Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title: **TRANSFORMERS AND AC MOTORS**		Course Code	: 15EE41T
Semester	: **IV**	Course Group	: **Core**
Teaching Scheme (L:T:P)	: **4:0:0** (in Hours)	Credits	: **4 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **52**
CIE	: **25 Marks**	SEE	: **100 Marks**

Pre-requisites : Elements of Electrical Engineering, Electrical Circuit Theory, DC Machines and Alternators.
Course Objectives : To learn working principle, construction, operation and performance of Transformers, Induction Motors and Synchronous Motors.

Course Topics:

Unit No	Unit Name	Hours
1	Transformers	14
2	Three phase Transformers	6
3	Induction Motors	11
4	Starting and Speed control of Induction Motors.	7
5	Synchronous Motors	7
6	Single phase Motors	7
	Total	**52**

CourseOutcomes

On successful completion of the course, the student will be able to:

1. Explain the construction, working, types of Transformers. Understand equivalent circuit, regulation and efficiency.
2. Explain different 3 phase transformer connections, parallel operation, cooling of transformers and auto transformers.
3. Explain the construction, working, types of Induction Motors. Understand equivalent circuit, power, torque and types.
4. Analyze different starting and speed control methods.
5. Describe working, operation on load, characteristics, hunting, starting of Synchronous motors.
6. Differentiate single phase motors, linear induction motors and induction generators.

Composition of Educational Components

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's Taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)	Total Marks (Out of 145)
1	Remembering	15	20
2	Understanding	50	75
3	Application/ Analysis	35	50
Total		**100**	**145**

Course Outcome linkage to Cognitive Level

Cognitive Level Legend: R- Remember, U- Understand, A- Application

Course Outcome		CL	Linked PO	Teaching Hrs
CO1	Explain the construction, working, types of Transformers. Understand equivalent circuit, regulation and efficiency.	***R/U/A***	2, 10	14
CO2	Explain different 3 phase transformer connections, parallel operation, cooling of transformers and auto transformers.	***U/A***	2,10	6
CO3	Explain the construction, working, types of Induction Motors. Understand equivalent circuit, power, torque and types.	***R/U/A***	2,10	11
CO4	Analyze different starting and speed control methods.	***U/A***	2,10	7
C05	Describe working, operation on load, characteristics, hunting, starting of Synchronous motors.	***R/U/A***	2, 5, 10	7
C06	Differentiate single phase motors, linear induction motors and induction generators.	***R/U***	2, 5, 6, 10	7
		Total sessions		**52**

Course Content and Blue Print of Marks for SEE:

Unit No	Unit Name	Hour	Max. Marks per Unit	Questions to be set for (5marks) PART - A			Questions to be set for (10marks) PART - B			Marks weightage (%)
				R	U	A	R	U	A	
1	Transformers	14	40	1	1			1	2	28
2	Three phase Transformers	06	15		1			1		10
3	Induction Motors	11	30	1		1		1	1	20
4	Starting and Speed control of Induction Motors.	7	20		1			0.5	1	14
5	Synchronous Motors	7	20	1	1				1	14
6	Single phase Motors	7	20	1				1	0.5	14
	Total	**52**	**145**	**9 (45 Marks)**			**10 (100 Marks)**			**100**

Course-PO Attainment Matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Electrical Machines - II	**-**	**3**	**-**	**-**	**2**	**1**	**-**	**-**	**-**	**3**

LEVEL 3- HIGHLY ADDRESSED, LEVEL 2-MODERATELY ADDRESSED, LEVEL 1-LOW ADDRESSED.

METHOD IS TO RELATE THE LEVEL OF PO WITH THE NUMBER OF HOURS DEVOTED TO THE COS WHICH ADDRESS THE GIVEN PO.
IF ≥40% OF CLASSROOM SESSIONS ADDRESSING A PARTICULAR PO, IT IS CONSIDERED THAT PO IS ADDRESSED AT LEVEL 3
IF 25 TO 40% OF CLASSROOM SESSIONS ADDRESSING A PARTICULAR PO, IT IS CONSIDERED THAT PO IS ADDRESSED AT LEVEL 2
IF 5 TO 25% OF CLASSROOM SESSIONS ADDRESSING A PARTICULAR PO, IT IS CONSIDERED THAT PO IS ADDRESSED AT LEVEL 1
If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

Course Content:

Unit 1

Transformers

Working principle, construction and classification- Working principle of transformer. Classify the various types of transformers Based on construction Based on application. Explain briefly the various parts of the transformer and explain the functions of each part. Name the different insulating material used in transformer. Write the properties and uses of transformer oil. Explain the construction of core type and shell type transformers.

