ELECTRICAL MACHINES-I

Subject Code : EE304PC

Regulations : R18 - JNTUH

Class : II Year B.Tech EEE I Semester

Department of Electrical and Electronics and Engineering

BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY

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ELECTRICAL MACHINES-I (EE304PC)
COURSE PLANNER

I. COURSE OVERVIEW:

This course will introduce the basic concepts and operation of rotating electric machines such as DC generator, DC Motor, single phase and three phase Transformers classification, performance characteristics and its applications.

II. PREREQUISITE:

Basic Electrical Engineering

III. COURSE OBJECTIVES:

1	To study and understand different types of DC generators, Motors and Transformers, their construction, operation and applications.
2	To analyze performance aspects of various testing methods.

IV. COURSE OUTCOMES:

S.No	Description	Bloom's Taxonomy Level
1	Students will be able to **identify** different parts of a DC machine & **understand** its operation.	Knowledge, Understand (Level1, Level2)
2	Students will be able to **carry out** different testing methods to predetermine the efficiency of DC machines.	Apply, Understand (Level2, Level1)
3	Students will be able **Understand** different excitation and starting methods of DC machines.	Understand (Level1)
4	Students will be able to **develop** the speed control of a DC machines.	Applying (Level3)
5.	Students will be able to **understand** and **classify** different parts of a transformer & understand its operation.	Knowledge, Understand (Level1, Level2)
6.	Students will be able to **analyze** 1-Ph and 3-Ph transformers circuits.	Analyze (Level3)

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assed by
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Assignments, Mock tests Mid and University Exams
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Assignments, Mock tests
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Mini and Major projects,
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Experiments

PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	1	Practice new software & hardware tools
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	1	Develop models
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	-	-
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	-	-
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	-	-
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective Presentations, and give and receive clear instructions.	-	-
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	1	Projects
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency assed by
PSO1	Talented to analyze, design and implement electrical & electronics systems and deal with the rapid pace of industrial innovations and developments	1	Assignments, Mock tests
PSO2	Skillful to use application and control techniques for research and advanced studies in Electrical and Electronics engineering domain	1	Projects, workshops and seminars

VII. SYLLABUS

JNTUH SYLLABUS

UNIT– I D.C. Generators:

Principle of operation, Action of commutator constructional features armature windings – lap and wave windings – simplex and multiplex windings – use of laminated armature – E. M.F Equation. Armature reaction – Cross magnetizing and de-magnetizing AT/pole – compensating winding – commutation – reactance voltage – methods of improving commutation. Methods of Excitation – separately excited and self excited generators – build-up of E.M.F - critical field resistance and critical speed - causes for failure to self excite and remedial measures. Load characteristics of shunt, series and compound generators

UNIT–II D.C Motors:

Principle of operation Back E.M.F, Torque equation characteristics and application of shunt, series and compound motors – Armature reaction and commutation. Speed control of D.C. Motors - Armature voltage and field flux control methods. Motor Starters (3 point and 4 point starters) Testing of D.C. machines - Losses – Constant & Variable losses – calculation of efficiency – condition for maximum efficiency.

UNIT–III Testing of DC Machines

Direct, indirect, and regenerative testing – Brake test – Swinburne's test– Hopkinson's test – Field's test - separation of stray losses in a D.C. motor test.

UNIT–IV Single phase transformers:

Types - constructional details-minimization of hysteresis and eddy current losses- EMF equation - operation on no load and on load - phasor diagrams Equivalent circuit - losses and efficiency – regulation - All day efficiency - effect of variations of frequency & supply voltage on iron losses.

UNIT–V Testing of Transformers and poly-phase Transformers

OC and SC tests - Sumpner's test - predetermination of efficiency and regulation-separation of losses test-parallel operation with equal and unequal voltage ratios - auto transformers equivalent circuit - comparison with two winding transformers. Poly phase transformers – Poly phase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δand openΔ

GATE

Electrical Machines: Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation; Auto-transformer, Electromechanical energy conversion principles, **DC machines**: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors

ESE

Electrical Machines:

Single phase transformers, three phase transformers - connections, parallel operation, auto-transformer, energy conversion principles, DC machines - types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors**.**

TEXT BOOKS:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.

