8. Diesel Locomotive-Mechanical-Electrical Fundamentals By Drancy.
9. Nuclear Power Plants by Dr. S.M. Bhutta
10. Power Plant Technology by El-Wakil (relevant sections only)
11. Electric Power System by B.M. Weedy (Chap-I,II only)
12. Literature from ENERCON (GOP)

**ET-322: POWER AND ENERGY CONSERVATION****INSTRUCTIONAL OBJECTIVES****TIME SCHEDULE**

S.No.	Major Topics	No. of Periods	No. of Questions in Q. Paper
1.	Source of power	6	½
2.	Thermal power stations	14	1 ½
3.	Nuclear power stations	8	½
4.	Hydel power stations	12	1
5.	Gas turbine power stations	8	1
6.	Tariffs and economics	8	½
7.	Conservation	8	1
	Total:	64	6

**1. KNOW DIFFERENT SOURCES OF ELECTRICAL POWER.**

- 1.1 Name different sources of power, (thermal, hydel, nuclear, solar, tidal, magneto hydro dynamic, wind)
- 1.2 State sources of power as Renewable and Exhaustible
- 1.3 State merits and demerits of each source (installation & working w.r.t. economics)
- 1.4 State characteristics of each category of sources: Power sensitivity, environmental effects, life an life-cycle, cost, technology.
- 1.5 State the power generation as an energy conversion process, starting from the available source.

**2. UNDERSTAND THE TYPES AND WORKING COMPONENTS THERMAL POWER STATION.**

- 2.1 List types of fuel used in thermal power house (Coal, Oil, Gas).
- 2.2 State requirements of site selection (cost of land, availability of abundant water, transport, load control location, climate, pollution) indicating relative weightages.
- 2.3 Enlist the types of thermal power station.
- 2.4 Explain working of a power plant showing parts/components on a block-diagram integrating into a unit (station)
- 2.5 Explain the parts of the thermal power plant.
- 2.6 State types of boilers water tube, fire tube.
- 2.7 Describe steam turbine (Reaction, impulse).
- 2.8 Explain construction and working of a steam turbine.

- 2.9 Explain types of steam turbines.
  - 2.10 Describe method of determining the capacity of a steam turbine.
  - 2.11 Describe construction of a turbo generator.
  - 2.12 Explain function and application of condenser in steam turbine.
  - 2.13 Draw layout of water circulation system in steam power station
  - 2.14 Describe diesel engine power station.
  - 2.15 Compare two stroke and four stroke diesel engine.
  - 2.16 Explain a diesel power station with the help of block- diagram.
  - 2.17 Show schematic diagram of diesel power station.
  - 2.18 State requirements of a site selection for diesel power plant (location, climatic condition, water cost of utilities, pollution etc. consideration), comparing relative weightage
  - 2.19 Describe environmental effects of thermal power stations and measures to offset such hazards.
- 3. UNDERSTAND CONSTRUCTION AND WORKING OF A NUCLEAR POWER STATION.**
- 3.1 Enlist main parts of a nuclear power station.
  - 3.2 Write working principle of nuclear energy in context with atomic structure, atomic number, mass number for materials used for nuclear energy.
  - 3.3 Define kinetic energy, isotope, nuclear fuel.
  - 3.4 Describe fusion and fission
  - 3.5 State importance of heavy water (H<sub>3</sub>O).
  - 3.6 Enlist the fissionable and fertile fuels
  - 3.7 List types of nuclear reactors.
  - 3.8 Describe the construction and working of a thermal Reactor
  - 3.9 Explain the working of a Nuclear Station with the held of a line diagram of a nuclear power plant.
  - 3.10 Describe salient features of nuclear power station working in Pakistan
- 4. UNDERSTAND THE TYPES, WORKING AND COMPONENTS OF HYDEL POWER STATION.**
- 4.1 Enlist types of hydro electric power station (head of water,demand of load & quantity of water)
  - 4.2 Enlist merits and demerits of hydel power station.
  - 4.3 Describe Hydel Power Stations.
  - 4.4 Explain requirements of site selection for installation of hydel power plant.
  - 4.5 Explain general arrangements and operation of hydel power station.
  - 4.6 Describe types of hydel turbines and their characteristics.
  - 4.7 Compare different hydel turbines.
  - 4.8 State function of turbine components.
  - 4.9 Name hydro-electric power plants working in Pakistan alongwith their capacities.
- 5. UNDERSTAND THE WORKING AND USES OF GAS TURBINE.**

- 5.1 Enlist advantages and disadvantages of Gas turbine stations
  - 5.2 Describe gas turbine (construction and working).
  - 5.3 Sketch block diagram of a gas turbine power station.
  - 5.4 List gas turbine power station working in Pakistan.
  - 5.5 Describe combined cycle power station.
  - 5.6 Explain combined cycle power station working in Pakistan.
  - 5.7 Describe environmental effects of gas turbine stations and measures to improve the situation.
- 6. UNDERSTAND TARIFF AND ECONOMICS.**
- 6.1 Explain effects of cost generation (Tariff, economics).
  - 6.2 Draw load curves.
  - 6.3 Define load factor, demand factor, diversity factor, power plant factor.
  - 6.4 Define type of tariff, flat rate, two part tariff, block rate tariff, maximum demand tariff, power factor tariff.
  - 6.5 Calculate simple problem relating to tariffs and cost of generation
  - 6.6 Describe measures to reduce cost of electricity
  - 6.7 Define the terms: supply-side load Management and Load-side Load Management
- 7. UNDERSTAND METHODS OF ENERGY CONSERVATION.**
- 7.1 Identify sources of energy losses, light, heat energy loss, electric energy loss, fuel losses.
  - 7.2 Explain methods to limit losses in energy (improvement of efficiency of working units, avoid over-sized drives).
  - 7.3 State effects of low power factor on energy losses.
  - 7.4 Explain methods of P.F. improvement for the purpose of energy conservation (Phase advancer, capacitor, synchronous condenser).
  - 7.5 Calculate the economic limit of PF improvement for given costs/tariff

**ET-335 TRANSMISSION, DISTRIBUTION AND PROTECTION OF ELECTRICAL POWER SYSTEM.**

**Total Contact Hours:**

Theory:	128	T P C
Practical:	96	4 3 5

**AIMS** The course aims to provide understanding of the systems, constants, effects and mechanical consideration of both overhead and underground transmission and distribution lines, effects of low power factor on system performance are also included.

The 2nd half of the course is designed to provide understanding of system protection techniques, switch gear involved and protective relaying schemes. It is also aimed to provide sufficient knowledge of various solid state (Static) relays being used and the schemes of protection of generators, transformers, feeders and transmission lines.

- 1. TRANSMISSION SYSTEMS. 16 Hrs.**
- 1.1 Introduction with respect to Voltages (Low Medium and E.H.T), overhead and underground and A.C. & D.C.
  - 1.2 Comparison between A.C. & D.C. supply systems.
  - 1.3 Purpose of transmission.
  - 1.4 Choice of frequency.
  - 1.5 Choice of voltages.
  - 1.6 Choice of conductors.
  - 1.7 Choice of supply circuits.
  - 1.8 Ring system of transmission (A.C.).
  - 1.9 Effect on transmission lines due to power factor and voltage
  - 1.10 Economic consideration of power factor improvement.
    - 1.10.1 Causes of low p.f.
    - 1.10.2 Disadvantages of low p.f.
    - 1.10.3 Effect of power factor on industrial tariff.
    - 1.10.4 Improving methods: (Bank capacitors, Synchronous compensators, Phase advancers)
    - 1.10.5 Calculations on power factor improvement.
- 2. TRANSMISSION LINES. 16 Hrs.**
- 2.1 Constants of transmission line for 1 phase & 3 phase (with equal spacing).
    - 2.1.1 Resistance.
    - 2.1.2 Inductance.
    - 2.1.3 Capacitance.
    - 2.1.4 Formulae & calculation (without derivations).
  - 2.2 Charging current of transmission lines.
  - 2.3 Voltage drop in H.V. transmission lines.

- 2.3.1 T-Method.
- 2.3.2 Pi( $\pi$ )-Method.
- 2.3.3 Simple calculation on voltage drop in short transmission lines with vector diagrams.
- 2.4 Effects on transmission lines.
  - 2.4.1 Feranti effect.
  - 2.4.2 Skin effect.
  - 2.4.3 Corona effect.
- 2.5 Kelvin's Economy-Law of Feeders (with-out calculations).
  
- 3. INSULATORS. 2 Hrs.**
  - 3.1 Types.
    - 3.1.1 Pin type.
    - 3.1.2 Suspension type.
    - 3.1.3 Strain.
    - 3.1.4 L.T.Insulators.
  - 3.2 Uses.
  
- 4. OVERHEAD LINE CONDUCTORS. 2 Hrs.**
  - 4.1 Types.
    - 4.1.1 Stranded copper.
    - 4.1.2 Hollow copper.
    - 4.1.3 Aluminum cable steel reinforced (ACSR).
  - 4.2 Uses of line conductors.
  
- 5. POLES & TOWERS FOR TRANSMISSION LINES. 2 Hrs.**
  - 5.1 Types.
  - 5.2 Supports.
  - 5.3 Vibrators.
  - 5.3 Dampers.
  
- 6. SAG. 5 Hrs.**
  - 6.1 Sag in transmission Lines.
  - 6.2 Minimum ground clearance standards.
  - 6.3 Calculation on sag.
  - 6.4 Effect of wind & ice on transmission lines.
    - 6.4.1 Problems solving.
  
- 7. UNDER GROUND POWER CABLES. 4 Hrs.**
  - 7.1 Types (HVXLPE cables, HV oil filled cable etc).
  - 7.2 Constructions.
  - 7.3 Effect, characteristics & uses.
  - 7.4 Stress on insulation & capacitance.