Emf Equation-Derive emf equation and explain transformation ratio. Solve problem on emf equation.

Operation- Explain the operation of a transformer on no load and on load with vector Diagrams. Solve the problem on transformer on no load.

Equivalent circuit-Define the equivalent resistance of a transformer as refereed to primary and secondary side .Explain magnetic leakage in a transformer core. Explain leakage reactance & calculate equivalent reactance as referred to primary and secondary side. Write the formula for equivalent impedance.
1) Referred to primary. 2) Referred to secondary
Draw the equivalent circuit diagram of a transformer.

Regulation and Efficiency- Explain the various losses in a transformer. Define voltage regulation and efficiency in the transformer. Write equation for voltage regulation and efficiency. State the condition for maximum efficiency Define all day efficiency. Solve the problems on all day efficiency. Pre-determine the Regulation and Efficiency of 1-ph transformer by conducting O.C. and S.C. tests.

Parallel operation-Explain the necessity and conditions for parallel operation. Explain with neat sketches parallel operation of single phase transformers with their load sharing.

Unit 2

Three- Phase transformers

Three-Phase transformers-Explain working principle & construction of 3 phase transformers. Explain star-star, Delta-Delta, star-Delta, Delta-star, open delta and Scott connections

Cooling of transformer-Explain the necessity of cooling of transformer. List and explain the various types of cooling of transformer. Write the meaning of AN, ON, OFA.

Auto transformer-Explain briefly an auto transformer. Compare auto transformer with two winding transformer. List the application of auto transformer.

Unit 3

Induction Motors

Working principle-Explain the working principle of induction motor. Compare with a Transformer. Explain how the rotating magnetic field is produced by polyphase supply. Define the terms slip, frequency of rotor current.

Types-Describe the construction of stator, squirrel cage rotor and phase wound rotor.

Torque-Derive an expression for starting torque. Explain the starting torques of squirrel cage and slip ring induction motor. State the condition for max starting torque. Explain the effect of change in supply voltage on starting torque. State equation for torque under running conditions. Draw torque - slip curves. State relationship between- Full load torque and maximum torque. Starting torque and maximum torque.

Equivalent circuit- Draw the equivalent circuit of an induction motor.

Power output-State the relationship between rotor power input, rotor copper loss, and Mechanical power developed and slips. Solve problems on the above.

Unit 4

Starting and Speed control of Induction Motors.

Starting-Explain the necessity of starters for 3-phase induction motors and list the various types of starters .Explain the construction and working of D.O.L. Starter, Star-Delta Starter and Auto-Transformer Starter.

Speed control-with neat circuit diagram. Explain the speed control of 3-ph induction motor. Change of applied voltage, Change of frequency (Variable voltage and variable frequency) and Rheostat control.

Unit 5

Synchronous Motors

Working principle-Describe the general principle of operation of synchronous motor. Compare the synchronous motor with induction motor.

Operation on load-Explain the effect of change in excitation at constant load and V-curves

Characteristics-Explain the effect of excitation on armature current & power factor.

Hunting-Explain hunting and its prevention.

Starting-Explain the methods of starting synchronous motor.

Applications-Explain the applications of synchronous motors.

Unit-6

Single Phase Induction Motors.

Principle of Operation-Double revolving field theory. **Starting**-Resistance Split phase motor, Capacitor split phase motor - Capacitor Start Induction motor, Capacitor Start and Run Induction motor, Shaded pole motor.

Linear induction motor-Introduction, Explain the principle of working & characteristics of linear induction motor. Magnetic Levitation.

Induction Generators-Explain Induction Generators and its applications.

REFERENCE BOOKS

1. Electrical Technology volume 2 - BL Theraja & A.K.Theraja S.Chand publication.
2. Principles of Electrical Machines by V.K.Mehtha.S.Chand publication.
3. Electrical machines - Theory and Practice by M.N. Bandyopadhyay PHI publication.
4. Electrical Machines by Bhattacharya. Tata McGraw Hill Co.
5. Electrical Machines - J.B.Guptha Kataria & Sons Publications.