REFERENCE BOOKS:

1. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.

2. P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
3. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.

OTHER BOOKS

1. Theory & Performance of Electrical Machines by J.B. Gupta, Kataria & Sons Publications.
2. A Text book of Electrical Technology by B.L.Theraja & A.L.Theraja, Volume-2, Schand Publishing.
3. Electrical Machines by Ashfaq Husain, Dhanpat Rai & Co.

NPTEL Video Course:

http://nptel.ac.in/courses/108105017/

VIII. Course Plan:

S.NO	Week	Topic	Course learning outcomes	Teaching Methodologies	Reference
		UNIT – 1 D.C Generators			
1.	1	Introduction , Principle of operation	**Define** DC generator	chalk & talk	**T1, R2&R3**
2.		Action of commutator	**Explain** commutator	chalk & talk	
3.		Armature windings – lap and wave windings	**Explain** Armature windings	chalk & talk	
4.		E.M.F Equation & Problems	**Find** EMF	chalk & talk	
5.		Armature reaction	**Explain** Armature reaction	chalk & talk	
6.	2	Cross magnetizing and de-magnetizing AT/pole	**Explain** Cross magnetizing and	chalk & talk	
7.			de-magnetizing AT/pole	chalk & talk	
8.		Compensating winding, Commutation – reactance voltage	**Explain**Compensating winding	chalk & talk	
9.		Methods of improving commutation	**Classify** improvement of commutation	chalk & talk	**T1, R2&R3**
10		Methods of Excitation – separately excited and self-excited generators	**Classify** excitation	chalk & talk	
11	3			chalk & talk	
12		Build-up of E.M.F - critical field resistance and critical speed	**Explain** build up of EMF	chalk & talk	
13		**Bridge Class-#1**			

14		Causes for failure to self-excite and remedial measures	**Identify** cause of failure	chalk & talk	
15		Load characteristics of shunt, series and compound generators	**Illustrate** of load characteristics	chalk & talk	
16	5	Problems	**Apply**	chalk & talk	
17		**Bridge Class-#2**			
18		**Mock test #1**			
			UNIT – 2 D.C Motors		
19	6	Introduction , Principle of operation , Back E.M.F	**Define** operation of DC motor		**T1, R2&R3**
20				chalk & talk	
21		Torque equation characteristics, Problems	**Explain** torque cha. and **apply**	chalk & talk	
22		Problems	**Apply**	chalk & talk	
23		Application of shunt, series and compound motors	**Classify** of motors	chalk & talk	
24	**7**	Armature reaction , commutation	**Explain** AR	chalk & talk	
25	**7**	Speed control of D.C. Motors	**Application**	chalk & talk	
26		Armature voltage and field flux control methods	**Application**	chalk & talk	
27		Motor Starters (3 point and 4 point starters)	**Explain** of starters	chalk & talk	
28		Testing of D.C. machines &Variable losses	**Choose** of testing methods	chalk & talk	
29	8	Problems	**Apply**	chalk & talk	**T1 & R2**
30		Calculation of efficiency	**Analyze**	chalk & talk	
31		Condition for maximum efficiency.	**Analyze**	chalk & talk	
32		**Bridge Class #3**			
		UNIT – 3 Methods of Testing		chalk & talk	**T1& R3**
33	9	Direct testing	**Analyze**	chalk & talk	
34		Types of Direct testing	**Analyze**	chalk & talk	
		II Mid Examinations (Week 9)		chalk & talk	
35	10	Indirect testing, Methods of	**Analyze**	chalk & talk	