- 7.5 Laying of under-ground cables.
- 8. D.C DISTRIBUTORS.** 5 Hrs.
- 8.1 Systems.
- 8.1.1 Two Wire.
- 8.1.2 Three Wire.
- 8.1.3 Radial.
- 8.1.4 Ring Mains.
- 8.2 Advantages & Disadvantages.
- 8.3 Calculation on,
- 8.3.1 Fed from one end.
- 8.3.2 Fed from both ends.
- 8.3.3 Both ends uniformly loaded.
- 8.3.4 Both ends Mixed loaded.
- 8.3.5 Both ends fed with equal voltages.
- 8.3.6 Both ends fed with different voltages.
- 8.3.7 Three wire Distributor.
- 8.3.8 Ring distributors.
- 9. CONCEPT OF A.C. DISTRIBUTED LOADS WITH THE HELP OF VECTOR DIAGRAMS.** 1 Hr.
- 10. BALANCERS & BOOSTERS (A.C & D.C).** 2 Hrs.
- 10.1 Balancers-Definition.
- 10.1.1 Types of Boosters.
- 10.1.2 Types of Balancers.
- 10.1.3 Uses of each.
- 11. SUB-STATION.** 5 Hrs.
- 11.1 Classification.
- 11.2 Relative merits of Indoor & outdoor.
- 11.3 Equipment.
- 11.4 Bus Bar arrangements.
- 11.5 Grounding of star Neutral point.
- 11.5.1 Necessity of grounding.
- 11.5.2 Solid grounding.
- 11.5.3 Resistance grounding.
- 11.5.4 Reactance grounding.
- 11.5.5 Different sub-station schemes.
- 11.6 Importance & advantages of Interconnected power stations.
- 11.7 National Grid system of Pakistan.
- 11.8 Necessity of Load management (Load Despatch Centre, KESC/WAPDA).

- 12. REPRESENTATION OF POWER SYSTEM BY. 5 Hrs.**
- 12.1 One (single) line diagram,
  - 12.2 Impedance diagram.
  - 12.3 Reactance diagram.
    - 12.3.1 Per unit & percentage quantities.
- 13. FAULTS IN POWER SYSTEM. 5 Hrs.**
- 13.1 Types of faults in power system.
  - 13.2 Selection of Base KVA.
  - 13.3 Calculation of percentage reactance at base KVA.
  - 13.5 Symmetrical fault.
  - 13.6 Problems on short circuit capacity.
- 14. REACTORS. 4 Hrs.**
- 14.1 Necessity of reactors.
  - 14.2 Construction of reactors.
  - 14.3 Advantages of reactors.
  - 14.4 Disadvantages of reactors.
  - 14.5 Types of reactors.
    - 14.5.1 Unshielded.
    - 14.5.2 Magnetically shielded.
  - 14.6 Methods of Locating Reactors.
    - 14.6.1 Generator reactors.
    - 14.6.2 Feeder reactors
    - 14.6.3 Bus bar reactors.
      - Ring system.
      - Tie bar system.
- 15. CIRCUIT BREAKERS. 16 Hrs.**
- 15.1 Necessity.
  - 15.2 Theory of A.C Interruption
    - 15.2.1 Phenomena of arc & its effects.
    - 15.2.2 Magnitude of arc
    - 15.2.3 Maintenance of arc (Arc quenching) in:
      - a. Oil circuit breakers.
      - b. Air circuit breakers.
      - c. Gas circuit breakers.
      - d. Vacuum circuit breakers.
  - 15.3 Oil circuit breaker.
    - 15.3.1 Working and construction.
    - 15.3.2 Advantages and disadvantages.
    - 15.3.3 Types
      - a) Bulk oil.

- Single break.
  - Double Break.
  - b) Low oil C.B.
  - c) Self generated pressure type.
  - d) Externally generated pressure type.
- 15.4 Air Circuit Breakers.
- 15.4.1 Working & Construction
  - 15.4.2 Advantages & Disadvantages.
  - 15.4.3 Types of Air Blast breakers.
    - a. Cross Blast.
    - b. Axial Blast.
    - c. Radial Blast.
  - 15.4.4 Ratings.
    - a. Breaking capacity.
    - b. Making capacity.
    - c. Short circuit line current ratings.
    - d. Rated voltages.
    - e. Normal current ratings.
    - f. Operating duty.
- 15.5 Gas Circuit Breakers.
- 15.5.1 Working & Construction of SF6 Circuit Breakers.
  - 15.5.2 Advantages.
  - 15.5.3 Physical & chemical properties.
  - 15.5.4 Dielectric properties of SF6 Gas.
- 15.6 Vacuum Circuit Breakers.
- 15.6.1 Working & construction.
  - 15.6.2 Advantages.
- 15.7 Gas Insulated Substations.

- 16. ISOLATORS.** 2 Hrs.
- 16.1 Working principle.
  - 16.2 Uses.
  - 16.3 Types of Isolation.

**PROTECTIVE DEVICES.**

- 17. FUSES.** 4 Hrs.
- 17.1 Definitions- Fuses, carrying current, fusing current, prospective current & cut off current, total operating time, breaking capacity.
    - 17.1.1 Fuses Materials.
    - 17.1.2 Factors effecting fusing currents.
    - 17.1.3 Fusing factors.
    - 17.1.4 Arcing & pre-arcing (Melting) time.

- 17.2 Selection of fuses.
  - 17.3 Advantages & disadvantages.
  - 17.4 Types of fuses.
  - 17.5 Application.
- 18. PROTECTIVE RELAYING. 12 Hrs.**
- 18.1 Necessity of relaying.
  - 18.2 Requirements of relaying.
    - 18.2.1 Speed.
    - 18.2.2 Selectivity.
    - 18.2.3 Sensitivity.
    - 18.2.4 Reliability.
    - 18.2.5 Simplicity.
    - 18.2.6 Economy.
  - 18.3 Primary & back-up protections.
  - 18.4 Classification of relays w.r.t
    - 18.4.1 Construction & Principle.
    - 18.4.2 Application (Uses).
    - 18.4.3 Time of operation.
  - 18.5 Construction & Principle of operation.
    - 18.5.1 Buchholz's relay.
    - 18.5.2 Induction over current relay (Non directional).
    - 18.5.3 Induction reverse-power relay.
    - 18.5.4 Induction directional over current relay.
    - 18.5.5 Distance relay.
    - 18.5.6 Impedance relay.
    - 18.5.7 Beam relay.
    - 18.5.8 Frequency relay.
    - 18.5.9 Static relays (Electronic relays).
      - 18.5.10 Amplitude-comparator relays.
      - 18.5.11 Phase comparator relay.
      - 18.5.12 Static over current relay.
      - 18.5.13 Static distance relay.
      - 18.5.14 Differential protection.
        - a. Current Balance.
        - b. Voltage Balance.
- 19. BUS-BAR PROTECTION. 4 Hrs.**
- 19.1 Bus bar protection.
  - 19.2 Frame leakage protection.
  - 19.3 Circulating current protection.
- 20. FEEDER & TRANSMISSION LINE PROTECTION. 4 Hrs.**

- 20.1 Time Graded Protection.
- 20.2 Differential protection.
- 20.3 Ring mains protection.
  
- 21. ALTERNATOR PROTECTION. 3 Hrs.**
  - 21.1 Alternator faults.
  - 21.2 Protection against stator faults (Merz-price).
  - 21.3 Balanced Earth fault protection.
  - 21.4 Stator In-turn protection.
  - 21.5 Un-Balanced loads.
  
- 22. TRANSFORMER PROTECTION. 3 Hrs.**
  - 22.1 Transformers faults.
  - 22.2 Merz-price system of protection for:
    - 22.2.1 Delta-Star.
    - 22.2.2 Delta-Delta.
    - 22.2.3 Star-Delta.
    - 22.2.4 Star-Star.
  - 22.3 Over current & Unrestricted earth fault protection.
  
- 23. LIGHTNING ARRESTERS. 2 Hrs.**
  - 23.1 Phenomenon (Mechanism) of lightning.
  - 23.2 Effects of lightning on Electrical power system.
  - 23.3 Lightning strokes.
    - 23.3.1 Direct stroke.
    - 23.3.2 Indirect strokes.
  - 23.4 Protection of H.T Lines & building with ground wire.
  - 23.5 Types of arrestor.
    - 23.5.1 Expulsion.
    - 23.5.2 Valve type.
    - 23.5.3 Horn gap (Rod gap) type.
  
- 24. CALIBRATION OF RELAYS. 4 Hrs.**
  - 24.1 Need for calibration.
  - 24.2 Equipment used for calibration.
  - 24.3 Calibration techniques.

\*\* Students must prepare theory and practical note books and get it checked weekly by the concerned teacher. They should produce these to external examiner for sessional work/marking check up at the time of final examination.

**ET-335          TRANSMISSION, DISTRIBUTION AND PROTECTION OF  
ELECTRICAL POWER SYSTEM.**

**PRACTICAL EXERCISE**

**UNIT-1          TRANSMISSION & DISTRIBUTION.**

Lab Assignment (Lab Report-1).

The student will visit all the workshop, administrative buildings, classes, hostel and colony etc to find out the connected load of whole Institute/College. He should be supposed to find out the demand in KW, Load of individual Technology unit, with following load factors.

Light Load-60%  
Motor Load-50%  
Welding shop load 40%

With the application of diversity factor of 1.3, he will find out the KVA Capacity required for a poly-technic along the residential accommodations, street lights & hostels.