E-Resources

1. http://www.schandgroup.com
2. http://phindia.com
3. http://ikbooks.com

Course Delivery:

The Course will be delivered through lectures, classroom interaction, animations, group discussion, exercises, assignments and Student activities.

Course Assessment and Evaluation

	What		To Whom	Frequency	Max Marks	Evidence Collected	Course Outcomes
Direct Assessment	CIE (Continuous Internal Evaluation)	I A Tests	Students	Three IA tests for Theory: (Average marks of Three Tests to be computed).	20	Blue Books	1 to 6
		Classroom Assignments		Student Activity	05	Handwritten Report	1 to 6
				TOTAL	**25**		
	SEE (Semester End Examination)	End Exam	Students	End Of the Course	100	Answer Scripts at BTE	1 to 6
Indirect Assessment	Student Feedback on course		Students	Middle Of The Course	Feed Back Forms		1 to 3
	End Of Course Survey			End Of The Course	Questionnaires		1 to 6

***CIE** – Continuous Internal Evaluation ***SEE** – Semester End Examination

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Course Contents with Lecture Schedule:

Lesson No./ Session No.	Contents	Duration
Unit 1	**Transformers**	**14**
1.	Working principle of transformers.	01 Hour
2.	Classification based on construction and based on application.	01 Hour
3.	Various parts of the transformer and functions of each part. Different insulating material used in transformer.	01 Hour
4.	Properties and uses of transformer oil. Construction of core type and shell type transformers.	01 Hour
5.	Derive emf equation and explain transformation ratio (K).	01 Hour
6.	problem on emf equation	01 Hour
7.	problem on emf equation	01 Hour
8.	Operation of a transformer on no load. Operation of a transformer on load with vector Diagrams.	01 Hour
9.	Problem on transformer on no load.	01 Hour
10.	Equivalent circuit of transformer	01 Hour
11.	Various losses in a transformer. Voltage regulation and efficiency in the transformer. Write equation for voltage regulation and efficiency. Pre-determine the Regulation and Efficiency of 1-ph transformer by conducting O.C. and S.C. tests	01 Hour
12.	State the condition for maximum efficiency. Define all day efficiency. Solve the problems on all day efficiency.	01 Hour
13.	Necessity and conditions for parallel operation.	01 Hour
14.	Parallel operation of single phase transformers with their load sharing.	01 Hour
Unit 2	**Three phase Transformers**	**06**
15	Working principle & construction of 3 phase transformers.	01 Hour
16	Star-star, Delta-Delta, star-Delta, Delta-star, open delta and Scott connections.	01 Hour
17	Necessity of cooling of transformer and types	01 Hour
18	Explain of types cooling of transformer.	01 Hour

Lesson No./ Session No.	Contents	Duration
19	Explain of types cooling of transformer.	01 Hour
20	Briefing of an auto transformer. Compare auto transformer with two winding transformer. And application.	01 Hour
Unit 3	**Induction Motors**	**11**
21	Working principle of induction motor. Compare with it a Transformer.	01 Hour
22	Rotating magnetic field produced by poly phase supply.	01 Hour
23	Define the terms slip, frequency of rotor current. problems	01 Hour
24	Construction of stator, squirrel cage rotor and phase wound rotor.	01 Hour
25	Derive an expression for starting torque. Explain of starting torques of squirrel cage and slip ring induction motor.	01 Hour
26	Condition for max starting torque. Effect of change in supply voltage on starting torque.	01 Hour
27	Equation for torque under running conditions. Draw torque – slip curves.	01 Hour
28	Relationship between- Full load torque and maximum torque. Starting torque and maximum torque	01 Hour
29	Equivalent circuit of an induction rotor.	01 Hour
30	Relationship between rotor power input, rotor copper loss, and Mechanical power developed and slips.	01 Hour
31	Problems on the above.	01 Hour
Unit 4	**Starting and Speed control of Induction Motors.**	**07**
32	Necessity of starters and list the various types of starters .	01 Hour
33	Explain of construction and working of D.O.L. Starter	01 Hour
34	Explain of construction and working of Soft Starter.	01 Hour
35	Explain of construction and working of star-delta Starter.	01Hour
36	Speed Control of induction motor Change of applied voltage methods	01 Hour
37	Speed Control of induction motor Change of Change of poles methods	01 Hour
38	Speed Control of induction motor by Change of frequency and Rheostat control methods	01 Hour

Lesson No./ Session No.	Contents	Duration
Unit 5	**Synchronous Motors**	**07**
39	Describe general principle of operation of synchronous motor.	01 Hour
40	Compare the synchronous motor with induction motor.	01 Hour
41	Explain the effect of change in excitation at constant load and V-curves	01 Hour
42	Explain the effect of excitation on armature current & power factor.	01 Hour
43	Effect of excitation on leading power factor.	01 Hour
44	Effect of excitation lagging and zero on power factor.	01 Hour
45	Methods of starting of synchronous motor. Hunting and its prevention. Explain of applications of synchronous motors	01 Hour
Unit 6	**Single phase motors**	**07**
46	Principle of Operation-Double revolving field theory	01 Hour
47	Resistance Split phase motor.	01 Hour
48	Capacitor Start Induction motor.	01 Hour
49	Operating principle, construction, characteristics of Single phase capacitor start capacitor run Induction Motor.	01 Hour
50	Shaded pole motor	01 Hour
51	Magnetic Levitation.	01 Hour
52	Working Principle & characteristics of Induction Generators and its applications	01 Hour

Suggested Student Activities:

Each Student has to prepare and submit at least 3 pages of self hand written report (Construction details, type of windings used, Insulating materials used, cooling methods, applications etc.,) preferably by visiting a nearby Substation/ Power station/ Industry/ Factory etc., considering any one of the following topics.

1. 1-ph & 3-ph Transformers, Core type, Shell type, Step-up Transformer, Step-Down Transformer.
2. Different Cooling Methods (any one type)
3. Transformer winding with properties of insulating materials used.
4. 1-ph and 3-ph Auto-Transformer.
5. 3-ph Induction motor- Squirrel-cage and Slip-ring type.
6. Speed control of Induction motor.
7. Types of Starters.
8. 3-ph Synchronous Motors.
9. 1-ph Induction motors and Linear Induction Motors.
10. Magnetic Levitation.
11. Induction Generators.

MODEL OF RUBRICS / CRITERIA FOR ASSESSING STUDENT ACTIVITY (Course Coordinator)

Dimension	Scale					Students score (Group of five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	3				
2	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2				
3	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	5				
4	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	4				
Note: Concerned faculty (Course coordinator) must devise appropriate rubrics/criteria for assessing Student activity for 5 marks **One activity on any one CO (course outcome) may be given to a group of FIVE students** **Grand Average/Total**						14/4 =3.5 ≈4				

Example only: MODEL OF RUBRICS / CRITERIA FOR ASSESSING STUDENT ACTIVITY-
Task given- Industrial visit and report writing

Dimension	Scale					Students score (Five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1.Organisation	Has not included relevant info	Has included few relevant info	Has included some relevant info	Has included many relevant info	Has included all relevant info needed	3				
2. Fulfill team's roles & duties	Does not perform any duties assigned	Performs very little duties	Performs partial duties	Performs nearly all duties	Performs all duties of assigned team roles	2				
3.Conclusion	Poor	Less Effective	Partially effective	Summarises but not exact.	Most Effective	5				
4.Conversions	Frequent Error	More Error	Some Error	Occasional Error	No Error	4				
					Total marks	14/4=3.5 ≈4				

FORMAT OF I A TEST QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I test/6 th weak of sem 10-11 Am	I/II SEM		20
	Year:		

Name of Course coordinator : Units:__
CO's:____

Question no	Question	MARKS	CL	CO	PO
1					
2					
3					
4					

Note: Internal Choice may be given in each CO at the same cognitive level (CL).