On the main switch gear side he will divide the system into 3-Sub-mains and find out the feeder size with pole design, conductor size conductor spacing & insulator etc., service lines for each Technology. Service lines may be connected through underground cables. Capacities of Main switches, fuses & circuit breakers used may also be ascertained.

This report must be submitted in the 18 week of the session

Lab Report-2

1. Design of pole with minimum sag of 11 KV lines as per WAPDA/KESC specifications in streets, on road crossings, road sides & high ways.
2. Study of various poles & towers used in distribution & transmission lines and their designs.
3. Study of various types of insulators used in distribution & transmission systems and their designs.
4. Prepare a lay-out & scheme for a small grid station of a tehsil HQ/city on the drawing sheet.

Visit and Prepare Report for Report-3

- Large grid station for general study .
- Power House.
- Enlist the equipment with KV rating & power cables used in above installations.
- Draw the drawings of: Insulators & Poles used in above installation Industrial power

- plant (Diesel set), Industrial scheme of distribution of a factory with at least the load of 200 KVA capacity on drawing sheets. Enlist all Electrical equipment installed there.
- Also note the power factor improving methods used by the industries visited.

## **UNIT-2 SWITCH GEAR & PROTECTION.**

### **1 Study of different types of relays such as:-**

- 1.1 Attracted Armature type relay.
- 1.2 Buchholz's relay.
- 1.3 Plunger type relay.
- 1.4 Induction over current relay.
- 1.5 Induction reverse power relay.
- 1.6 Induction relay.
- 1.7 Impedance relay.
- 1.8 Reactance relay.
- 1.9 Beam relay.
- 1.10 Frequency relay.
- 1.11 Static relays.
- 1.12 Amplitude-comparator relay.
- 1.13 Phase comparator relay.
- 1.14 Over voltage, Under voltage relay.
- 1.15 Static over-current relay.
- 1.16 Static distance relay.
- 1.17 Differential protection relay.
- 1.18 Current Balance.
- 1.19 Voltage Balance.
- 1.20 Photoelectric relay.
- 1.21 Thermal relay.

Note: The study should include physical design, electrical/mechanical systems, operation, maintenance procedures, and special the techniques of setting various relays on the front panels.

2. **Study various protective schemes employing protective relays.**
3. **Perform calibration of electro-mechanical and static relays using calibrating equipment.**
4. **Study the:-** Protection schemes used for Bus bar & its Protection, Alternators protection, Transformer protection, Feeder protection, Protecting relaying in a power house/grid station.
5. **Study the Mechanical Designs, Operation and maintenance procedures for various**

**types of circuit breakers, isolators, lightning arrestors.**

**Note:** All the reports, journals/assignments must be periodically checked by the teacher and presented for assessment to the examiner during final practical test.

**Books:**

1. Transmission & Distribution by A.T.Starr.
2. Transmission & Distribution by Ghulam Mohiud-Din.
3. Electrical Technology by B.L Theraja.
4. A Course in Electrical Power by Soni Gupta.
5. Electrical Power by SL Uppal.
6. Transmission & Distribution by H.Cotton.
7. Construction Practice of Substations in India by R. Sabal.

**INSTRUCTIONAL OBJECTIVES****TIME SCHEDULE**

S.No.	Major Topics	No. of Periods	No. of Questions in Q. Paper
1.	Transmission		
	a. System choice & power factor	16	1½
	b. Transmission lines & conductor	16	1½
	c. Insulators & towers etc.	6	½
	d. Sag and under ground cables etc.	9	1
2.	Distributors	13	1½
3.	a. Power System	10	
	b. Reactor etc.	4	½
	c. Circuit Breakers Oil, Air, Vacuum, and gas type C.B. etc.	16	1½
	d. Isolator	2	1
4.	Protective devices	16	1½
5.	Protective systems	14	1
6.	Lightning arrestor	6	½
	Total:	128	12

**1. UNDERSTAND DIFFERENT ELEMENTS AND TYPES OF TRANSMISSION SYSTEMS.**

- 1.1 Explain how transmission systems are classified with respect to different factors.
- 1.2 Explain the need of transmission and distribution lines.
- 1.3 Explain both supply systems (A.C. and D.C.)
- 1.4 Compare supply systems with their relative advantages and disadvantages.
- 1.5 Compare over head and underground transmission systems with respect to cost

- ease of maintenance and installation etc.
- 1.6 Explain effects of following on transmission line performance:
    - a) Supply frequency.
    - b) Supply voltages
    - c) No of conductors.
    - d) Power factor.
  - 1.7 Explain the effects of low power factor in industry and on performance of transmission lines.
  - 1.8 Choose correct method of improving of P.F.
  - 1.9 Solve problems on power factor improvement.
- 2. UNDERSTAND THE CONSTANTS AND EFFECTS OF TRANSMISSION LINES.**
- 2.1 State & Explain constants of transmission lines.
  - 2.2 Perform calculations on the constants of transmission lines.
  - 2.3 Explain effect of charging current on transmission lines.
  - 2.4 Explain the voltage drop in High Voltage transmission lines.
  - 2.5 Solve problems on voltage drop in short transmission lines.
  - 2.6 Define effects on transmission lines.
    - (a) Ferranti effect.
    - (b) Skin effect.
    - (c) Corona effect.
  - 2.7 Explain Kelvin's Economy Law of feeders.
- 3. UNDERSTAND THE TYPES AND USES OF INSULATORS USED IN TRANSMISSION & DISTRIBUTION LINES.**
- 3.1 Explain various insulators used in overhead high voltage transmission lines.
  - 3.2 State uses of each type.
  - 3.3 Explain various insulators used in medium and low voltage transmission/distribution line.
  - 3.4 Select proper insulators for given systems.
- 4. UNDERSTAND OVER-HEAD LINE CONDUCTORS.**
- 4.1 Name the conductors used in over-head lines.
  - 4.2 Compare various transmission line conductors.
  - 4.3 Select the most useful conductor for given situation.
  - 4.4 State the merits and demerits of different conductor materials.
- 5. UNDERSTAND THE CONSTRUCTION AND USES OF DIFFERENT POLES & TOWERS (LINE SUPPORTS).**
- 5.1 State the requirements of line supports.
  - 5.2 State the advantages & disadvantages of different line supports.
  - 5.3 Enlist the formula for the spacing of conductors.
  - 5.4 Explain the necessity of vibrators and dampers.
- 6. UNDERSTAND THE IMPORTANCE AND NEED OF SAG IN LINES.**
- 6.1 Define sag.
  - 6.2 State the factors effecting the sag.
  - 6.3 Write the minimum ground clearance at different locations.
  - 6.4 Write the formula of sag at same level.
    - (a) Under still air conditions.

- (b) Under wind storm.
  - (c) Under ice condition (snow fall).
  - 6.5 Enlist the demerits of loose sag.
  - 6.6 Solve the simple problems of sag.
- 7. UNDERSTAND THE NEED, TYPES, AND CHARACTERISTICS OF UNDERGROUND CABLES USED IN L.T/H.T CIRCUIT.**
- 7.1 Define cable.
  - 7.2 Compare over head lines with under ground cables.
  - 7.3 Explain necessity of underground cables.
  - 7.4 Enlist types of cables for LT/HT/E.H.T/H type/SL.type/HSL type/Gas filled.
  - 7.5 State the construction of different cables.
  - 7.6 Explain the characteristics and uses of each type.
  - 7.7 State the classification of cables according to.
    - (a) No. of conductors.
    - (b) Voltage.
    - (c) Insulation.
  - 7.8 Explain the stress produced due to tangential forces due to dielectric stress.
  - 7.9 Explain the causes of formation of voids in cables.
  - 7.10 Explain the methods of laying the under ground cables.
  - 7.11 Explain jointing methods for underground cables.
- 8. UNDERSTAND THE TYPES OF D.C. AND A.C. DISTRIBUTORS.**
- 8.1 Enlist the different types of D.C. Distributor system.
    - (a) Two wire.
    - (b) Three wire.
    - (c) Radial.
    - (d) Ring mains.
  - 8.2 Explain the advantages & disadvantages of each type of distributors.
  - 8.3 Solve the problem of distributors.
    - (a) Fed at one end.
    - (b) Fed at both ends.
    - (c) Both ends fed with equal voltage.
    - (d) Both ends fed with different voltage.
    - (e) Three wire distributors.
    - (f) Ring distributors.
  - 8.4 Sum up the single phase loads of different types (Resistive, Motor, Capacitors) on one phase with the help of vector diagram.
  - 8.5 State the summing up method of different 3-phase loads of different industries.
- 9. UNDERSTAND THE NEED AND WORKING OF BALANCER AND BOOSTERS.**
- 9.1 Define the Balancer.
  - 9.2 Define the booster.
  - 9.3 Explain the uses of Balancer.
  - 9.4 Explain the uses of Boosters.
  - 9.5 Solve simple problems of D.C balancer.
  - 9.6 Discuss the working of Boosting transformer.

- 10. UNDERSTAND THE TYPES, COMPONENTS AND SYSTEMS OF SUB-STATIONS.**
- 10.1 Explain the types of substations,
    - (a) Step up substation,
    - (b) Primary Grid substation,
    - (c) Secondary substation,
    - (d) Distributor substations.
  - 10.2 Explain the merits of indoor and out door substations.
  - 10.3 Enlist the equipment installed at a substation.
  - 10.4 Explain the necessity of various Bus Bar arrangements.
    - (a) Single Bus Bar.
    - (b) Double Bus Bar.
    - (c) Sectionizing Bus Bar.
    - (d) Bus Bar coupler.
  - 10.5 Describe the necessity of single C.B, one & half C.B. and double C.B-scheme.
  - 10.6 Explain the necessity of neutral Point grounding.
  - 10.7 Select the suitable grounding method for given system:
    - (a) Solid Grounding.
    - (b) Resistance Grounding.
    - (c) Reactance Grounding.
  - 10.8 Explain advantages of neutral grounding.
  - 10.9 Explain the advantages of interconnected power stations.
  - 10.10 Draw the line diagram of Pakistan National Grid System of 500 KV, 220 KV, 132 KV.