MODEL QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
1st Test/ 6 th week, 9 Feb 16, 10-11 AM	IV SEM, E & E Engg	**Transformers and AC Motors**	20
	Year: 2015-16	Course code:	

Name of Course coordinator :
Units Covered :1 and 2
Course Outcomes : 1 and 2

Instruction : *(1). Answer all questions (2). Each question carries five marks*

Question No.	Question	CL	CO	PO
1	Write a short note on All day efficiency of the transformer.	R	1	2, 10
2	Explain the principle of operation of transformer. OR A single phase 50 Hz transformer has 100 turns on the primary and 400 turns on the secondary winding. The net cross-sectional area of core is 250 cm2 . If the primary winding is connected to a 230 V 50 Hz supply, determine i. The EMF induced in the secondary winding ii. The maximum value of flux density in the core.	U A	1	2, 10
3	Explain the construction of 3 phase transformers	U	2	2, 10
4	Explain Necessity of cooling of transformer and types OR Discuss Parallel operation of single phase transformers with their load sharing.	A A	2	2, 10

CL: Cognitive Level, R-Remember, U-Understand, A-Application, PO: Program Outcomes

Model Question Paper:

Code: 15EE41T

IV Semester Diploma Examination

Department of Electrical and Electronics Engineering

TRANSFORMERS AND AC MOTORS

Time: 3 Hours] **[Max Marks: 100**

***Note*:** i) Answer any SIX questions from PART - A. Each question caries 5 marks.
ii) Answer any SEVEN Questions from PART - B. Each question caries 10 marks.

PART – A

1. How the iron losses are minimized?
2. Explain the working principle of transformer.
3. What are the advantages of 3-phase transformers over 1-phase transformers?
4. Arrange the connections for 3-phase transformers for the following
   i)Star-star ii)Delta-star
5. Explain the principle of operation of a three-phase induction motor.
6. Explain how torque is produced in the rotor of an induction motor?
7. Explain the necessity of starter in Induction motor.
8. Describe the general principle of operation of synchronous motor.
9. State applications capacitor start 1-phase IM.

PART – B

1. a) Derive the emf equation of single phase transformer. 5
   b) A single phase 50 Hz transformer has 100 turns on the primary and 400 turns on the secondary winding. The net cross-sectional area of core is 250 cm^2 . If the primary winding is connected to a 230 V 50 Hz supply, determine i. The EMF induced in the secondary winding ii. The maximum value of flux density in the core. 5
2. a) Draw and explain phasor diagram of transformer on lagging load. 6
   b) What are the conditions required for the parallel operation of two 1-phases Transformers. 4
3. a) Arrange the connections for 3-phase transformers for the following
      i) Delta-delta
      ii) Star-delta
      iii) Scot-connection 6
   b) Give the comparison between 3-phae and 1- phase transformers. 4
4. a) Explain why an induction machine is called a generalized transformer. 6
   b) Explain how torque is produced in the rotor of an induction motor? 4
5. a) Explain with neat sketch the construction of slip ring induction motor. 6
   b) Derive condition of maximum torque developed in a 3-phase induction motor. 4

6. a) Explain with neat sketch the construction and working of DOL starter. 6
   b) Explain with neat sketch the construction and working of star delta starter. 4

7. a) Explain speed control of 3-phase slip ring induction motor by rheostat control .6
   b) Explain the effect of change in excitation at constant load. 4

8. a) Explain with neat sketches the effect of excitation on armature current. 6
   b) Compare Synchronous motor with Induction motor 5

9. a) State the characteristics of permanent magnet synchronous motor. 4
   b) Explain construction, principle of operation, Single phase Capacitors start I.M. 6

10. a) Explain the principle of working & characteristics of linear induction motor.6
    b) Explain Magnetic Levitation. 4

Model Question Paper Bank

Course Title: **TRANSFORMERS AND AC MOTORS**	Course Code : 15EE41T

Unit-1

Cognitive Level: REMEMBER

1. Give the constructional differences between a core type and shell type transformers.
2. How the iron losses are minimized?
3. Define efficiency and regulation of a transformer.
4. Write a short note on All day efficiency of the transformer.

Cognitive Level: UNDERSTAND

5. Derive the emf equation of single phase transformer.
6. What are the conditions required for the parallel operation of two 1-phase transformers.
7. Explain the working principle of transformer.
8. Explain how equivalent circuit of transformer can be obtained?
9. Explain the principle of operation of transformer.
10. Explain why hysteresis and eddy current losses occur in a transformer.
11. Draw the phasor diagram of a transformer on no load