**UNIT-3: SWITCH GEAR:**

- 11. UNDERSTAND SHORT CIRCUIT FAULT CONSIDERATIONS IN THE POWER SYSTEMS.**
- 11.1 Draw the single line diagram of power system.
  - 11.2 Write the formula of percentage reactance and percentage reactance at base KVA.
  - 11.3 Solve the short circuit KVA at symmetrical fault (Simple Problems).
  - 11.4 Solve the short circuit capacity of a Alternator in a system (Simple Problems).
- 12. UNDERSTAND THE NEEDS, TYPES AND LOCATIONS OF REACTORS.**
- 12.1 Explain the necessity of reactors.
  - 12.2 Explain the type of reactors from constructional point of view.
  - 12.3 Propose the location of reactors in a system (Feeder, Bus Bar, Generator).
  - 12.4 Point out the advantages & disadvantages of reactors.
  - 12.5 Draw a diagram showing the reactor in a ring system, Tie-Bar system.
- 13. UNDERSTAND THE TYPES, CONSTRUCTION AND WORKING OF CIRCUIT BREAKERS.**
- 13.1 Explain the theory of A.C Arc Interruption.
  - 13.2 State the arc phenomena.
  - 13.3 Enlist type of circuit breakers.
  - 13.4 Explain working and construction of oil circuit breaker.
  - 13.5 Discuss advantages and disadvantages of O.C.B.
  - 13.6 Enlist the types of O.C.B, also discuss the comparison between each case.
  - 13.7 Explain working and construction of air circuit breaker.

- 13.8 Discuss advantages and disadvantages of A.C.B.
- 13.9 Explain the types of A.C.B.
- 13.10 State rating of A.C.B.
- 13.11 Discuss the factors effecting on rating of A.C.B.
- 13.12 Explain working and construction of gas circuit breaker (SF6).
- 13.13 Enlist advantages of G.C.B.
- 13.14 Discuss chemical, physical and dielectric properties of SF6 gas.
- 13.15 Explain working and construction of vacuum circuit breaker.
- 13.16 Explain advantages of V.C.B.

**14. UNDERSTAND WORKING AND USES OF ISOLATORS.**

- 14.1 Explain working principle and need of Isolator.
- 14.2 State uses of Isolators.
- 14.3 Enlist types of Isolators.

**UNIT-4. PROTECTIVE DEVICES:**

**15. APPLY CONCEPTS FOR SELECTION OF PROPER FUSES FOR GIVEN LOADS.**

- 15.1 Define the terms, fuse carrying, current fusing current protective current, cut-off current, total operating time, breaking capacity, fuse materials.
- 15.2 State fuse materials, with their characteristics.
- 15.3 Explain fuse factors and other factors effecting fusing current.
- 15.4 Explain arcing & pre-arcing (Melting) time.
- 15.5 Compare advantages and disadvantages of each type.
- 15.6 Enlist types of fuses.
- 15.7 Select fuses for given conditions.

**16. APPLY CONCEPTS OF PROTECTIVE RELAYS FOR SELECTION AND SETTING.**

- 16.1 Explain the necessity of protective relaying.
- 16.2 Define the requirements of relaying such as
  - a) Speed,
  - b) Selectivity,
  - c) Sensitivity,
  - d) Reliability,
  - e) Simplicity,
  - f) Economy.
- 16.3 Explain primary and backup protections.
- 16.4 Enlist classifications of relays w.r.t,
  - a) Construction and Principle.
  - b) Applications (uses)
  - c) Time of operation.
- 16.5 Describe construction and working of following relays.
  - a) Buchholz's.
  - b) Induction over current.
  - c) Induction reverse-power.
  - d) Induction directional over current.
  - e) Distance
  - f) Impedance

- g) Beam
  - h) Frequency
  - i) Static (Electronic)
  - j) Amplitude Comparator.
  - k) Phase comparator relay.
  - l) Static over current.
  - m) Static distance.
  - n) Differential protection with current and voltage balance.
- 16.6 Draw protective schemes using relays.
- 16.7 Explain the calibration procedure for relays.
- 16.8 Explain the relay setting procedure for each type of relay
- 17. UNDERSTAND BUS BAR PROTECTION.**
- 17.1 Define and explain bus bar protection.
- 17.2 Describe frame leakage protection.
- 17.3 Explain circulating current protection.
- 17.4 Perform relay settings
- 18. UNDERSTAND FEEDER AND TRANSMISSION PROTECTION.**
- 18.1 Define time grade protection.
- 18.2 Explain differential protection.
- 18.3 Draw and discuss feeder protection.
- 18.4 Perform relay settings
- 19. UNDERSTAND ALTERNATOR PROTECTION.**
- 19.1 Explain alternator faults.
- 19.2 Explain Merz-price systems of protection.
- 19.3 Discuss balanced earth fault protection.
- 19.4 Explain stator inter turn protection scheme.
- 19.5 Describe protection for unbalanced loads.
- 19.6 Perform relay settings
- 20. UNDERSTAND TRANSFORMER PROTECTION.**
- 20.1 Enlist transformer faults.
- 20.2 Describe and draw merz-price system of transformer protection for Star-Delta, Star-Star, Delta-Star and Delta-Delta
- 20.3 Explain over current and unrestricted earth faults protection schemes.
- 20.4 Perform relay settings
- 21. UNDERSTAND LIGHTNING AND LIGHTNING ARRESTOR.**
- 21.1 Explain phenomena of Lightning.
- 21.2 Define effect of lightning on electrical power system.
- 21.3 Discuss about direct and indirect lightning strokes.
- 21.4 Describe protection of HT lines and buildings with the help of ground wires.
- 21.5 Enlist and explain following types of lightning arrestor.
- a) Expulsion type,
  - b) Valve Type.
  - c) Horn (rod) gap type

## ET-343: TELECOMMUNICATION

### Total Contact Hours

Theory	64	T	P	C	
Practical	96		2	3	3

**AIM** Based on sound principles of electrical and electronics engineering, this area has become the back bone of present day economy. Knowledge of state of the art equipment and practices such as digital communication have been included in this course.

### COURSE CONTENTS

- 1 TELEGRAPHY** 6 Hrs.
  - 1.1 Essentials of telegraphy
  - 1.2 Four channel multiplex system
  - 1.3 Start - stop telegraphy
  - 1.4 Machine telegraphy/teleprinter
  
- 2 TELEPHONY** 28 Hrs.
  - 2.1 Electro-Mechanical telephone.
  - 2.2 Components of telephone (transmitter, receiver, telephone bell, indicators, telephone relay, dial, induction coil)
  - 2.3 Block diagram of an electro-mechanical telephone.
  - 2.4 Side tone and anti-side tone circuits.
  - 2.5 Telephone exchanges (manual and automatic)
  - 2.6 Automatic telephone exchanges (Block diagram of E.M.D. (Edible Motor Drehauler and Digital)
  - 2.7 Electro-Mechanical telephone switching.
  - 2.8 Telephone trunking system.
  - 2.9 Routing signalling system.
  - 2.10 Block diagram of a Digital telephone.
  - 2.11 Pulse code modulation, frequency modulation, amplitude modulation.
  - 2.12 Principles of digital switching.
  - 2.13 Time division multiplexing & DC multiplexing.
  - 2.14 Basic principle for stare.
  - 2.15 Stare programme control system/S.P.C. processor.
  - 2.16 Large scale electronic switching.
  - 2.17 P.C.M. based PABX (Block Diagram).
  - 2.18 N.W.D. system.
  - 2.19 I.S.D. system.
  - 2.20 Gate way exchange
  
- 3 OPTICAL FIBRE.** 8 Hrs.
  - 3.1 Components of optical fibers.
  - 3.2 Fibre-optics transmission system
  - 3.3 Use of optical fibers in telecommunication system
  - 3.4 Merits and Demerits.
  
- 4 MICROWAVE AND SATELLITE COMMUNICATION.** 18 Hrs.
  - 4.1 Microwave, frequency ranges in terms of bands

- 4.2 Generation of microwave by Klystrons, Magnetrons and Travelling wave tubes (TWTs)
- 4.3 Microwave transmission lines
- 4.4 Inter linkage of telephonic exchanges through microwave
- 4.5 Block diagram of satellite communication
- 4.6 Function of earth satellite station
- 4.7 Function of geo-stationary satellite
- 4.8 inter linkage of telephonic exchange through satellite
- 4.9 Merit and demerit of satellite communication.

**ET-343 TELECOMMUNICATION****INSTRUCTIONAL OBJECTIVES****TIME SCHEDULE**

S.No.	Major Topics	No. of Periods	No. of Questions in Question Paper
1.	Telegraphy	6	½
2.	Telephony		
	a. Electro-mechanical telephone and components	10	1
	b. Electro-mechanical switching		
	c. Digital switching	20	1½
	d. Digital telephone exchanges		
3.	Optical fibre		
	a. Components of optical fibre	10	1
	b. Transmission system		
4.	Microwave & Satellite Communication		
	a. Generation of microwave	8	1
	b. Microwave transmission		
	c. Interfacing microwave station with telephone exchange		
	d. Essentials of satellite communication	10	1
	e. Working telecommunication system through satellite		
	Total:	64	6

**1 UNDERSTAND FUNDAMENTALS OF TELEGRAPHY.**

- 1.1 Define telegraphy
- 1.2 Name telegraphy codes (Morse etc.)
- 1.3 State Morse, machine and cable telegraphy
- 1.4 Describe two-way morse working system
- 1.5 Explain Automatic morse working transmitter and receiver
- 1.6 Explain form channel multiplex system
- 1.7 Describe the salient features of teleprinter.

## **2 UNDERSTAND THE TYPES, WORKING AND APPLICATIONS OF TELEPHONY.**

- 2.1 Describe automatic telephone system
- 2.2 Explain the block circuit diagram of an electro-mechanical telephone
- 2.3 Describe the schematic diagram of side tone and anti side tone circuits
- 2.4 List the parts of an electro mechanical telephone set
- 2.5 Explain functioning of dialing, signalling, receiving and transmitting mechanisms
- 2.6 Describe manual exchange
- 2.7 Explain automatic exchange (EMD and digital)
- 2.8 Describe step by step impulsing switching
- 2.9 Explain working of electro-mechanical selectors (two-motion, uniselectors)
- 2.10 Describe trunking and routing signalling system
- 2.11 Explain demerits of manual exchange
- 2.12 Explain block diagram of a digital telephone
- 2.13 Describe waveform of pulse modulation
- 2.14 Explain waveform of frequency and amplitude modulation
- 2.15 Describe the principle of digital switching
- 2.16 Explain time division multiplexing
- 2.17 Describe the basic principle of stare
- 2.18 Describe block diagram of digital symmetrical matrix (DSD)
- 2.19 Explain programme control system/S.P.C. processor
- 2.20 Explain block diagram of PCM based PABX
- 2.21 Describe N.W.D. system
- 2.22 Explain I.S.D. system
- 2.23 Describe gate way exchange

## **3 OPTICAL FIBRE: UNDERSTAND THE FIBRE OPTICAL COMMUNICATION SYSTEM.**

- 3.1 Explain the transmitter and receiver
- 3.2 Describe the construction of fibre cable
- 3.3 Explain sources and detectors
- 3.4 Describe the fibre-optics transmission system
- 3.5 Explain the uses of optical fibers in telecommunication system
- 3.6 Enlist the merits and demerits of optical fibre communication

## **4 UNDERSTAND FUNDAMENTALS OF MICROWAVE AND SATELLITE COMMUNICATION SYSTEM.**

- 4.1 State microwave communication
- 4.2 Describe microwave frequency and microwave channel
- 4.3 Tabulate microwave frequency ranges in terms of bands
- 4.4 Explain generation of microwave by;
  - 4.4.1 Klystrons
  - 4.4.2 Magnetrons

- 4.4.3 Travelling wave tubes (TWTS)
- 4.5 Describe microwave transmission line
- 4.6 Explain interfacing microwave station with telephone exchange
- 4.7 Describe block diagram of satellite communication system
- 4.8 Explain block diagram of earth satellite station
- 4.9 Describe the working communication of geo-stationery satellite
- 4.10 Explain telephone link via satellite

## ET-343 TELECOMMUNICATION

### LIST OF PRACTICALS

96 hours

- 1 Practice of Morse Code.
- 2 Study of 4-channel multiplex telegraph system
- 3 Study the working of teleprinter
- 4 Study the electro-mechanical telephone set and draw its block diagram
- 5 Study side-tone and anti-side tone circuits
- 6 Observe electro-mechanical telephone exchange switching system
- 7 Draw line diagram of 12 lines intercom set
- 8 Draw block diagram of digital telephone set
- 9 Study generation of double side band AM with carrier present or suppressed
- 10 Demodulation of double side band modulation with carrier
- 11 Observe frequency modulated carrier and measurement of frequency component when carrier is modulated by sinusoid
- 12 Observe demodulation by an FM detection circuit
- 13 Study of aerials
- 14 Study of demodulation of binary coding of dc input levels for 3, 4 and 8 bit words in PCM
- 15 Investigate effects of sampling and TDM on analog wave form
- 16 Measurement of analyzing signal-to-noise in TDM
- 17 Demonstrate channel switching
- 18 Study power & current of LED
- 19 Determine fibre-photodiode coupling efficiency
- 20 Determine Fibre-Fibre coupling efficiency
- 21 Study analog transmission by fibre optics
- 22 Study digital transmission by fibre optics
- 23 Draw block diagram of PCM based PABX
- 24 Visit microwave station
- 25 Study satellite receiving stations
- 26 Study a satellite receiving system
- 27 Study of microwave signal generators
- 28 Study of microwave wave guides
- 29 Install a home satellite dish system
- 30 Visit to a digital telephone exchange

### RECOMMENDED BOOKS.

- 1 Telephony & Telegraphy by E.H. Jolley
- 2 A Text Book of Telegraphy by M. M. Biswas
- 3 Electronic Communication System by Geerge Kanady
- 4 Electronic Communication Techniques by Young
- 5 Electronics for Today & Tomorrow by Tom Duncan
- 6 Electronic Communication by Robert L. Shrader

- 7 Review of Digital Communication by J. Dos
- 8 Communication Engineering Journal by TecQuipment Ltd., Nottingham, England

## ET-353 REPAIR AND MAINTENANCE OF ELECTRICAL EQUIPMENT

<b>Total Contact Hours</b>		<b>T</b>	<b>P</b>	<b>C</b>
Theory 32		<b>1</b>	<b>6</b>	<b>3</b>
Practical 192				

- AIMS**
1. Understand different faults in Electrical Equipment, Machines and Appliances.
  2. Undertake repair work on various electrical appliances and equipment safely.
  3. Schedule routine and preventive maintenance for a given installation.

### COURSE CONTENTS

- 1 FUNDAMENTALS OF ELECTRICAL MAINTENANCE. 3 Hrs.**
  - 1.1 Scheduled maintenance
  - 1.2 Minor repairs
  - 1.3 Major repairs, overhauls
  - 1.4 Tools and Equipment used for repair work.
  - 1.5 Safety rules to be observed during repair work
- 2 COMMON FAULTS OF STARTERS AND SPEED CONTROLLERS. 3 Hrs.**
  - 2.1 Direct on line magnetic starter
  - 2.2 Star Delta Starter (Manual and Automatic)
  - 2.3 3 point D.C. motor starter
  - 2.4 4 point D.C. motor starter
  - 2.5 Speed controllers for D.C. motors.
  - 2.6 Testing
- 3 FAULTS THEIR CAUSES AND REMEDIES OF A.C. 3 PHASE MOTORS. 4 Hrs.**
  - 3.1 Squirrel Cage Induction motor
  - 3.2 Wound Rotor Induction motor
  - 3.3 Synchronous motor
  - 3.4 Testing
- 4 FAULTS THEIR CAUSES AND REMEDIES OF SINGLE PHASE A.C. MOTORS. 3 Hrs.**
  - 4.1 Split phase motors (capacitor start and capacitor run motors)
  - 4.2 Universal motors
  - 4.3 Synchronous motors.
  - 4.4 Testing
- 5 DIRECT CURRENT MOTORS; THEIR FAULTS, CAUSES AND REMEDIES. 4 Hrs.**
  - 5.1 D.C. series motor

- 5.2 D.C. shunt motor
- 5.3 D.C. compound motor.
- 5.4 Testing
  
- 6 DIRECT CURRENT GENERATORS THEIR FAULTS, CAUSES AND REMEDIES. 3 Hrs.**
  - 6.1 D.C. series generator
  - 6.2 D.C. shunt generator
  - 6.3 D.C. compound generator.
  - 6.4 Testing
  
- 7 FAULTS, THEIR CAUSES AND REMEDIES OF ALTERNATORS. 2 Hrs.**
  - 7.1 3 phase salient pole type
  - 7.2 3 phase non salient pole type
  
- 8 FAULTS THEIR CAUSES AND REMEDIES OF TRANSFORMERS. 3 Hrs.**
  - 8.1 3 phase power transformer oil cooler
  - 8.2 Air cooled transformers, 1-phase and 3-phase
  - 8.3 Auto transformer
  
- 9 FAULT THEIR CAUSES AND REMEDIES OF HOUSE HOLD APPLIANCES.5 Hrs.**
  - 9.1 Automatic Electric Iron
  - 9.2 Toaster
  - 9.3 Refrigerator
  - 9.4 Air conditioner
  - 9.5 Washing Machine
  - 9.6 Cooking oven
  - 9.7 Safety
  
- 10 BATTERIES, THEIR FAULTS, CAUSES AND THEIR REMEDIES. 2 Hrs.**
  - 10.1 Lead Acid Battery
  - 10.2 Alkaline Battery
  - 10.3 Safety which using acids

\*\* Students must prepare theory and practical note books and get then checked weekly by the concerned teacher. They should produce these to external exam for sessional work/marking check up at the time of final exam.