Cognitive Level: APPLICATION

12. A single phase 50 Hz transformer has 100 turns on the primary and 400 turns on the secondary winding. The net cross-sectional area of core is 250 cm2 . If the primary winding is connected to a 230 V 50 Hz supply, determine i. The EMF induced in the secondary winding ii. The maximum value of flux density in the core.
13. Explain the function of active and reactive components of no load current of transformer.
14. Explain the functions of the following in a transformer i. Breather ii. Conservator iii. Oil
15. Draw and explain phasor diagram of transformer on lagging load
16. Discuss how will you perform O.C and S.C test on a single phase transformer?
17. Explain the following with respect to single phase transformer i) Core ii) Winding iii) Methods of cooling iv) Conservator and bushing.
18. Explain various losses and derive the condition for maximum efficiency of a transformer.
19. Explain the Woking of an auto transformer
20. Compare autotransformer with two winding transformer.
21. Derive the equation for saving in copper in using Auto transformer when compared to two winding transformer.

Unit-2

Cognitive Level: UNDERSTAND

22. What are the advantages of 3-phase transformers over 1-phase transformers?
23. Explain the working principle of 3 phase transformers.
24. Explain the construction of 3 phase transformers.
25. Discuss about an auto transformer.

Cognitive Level: APPLICATION

26. Discuss the arrangement of the connections for 3-phase transformers for the following (a). Star-star (b). Delta-star
27. Explain the arrangement of the connections for 3-phase transformers for the following (a).Delta-delta (b).Star-delta (c) Scot-connection
28. Explain Star-star, Delta-Delta, star-Delta, Delta-star, open delta and Scott connections.
29. Explain Necessity of cooling of transformer and types
30. Explain of types cooling of transformer.
31. Compare auto transformer with two winding transformer and application.
32. Explain the necessity and conditions for parallel operation.
33. Discuss Parallel operation of single phase transformers with their load sharing.

Unit-3

Cognitive Level: REMEMBER

34. Explain the principle of operation of a three-phase induction motor.
35. Explain how torque is produced in the rotor of an induction motor?
36. Explain with neat sketch the construction of squirrel induction motor.

Cognitive Level: UNDERSTAND

37. With the help of rotor equivalent circuit of an induction motor, show that the power transferred magnetically from stator to rotor.
38. Sketch & discuss the typical torque-speed characteristics of an induction motor.
39. Derive the condition of maximum torque developed in a 3-phase induction motor.

Cognitive Level: APPLICATION

40. Discuss the points of similarities between a transformer and an induction machine.
41. Explain why an induction machine is called a generalized transformer.
42. Explain how torque is produced in the rotor of an induction motor?
43. Derive the expression for the rotor e.m.f and rotor current of an induction motor.
44. Explain with neat sketch the construction of slip ring induction motor.

Unit-4

Cognitive Level: UNDERSTAND

45. Explain the necessity of starter in Induction motor.
46. Explain with neat sketch the construction and working of DOL starter
47. Explain with neat sketch the construction and working of star delta starter.
48. Explain speed control of 3-phase slip ring induction motor by rheostat control.

Cognitive Level: APPLICATION

49. Explain with neat sketch the construction and working of soft starter.
50. Explain speed control of 3-phase induction motor by variable voltage
51. Explain speed control of 3-phase induction motor by variable frequency
52. Explain speed control of 3-phase induction motor by change of poles.

Unit-5

Cognitive Level: REMEMBER

53. Explain permanent magnet Synchronous motor.
54. State the characteristics of permanent magnet.

Cognitive Level: UNDERSTAND

55. Describe the general principle of operation of synchronous motor.
56. Compute Comparison between synchronous motor with induction motor.
57. Explain the effect of change in excitation at constant load.
58. Explain with neat sketches the effect of excitation on armature current.

Cognitive Level: APPLICATION

59. Explain with neat sketches the effect of excitation on power factor.
60. Explain hunting and its prevention in synchronous motor.
61. Explain the methods of starting of synchronous motor.
62. Explain the applications of synchronous motors.

Unit-6

Cognitive Level: REMEMBER

63. State applications capacitor start 1-phase IM.
64. State applications induction generator.
65. State applications permanent magnet Synchronous motor.

Cognitive Level: UNDERSTAND

66. Explain the construction, principle of operation, characteristics of Single phase Capacitors start I.M.

67. Explain the construction, principle of operation, characteristics of Single phase Capacitors run I.M.
68. Explain the principle of working & characteristics of linear induction motor.
69. Explain Magnetic Levitation.
70. Explain Induction Generators.