**ET-353 REPAIR AND MAINTENANCE OF ELECTRIC EQUIPMENT****INSTRUCTIONAL OBJECTIVES****TIME SCHEDULE**

S.NO.	TOPICS	NO. OF PERIODS	NO. OF QUESTIONS	
1.	Fundamentals of Electrical Maintenance	3	½	
2.	Faults causes and their remedies			
	a. Motor starter and speed controllers	3	½	
	b. A.C. Motors	(B-1) Three Phase	4	½
		(B-2) Single Phase	3	½
		c. D.C. Motors	4	½
	d. D.C. Generator	3	½	
	e. Alternator	2	½	
	f. Transformer	3	½	
	g. House Hold Appliance	5	½	
	h. Lead Acid Battery	2	½	
	Total:	32	5	

**1 UNDERSTAND THE NEED AND TYPES OF MAINTENANCE OF ELECTRICAL EQUIPMENT.**

- 1.1 Compare routing maintenance and general overhaul
- 1.2 Explain maintenance schedule
- 1.3 Differentiate between minor and major repair
- 1.4 Enlist the tools and instruments necessary for an electrical maintenance shop
- 1.5 Sketch the single line diagram of maintenance shop
- 1.6 Demonstrate use of testing tools and testing equipment

**2 APPLY THE KNOWLEDGE ABOUT THE FAULTS, CAUSES AND REMEDIES OF MOTOR STARTERS AND CONTROLLERS.**

- 2.1 Identify the parts of a Direct on line magnetic starter, star delta starter
  - 2.2 Describe the parts of 3 point and 4 point D.C. starters and D.C. motor controllers
  - 2.3 Explain the faults, their causes and remedies starters and controllers.
  - 2.4 Perform maintenance on starters and controllers
- 3 UNDERSTAND FAULTS, CAUSES AND REMEDIES OF A.C. 3 PHASE MOTORS.**
- 3.1 Enlist the faults their causes and remedies of squirrel cage 3 phase A.C. motor and wound rotor motor.
  - 3.2 Identify the faults, their causes and remedies of 3 phase synchronous motor.
  - 3.3 Explain common tests to locate faults in A.C. motors stators.
  - 3.4 State the mechanical faults in A.C. motors.
  - 3.5 Perform maintenance work on AC 3-phase motors
- 4 APPLY THE KNOWLEDGE OF THE FAULTS, CAUSES AND REMEDIES OF A.C. SINGLE PHASE MOTORS.**
- 4.1 Explain the faults, causes and remedies of single phase capacitor motors.
  - 4.2 Explain the faults, causes and remedies of single phase capacitor motors.
  - 4.3 Explain the faults, causes and remedies of universal motors.
  - 4.4 Prepare the list of faults, causes and remedies of single phase synchronous motors.
  - 4.5 Perform maintenance work on AC single phase motors.
- 5 UNDERSTAND THE FAULTS, CAUSES AND THEIR REMEDIES OF D.C. MOTORS.**
- 5.1 Explain the various tests to be carried out for locating the faults in armature.
  - 5.2 Enlist the faults, causes and remedies of series, shunt and compound motors.
  - 5.3 Perform maintenance on DC Motors
- 6 UNDERSTAND THE FAULTS AND REMEDIES OF D.C. GENERATORS.**
- 6.1 Describe the causes of failure of the building up process in D.C. Generator.
  - 6.2 Explain the methods for controller of armature reaction in D.C. machines.
  - 6.3 Explain the fault, causes and remedies of D.C. generators.
  - 6.4 Perform maintenance work on DC generators
- 7 UNDERSTAND FAULTS, CAUSES AND REMEDIES OF ALTERNATORS.**
- 7.1 Explain the effect of speed and weakening of main magnetic field on Emf of an alternator.
  - 7.2 Prepare list of faults, causes and remedies of Brushless alternators.
  - 7.3 Enlist the common faults of salient and cylindrical rotor alternators.
  - 7.4 Perform maintenance work on alternators
- 8 UNDERSTAND THE FAULTS, CAUSES AND THEIR REMEDIES OF TRANSFORMER.**

- 8.1 Explain the methods of testing transformer oil and its reconditioning.
- 8.2 Explain the test of presence of moisture in silica gel and its drying method.
- 8.3 Identify the faults, causes and remedies of three phase power transformer.
- 8.4 Enlist the faults and remedies of on load and off load tap changer.
- 8.5 Perform maintenance work on oil and air cooled transformer

**9 UNDERSTAND THE FAULTS AND THEIR REMEDIES OF HOUSE HOLD APPLIANCES.**

- 9.1 Explain the function of thermostat and its faults in an electric iron.
- 9.2 Enlist the general faults and their remedies of automatic electric iron.
- 9.3 Enlist the major faults in fans and their remedies.
- 9.4 State the common faults with causes in Refrigerators and Air conditioners and their remedies.
- 9.5 Explain the faults in components of a washing machines and their rectification.
- 9.6 State the defects in electric cooking oven and their remedies.
- 9.7 Explain the defects and their remedies in water heaters
- 9.8 Explain the common defects and their remedies in kitchen appliances.

**10 UNDERSTAND THE MAJOR FAULTS, CAUSES AND THEIR REMEDIES OF ACCUMULATORS.**

- 10.1 Explain the method of preparing and checking gravity of an electrolyte.
- 10.2 Describe the different methods of battery charging.
- 10.3 Explain the faults, causes and remedies of lead acid and alkaline batteries.

## **ET-353 REPAIR AND MAINTENANCE OF ELECTRICAL EQUIPMENT**

### **LIST OF PRACTICALS**

- 1 Draw the Layout of Repair shop and also prepare a safety chart.
- 2 Prepare the list of tools and equipment used in Electrical repair shop.
- 3 Rewind and replace a hold-on coil of D.C. Motor Starter. This should include Varnishing & baking of coil. Also Polish the contact points of the starter and perform its general maintenance. Maintenance of timers/over load relays installed in starters should also be done.
- 4 Repair & general overhauling and maintenance of
  - 4.1 Direct on the line starter
  - 4.2 Star Delta starter
    - 4.2.1 Non automatic
    - 4.2.2 Automatic
  - 4.3 Auto transformer starter
    - 4.3.1 Non Automatic
    - 4.3.2 Automatic
  - 4.4 D.C. motor starters
    - 4.4.1 3 point starter
    - 4.4.2 4 point starter
  - 4.5 Automatic D.C. motor starter
- 5 Pull out a bearing of a motor and replace it after cleaning and greasing.
  - 5.1 Replace a bush bearing.
- 6 Polarity testing of stator winding of a 3 phase motor i.e. no of poles/phase and their position.
- 7 Repair, over hauling and maintenance of
  - 7.1 Three phase squirrel cage induction motors.
  - 7.2 Three phase wound rotor induction motors.
  - 7.3 Three phase synchronous motor induction motors.
  - 7.4 Single phase capacitor start capacitor run motor.
  - 7.5 Single phase capacitor run motor.
  - 7.6 Single phase shaded pole motor.
  - 7.7 Single phase universal motor.
  - 7.8 Single phase synchronous motor.
- 8 Pony Brake Load Test of a Repaired Motor.

- 8.1 Dynamic Brake Test of a Repaired Motor.
- 9 Repair, overhauling and maintenance of DC motors and generators.
  - 9.1 Polarity marking of D.C. Motor/Generator.
  - 9.2 Repair and Polishing of D.C. commutator trueing of brush.
  - 9.3 General overhauling and maintenance of
    - 9.3.1 D.C. motors
    - 9.3.2 D.C. generators
  - 9.4 Armature and field winding testing by Growler.
- 10 Test the sample of oil by:
  - 10.1 Oil Tester
  - 10.2 Copper Sulphate
- 11 Take out the silica gel from a oil cooled transformer and recondition it.
- 12 Recondition the oil of a transformer.
- 13 General repair and over hauling of a oil cooled transformer.
- 14 Testing & calibrating an energy meter
- 15 Repair, over hauling, maintenance and assembling of
  - 15.1 Electric Iron
  - 15.2 Pedestal Fan
  - 15.3 Ceiling Fan
  - 15.4 Kitchen Grinder
  - 15.5 Juicer
  - 15.6 Water Heater
  - 15.7 Kitchen Oven
  - 15.8 Air Conditioner
  - 15.9 Refrigerator
- 16 Preparation of Electrolyte for Battery charging.
  - 16.1 Charging a Battery with
    - 16.1.1 Constant current method
    - 16.1.2 Constant voltage method

**RECOMMENDED BOOKS:**

1. Repair and Maintenance of Electrical Equipment by Stafford.
2. Testing and Connecting D.C. Motors by Annet.
3. Repair of Electrical Appliances by A.I.O.U.

## ET-364      DIGITAL & INDUSTRIAL ELECTRONICS

<b>Total contact hours:</b>	<b>T</b>	<b>P</b>	<b>C</b>
Theory 96	3	3	4
Practical      96			

**AIM** This course is aimed to provide sufficient knowledge in digital and industrial electronics so as to make the student capable of working with control systems employing these two technologies. Students should be able to understand and assemble functional projects in digital electronics and also to understand the fundamentals of microprocessors. As the application of solid state electronics in the control of electrical systems is increasing rapidly, the 2nd half of this course provides reasonable knowledge of power electronics including control of AC/DC motors, synchro-servo system etc. concepts and applications of Programmable Logic Controllers (PLC) have also been included.

### PART-I

#### **DIGITAL ELECTRONICS**

- 1      **INTRODUCTION.**      3 Hrs.
  - 1.1      Comparison of digital and analogy quantities
  - 1.2      Review of number systems, BIT, BYTE, NIBBLE
  - 1.3      Elements of digital electronics
  
- 2      **LOGIC GATES (ALL INCLUDE LOGIC, TRUTH TABLE AND TTL CIRCUITRY)**      3 Hrs.
  - 2.1      NOT (Inverter)
  - 2.2      OR
  - 2.3      AND
  - 2.4      NAND
  - 2.5      NOR
  - 2.6      XOR
  
- 3      **ARITHMETIC LOGIC CIRCUITS(INCLUDING LOGIC AND CIRCUITY).** 3 Hrs.
  - 3.1      Half adders
  - 3.2      Full adders
  - 3.3      Adder-Subtractor
  - 3.4      Comparators
  
- 4      **COMBINATIONAL LOGIC AND DATA PROCESSING CIRCUITS.**      3 Hrs.
  - 4.1      Multiplexers and logic (IC's such as 74150)
  - 4.2      Demultiplexers (IC's such as 74154)

4.3	Decoders	
4.4	BCD-to-Decimal Decoders (such as 7445)	
4.5	Seven-Segment Decoders and Displays	
4.6	Encoders(IC's such as 74147)	
4.7	Read-only memories	
4.7.1	Diode ROM	
4.7.2	Commercially available ROM's.	
<b>5</b>	<b>FLIP-FLOPS.</b>	<b>4 Hrs.</b>
5.1	RS Flip-Flop	
5.2	Clocked RS Flip-Flop	
5.3	D Flip-Flop	
5.4	Edge-Triggered D Flip Flop	
5.5	JK Flip Flop	
5.6	Schmitt Trigger	
<b>6</b>	<b>CLOCKS &amp; TIMERS.</b>	<b>4 Hrs.</b>
6.1	TTL Clock	
6.2	555 - astable, monostable	
6.3	Applications	
<b>7</b>	<b>SHIFT REGISTERS.</b>	<b>3 Hrs.</b>
7.1	Introduction, shift-Right and shift Left	
7.2	Serial in-serial out	
7.3	Serial-in parallel-out	
7.4	Parallel-in serial-out	
<b>8</b>	<b>COUNTERS.</b>	<b>3 Hrs.</b>
8.1	Introduction, types	
8.2	Ripple counter	
8.3	Synchronous Counter	
8.4	Presentable counters	
8.5	Digital clock	
<b>9</b>	<b>MEMORIES.</b>	<b>3 Hrs.</b>
9.1	Introduction, volatile, non-volatile,	
9.2	Memory Addressing	
9.3	ROM, PROM, EPROM, capacity	
9.4	RAM, Static & dynamic, capacity	
<b>10</b>	<b>D/A AND A/D CONVERTERS.</b>	<b>4 Hrs.</b>
10.1	Introduction	
10.2	D/A converter	

10.3	A/D converter	
11	<b>MICROPROCESSORS.</b>	4 Hrs.
11.1	Introduction	
11.2	Characteristics, function	
11.3	8085 microprocessor	
11.4	Architecture	
12	<b>APPLICATIONS OF DIGITAL ELECTRONICS.</b>	7 Hrs.
12.1	Digital clock	
12.2	Frequency and time period counter	
12.3	Moving Message Display	

## **PART-II**

### **INDUSTRIAL ELECTRONICS**

- 1. POWER DIODES & THYRISTORS.** 6 Hrs.
  - 1.1 Construction, ratings and characteristics of power diodes
  - 1.2 Series & parallel operation of power diodes
  - 1.3 Review of SCR, its characteristics
  - 1.4 SCR phase control
  - 1.5 Series & parallel operation of SCR's
  
- 2. PHASE CONTROLLED RECTIFIERS (1-PHASE & 3-PHASE)** 8 Hrs.
  - 2.1 Basic controlled rectifier circuits
  - 2.2 Forced commutated controlled rectifier circuit
  - 2.3 Naturally commutated convertors (half & full wave)
  
- 3. INVERTERS.** 7 Hrs.
  - 3.1 1-Phase full-wave circuit
  - 3.2 3-phase full-wave bridge circuit as a line-commutated inverter
  - 3.3 Four quadrant control
  
- 4. CONTROL OF DC & AC MOTORS.** 8 Hrs.
  - 4.1 DC motor speed control system
  - 4.2 3-phase full-wave controlled rectifier circuit to control DC motors
  - 4.3 1-phase full-wave controlled rectifier circuit to control DC motor
  - 4.4 Introduction to speed control of induction motors
  - 4.5 Voltage variation, frequency variation
  - 4.6 Pulse width modulation technique of frequency control
  - 4.7 Variable frequency, variable voltage control system (AC to AC converter)
  - 4.8 SCR cyclo-converter.
  - 4.9 Open-loop & closed-loop induction motor speed control.
  
- 5. SYNCHRO-SERVO SYSTEMS.** 8 Hrs.
  - 5.1 Synchro-generator and synchro-motor
  - 5.2 Differential synchro
  - 5.3 AC & DC servo-mechanism
  - 5.4 Servo motors, characteristics & uses
  
- 6. PROGRAMMABLE LOGIC CONTROLLER  
Dedicated PLC's.** 5 Hrs.
  - 6.1 Introduction to PLC's
  - 6.2 Input, logic, output, symbols

- 6.3 Codes for inputs and outputs; input-output devices
- 6.4 Timers, sequentials, batch processors
- 6.5 Modes of operation
- 6.6 Ladders and Rungs
- 6.7 Multiple contacts
- 6.8 Use of A/D and D/A converters
- 6.9 Programming and operation of simple motor control circuits for given ladder logic.

**Computer Software Control.**

5 Hrs.

- 6.10 Logging-in of logic software on computers
- 6.11 Symbols, codes, input-output & control element
- 6.12 Timers, Sequential registers, batch-processing, modes of operation, multiple contacts
- 6.13 Use of A/D and D/A converters and computer interfacing
- 6.14 Computer based control of given operation.

**ET-364      DIGITAL & INDUSTRIAL ELECTRONICS**

**INSTRUCTIONAL OBJECTIVES**

**TIME SCHEDULE**

S.No.	Major Topics	No. of Periods	No. of Question in Q.Paper
<b>PART-I: DIGITAL ELECTRONICS</b>			
1.	Logic Gates	4	½
2.	Arithmetical circuits	4	½
3.	Combinational logic	4	½
4.	Data Processing circuits	4	½
5.	Flip-Flop	4	½
6.	Clocks and Timers	4	½
7.	Shift-Registers	3	½
8.	Counters	3	½
9.	Memories	3	½
10.	D/A AND A/D converters	4	½
11.	Microprocessors	4	½
12.	Application of Digital Electronics	7	½
	Sub-Total:	48	6
<b>PART-II: INDUSTRIAL ELECTRONICS</b>			
1.	Power Diodes & Thyristors	6	½
2.	Phase controlled rectifiers	8	1
3.	Invertors	8	1
4.	Control of DC and AC motors	8	1
5.	Synchro-Servo System	8	1
6.	Programmable logic controllers		
	a.      Fundamental	5	1
	b.      Programming logic	5	1/2
	Sub-Total:	48	6
	Grand Total:	96	12

## **PART-I**

### **DIGITAL ELECTRONICS.**

- 1 KNOW BASIC TERMS RELATED TO DIGITAL ELECTRONICS.**
  - 1.1 State in a tabulated form the merits and demerits of analog & digital quantities
  - 1.2 Define basic terms related to digital electronics.
  
- 2 UNDERSTAND THE WORKING OF LOGIC GATES, USING TRUTH TABLES AND TTL CIRCUITRY.**
  - 2.1 Define the logic gates NOT, OR, AND, NAND, NOR, XOR.
  - 2.2 Draw truth tables for the logic gates, showing symbols and equations.
  - 2.3 Explain logic gates, using TTL circuitry.
  
- 3 UNDERSTAND ARITHMETIC CIRCUITS FOR LOGIC CIRCUIT ELEMENTS.**
  - 3.1 Define elements of arithmetic logic circuits: half-adder, full-adder, adder-subtracted, comparators.
  - 3.2 Explain the operation of arithmetic logic circuits (as above), using symbols, and block-diagram.
  - 3.3 Explain the inter-connection and inter-conversion of arithmetic logic circuits
  
- 4 UNDERSTAND THE WORKING AND USES OF COMBINATIONAL LOGIC CIRCUITS, INCLUDING DATA PROCESSING CIRCUITS.**
  - 4.1 Define the terms multiplexers, demultiplexers, decoders, encoders, BDC converters.
  - 4.2 Explain multiplexers, using logic circuits & block-diagrams (multiplexers using IC's such as 74150).
  - 4.3 Explain Demultiplexers using block-diagrams (using IC's such as 74154).
  - 4.4 Explain using block diagram, BCD and its conversion to Decimals, using IC's, such as 7445.
  - 4.5 Explain seven segments decoders, showing block diagrams, giving examples for letters & digits.
  - 4.6 Describe the operation of combinational logic circuits as applied to data processing circuits.
  - 4.7 Explain the working of 7-segment display circuit
  
- 5 UNDERSTAND FLIP-FLOPS AS ELEMENTS OF DIGITAL LOGIC CIRCUITS, USING BLOCK DIAGRAMS.**
  - 5.1 Define the terms flip-flops & triggers.
  - 5.2 State different types of flip-flops at triggers
  - 5.3 Explain various flip-flops (RS, JK, D, Clocked RS), using block diagrams for

- describing their functions.
- 5.4 Describe the functions of trigger circuits (Edge, Schmitt), with the help of circuit diagram.
- 6 UNDERSTAND THE WORKING OF CLOCKS & TIMERS FOR APPLICATIONS IN DIGITAL LOGIC CIRCUITS.**
- 6.1 Define timers, clocks, enlisting their types
- 6.2 Explain with the help of block diagram, the TTL Clock
- 6.3 Explain 555 timer, describing its use as astable and monostable multivibrators
- 6.4 Give examples of the use of clocks and timers for digital circuits, showing block diagrams.
- 7 EXPLAIN THE FUNCTION OF SHIFT REGISTERS, USING BLOCK DIAGRAMS.**
- 7.1 Define shift-registers, stating its various types
- 7.2 Describe the function of the following shift registers, using block-diagrams:-
- 7.2.1 Serial-in, serial-out (SISO)
- 7.2.2 Serial-in, parallel-out (SIPO)
- 7.2.3 Parallel-in, serial-out (PISO)
- 7.2.4 Parallel-in, parallel-out (PIPO)
- 7.3 Explain shift-Right and Shift-Left registers
- 8 UNDERSTAND DIGITAL COUNTERS & CLOCK USING BLOCK DIAGRAMS.**
- 8.1 Enlist various types of counters
- 8.2 Describe various types of counters using block diagram (ripple, synchronous, presentable).
- 8.3 Explain working of a digital clock, using block diagram.
- 8.4 Select components for a digital clock, moving message display and frequency counters.
- 9 KNOWS VARIOUS TYPES OF MEMORIES.**
- 9.1 Define various types of memories: ROM, PRM, EPROM, RAM.
- 9.2 State memory of common memory devices in KB, MB.
- 9.3 Know the system of memory addressing.
- 10 UNDERSTAND INTERCONVERSION OF ANALOG AND DIGITAL SIGNALS, USING BLOCK DIAGRAMS.**
- 10.1 State need for D/A and A/D conversion.
- 10.2 Describe the system of D/A conversion using block diagram.
- 10.3 Explain the system of A/D conversion, using block diagram.
- 10.4 Give example of a simple system from analog input to analog output, using A/D & D/A converters.

**11 UNDERSTAND THE ORGANIZATION (ARCHITECTURE) OF 8085 MICROPROCESSOR, USING BLOCK DIAGRAM.**

- 11.1 Explain the block diagram of a simple microprocessor system
- 11.2 Explain characteristics & functions of components of a microprocessor system
- 11.3 Explain the architecture/organization of a microprocessor system
- 11.4 Describe the 8085 microprocessor, using block diagram.

**12 APPLY THE CONCEPTS OF DIGITAL ELECTRONICS FOR PROJECT MAKING.**

- 12.1 Explain the use of digital electronic circuits as elements of a chosen larger system
  - 12.2 Describe the use of digital electronic circuits for the following: -
    - 12.2.1 Moving displays
    - 12.2.2 Frequency counters
    - 12.2.3 Digital Clock
-

## **PART-II**

### **INDUSTRIAL ELECTRONICS**

#### **13 UNDERSTAND THE WORKING OF POWER DIODES AND THYRISTORS.**

- 13.1 State the ratings of power diodes and SCR.
- 13.2 Explain characteristics of power diodes
- 13.3 Explain the series & parallel operation of power diodes
- 13.4 Draw and explain characteristics of SCR.
- 13.5 Describe the phase control and resulting output of SCR.
- 13.6 Explain series & parallel operation of SCRs.

#### **14 UNDERSTAND THE OPERATION OF PHASE CONTROLLED RECTIFIERS & CONVERTERS, WITH THE HELP OF CIRCUIT AND WAVE DIAGRAMS.**

- 14.1 State various methods of phase control for SCRs.
- 14.2 Explain with the help of circuit and wave diagrams the operation of controlled rectifier.
- 14.3 Explain the forced commutation control method SCR
- 14.4 Explain the operation of half and full-wave naturally commutated converters.

#### **15 UNDERSTAND SINGLE AND THREE PHASE FULL-WAVE CONVERTER/INVERTER.**

- 15.1 Draw circuit for 1-phase and 3-phase full-wave inverter circuit.
- 15.2 Explain the working of inverter circuit (1-phase & 3-phase)
- 15.3 Explain the line commutated (single and three phase) inverter with full-wave output.
- 15.4 Know the combined operation of rectifier and inverter as four quadrant control of a converter.

#### **16 UNDERSTAND THE USE OF POWER ELECTRONICS FOR CONTROL OF A.C./D.C. MOTORS - UNDERSTAND THE USE OF DIODES & SCRs CONNECTED FOR 1-PHASE & 3-PHASE, FOR SPEED CONTROL OF D.C. MOTORS.**

- 16.1 State the methods of speed control of DC motors.
- 16.2 Explain the speed control of DC motors employing 3-phase full-wave controlled rectifier circuits.
- 16.3 Describe the speed control of DC motors employing 1-phase fully controlled rectifier circuit, with the help of circuit and waveform.
- 16.4 Draw circuit for a 3-phase fully phase controlled, 4-quadrant speed control of DC motors.

#### **17. UNDERSTAND USE OF POWER ELECTRONICS FOR CONTROL OF AC MOTORS.**

- 17.1 State methods of AC Motors Control.
- 17.2 Draw circuit, and waveform for 3-phase AC variable output voltage employing semi-conductor devices.
- 17.3 Draw circuits and waveforms for 3-phase AC variable frequency circuits employing semi-conductor devices.
- 17.4 Explain the methods employing SCRs and diodes for 3-phase variable voltage, variable frequency (AC to AC conversion) as applied to induction motor speed control, using circuits, and waveforms.
- 17.5 Describe with the help of block diagrams and waveforms, the pulse width modulation technique (PWM) of frequency variation, employing 1-phase and 3-phase input supply.
- 17.6 Explain PWM and variable-voltage method for speed control of 3-phase induction motors.
- 17.7 Draw block diagram and waveform for cyclo-converters giving 1-phase and 3-phase variable frequency output.
- 17.8 State the use of SCR cyclo-converters for speed control of AC motors.
- 17.9 Draw and explain the open-loop speed control of electric motors.
- 17.10 Draw and explain the closed-loop speed control of motors.

**18 UNDERSTAND WORKING AND USES OF SERVO AND SYNCHRO SYSTEMS.**

- 18.1 Define synchro-generator, synchro motor, types of synchro-servo mechanism.
- 18.2 Draw and explain diagram showing use of synchro-generator and synchro-motor.
- 18.3 Describe the differential synchros.
- 18.4 Draw and explain block and circuit diagrams for AC and DC systems of servo mechanism.
- 18.5 Explain characteristics and industrial applications of servo-motors.

**19 UNDERSTAND THE USE OF PLC'S FOR A GIVEN LADDER-LOGIC CONTROL.**

- 19.1 Explain the working of PLC's
- 19.2 Explain the uses of PLC in industrial control
- 19.3 Define the terms: ladder logic, input logic output of PLC's.
- 19.4 Write the codes for the input-output devices for a given logic.
- 19.5 Know the various modes of operation for PLC's.
- 19.6 Converts the given ladder logic diagram of a control problem into its components as inputs, outputs, logic elements & numbering the logic elements.
- 19.7 Know method for sequencing multi-rung circuits into sequenced sections for additional capacity of PLC.
- 19.8 Know the use of A/D & D/A converter for use alongwith a given ladder logic diagram.
- 19.9 Know the use of timers, sequential registers and other multi-contact logic devices.

**20. UNDERSTAND USE OF COMPUTER SOFTWARE FOR LADDER LOGIC**

**CONTROL.**

- 20.1 Explain the development of logic software for PLCs
- 20.2 Explain logging in of logic software
- 20.3 Control a given operation through PLCs

**LIST OF PRACTICALS**

- 1        Identify and verify truth tables for AND, OR, NOT Gates IC's
- 2        Identify and verify truth tables for NOR, NAND, XOR Gates IC's
- 3        Identify various IC gate packages and verify operation of each gate
- 4        Construct and verify truth tables of half adder, full adder
- 5        Study multiplexing and demultiplexing circuits
- 6        Connect & study an adder-subtractor circuit
- 7        Study decoder circuits
- 8        Study seven-segment decoder
- 9        Identify and verify the functions of RS Flip-Flop
- 10       Identify and verify the functions of Clocked RS Flip-Flop
- 11       Identify and verify the functions of D Flip-Flop
- 12       Identify and verify the functions of JK Flip-Flop
- 13       Identify and verify the functions of Schmitt Trigger
- 14       Connect a 555 IC as
  - 14.1    Astable multivibrator
  - 14.2    Monostable multivibrator
  - 14.3    Bistable multivibrator
- 15       Connect and observe the working of shift registers (SISO, SIP, PISO, PIPO).
- 16       Identify, connect and observe working of ripple and synchronous counters
- 17       Select components, assemble and observe working of a digital clock (Project-1)
- 18       Study the working of memory devices
- 19       Connect and observe working of D/A and A/D converters
- 20       Study the architecture, functions and characteristics of 8085 microprocessor
- 21       Assemble and observe working of frequency counter(Project-2)
- 22       Assemble and observe working of moving message display (Project-3)

**INDUSTRIAL ELECTRONICS**

- 23       Study the characteristics and series-parallel working of power diodes
- 24       Demonstrate SCR phase control
- 25       Observe the characteristics & working of forced commutated controlled-rectifier circuits
- 26       Observe the characteristics and working of naturally commutated full-wave convertors
- 27       Study the 4-quadrant control of SCR's
- 28       Construct and study working of 1-phase full-wave inverter circuit
- 29       Construct and study working of 3-phase full-wave inverter
- 30       Study 3-phase full-wave control circuit for DC motors
- 31       Study working of AC to AC converters as AC motor speed controller
- 32       Study PWM technique of frequency control
- 33       Study working of SCR cyclo-converter
- 34       Study open & closed loop induction motor speed control
- 35       Study characteristics and working of synchro-generator and synchro-motors

- 36 Study the behaviour of Differential Synchro
- 37 Study characteristics & working of servo-motors.
- 38 Study of PLC hardware
- 39 Study of given process and development of ladder diagrams
- 40 Developing software for a given ladder diagram and inputting it
- 41 Application of PLC to practical control applications
- 42 Use of computer software for practical control applications.

**TEXT/REFERENCE BOOKS**

- 1 Digital Electronics by Malvino
- 2 Electronics in Industry by Chute
- 3 Power Electronics by B.W. Williams
- 4 Basic Principles & Practice of Microprocessor by Heffer, King, Keith
- 5 Power Electronics & Controls, Samir Datta
- 6 Trade Literature on PLC and their Applications
- 7 Allen Bradley: Mini-Programmable Controllers Programming and Operation Manual
- 8 Programmable Logic Controllers by Mike Birmingham and Keith Brown