		Indirect testing			
36		Regenerative testing	**Analyze**	chalk & talk	
37		Brake test & Swinburne's test	**Analyze**	chalk & talk	
38		Hopkinson's test& Field Test	**Analyze**	chalk & talk	
39		separation of stray losses in a D.C. motor test	**Analyze**	chalk & talk	**T1 & R2**
40	11	Problems	**Apply**	chalk & talk	
41		Problems	**Apply**	chalk & talk	
42		**Bridge Class #4**			
		UNIT – 4 Single Phase Transformers			
43		Types of Transformers	**Classify** of transformers	chalk & talk	
44	12	Constructional details	**Construct**	chalk & talk	
45		Minimization of hysteresis losses	**Illustrat**e of losses	chalk & talk	**R2 & R3**
46		Minimization of eddy current losses & EMF equation	**Illustrat**e of losses	chalk & talk	
47		**Bridge Class #5**			
48		Operation on no load	**Explain** no load	chalk & talk	
49	13	Operation on full load	**Explain** on full load	chalk & talk	
50		Phasor diagrams	**Illustrate** Phasor diagrams	chalk & talk	**R2 & R3**
51		Equivalent circuit – losses & Efficiency – regulation	**Develop** Equivalent circuits & **Determine** efficiency	chalk & talk	
52	14	**Bridge Class #6**			
53		All day efficiency	**Analyze**	chalk & talk	
54		Effect of variations of frequency on iron losses.	**Analyze**	chalk & talk	
55	15	Effect of variations of supply voltage on iron losses.	**Analyze**	chalk & talk	**R2 & R3**
56	15	Problems	Apply	chalk & talk	
57		**Bridge Class #7**			
		UNIT – 5 Testing of Transformers			
58	15	OC and SC tests, Sumpner's	**Analyze**	chalk & talk	**R2 & R3**

		test			
59	16	Predetermination of efficiency and Regulation	**Analyze**	chalk & talk	
60		Separation of losses, Problems	**Analyze**	chalk & talk	
61		Parallel operation with equal and unequal voltage ratios	**Explain** parallel operation	chalk & talk	**R2 & R3**
62		Transformers equivalent circuit - comparison with two winding transformers.	**Develop** transformers equi. circuits	chalk & talk	
63	17	Problem	**Apply**	chalk & talk	
64		Poly phase transformers & Poly phase connections	**Explain** poly phase Transformers	chalk & talk	
65		**OC and SC tests in MATLAB* (beyond syllabus)**	**Apply modern tools**	chalk & talk	
66	18	**Mock test-2**			
67		Revision			
68		Revision			
		II Mid Examinations (Week 19)			

IX.MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes (PO)												Program Specific Outcomes (PSO)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	1	1	-	1	-	-	-	-	1	-	2	1
CO2	2	1	2	1	-	1	-	-	-	-	1	-	2	2
CO3	2	1	2	1	-	1	-	-	-	-	1	-	2	2
CO4	2	2	1	2	1	2	-	-	-	-	1	-	2	2
CO5	3	2	2	2	2	2	-	-	-	-	1	-	2	3
CO6	2	2	2	2	2	2	-	-	-	-	1	-	2	2

X. QUESTION BANK: (JNTUH)

DESCRIPTIVE QUESTIONS:

UNIT – I DC Generators

Short answer questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	What is mmf? Give its expression	Remembering	1
2	What is magnetic field strength	Remembering	1
3	What are the materials used for brushes in dc machines?	Remembering	1
4	What is the principle of energy conversion?	Remembering	1
5	What is the purpose of single excited devices?	Remembering	1
6	Give the function of electro-mechanical transducer.	Remembering	1
7	Draw the B-H curve of permanent magnet.	Understanding	2
8	Write the expression of the energy absorbed by the magnetic system.	Remembering	1
9	What are the excitation methods in dc machines?	Remembering	1
10	What are the types of dc generators?	Remembering	1
11	What is multiplex winding?	Remembering	1
12	What is the purpose of laminating the armature?	Remembering	1
13	Distinguish between progressive and retrogressive wingding	Remembering	1
14	How does emf build up in dc shunt generator?	Remembering	1
15	Define critical field resistance and critical speed?	Remembering	1
16	Why is permanent magnet generators rarely used in industry?	Remembering	1
17	What is voltage drop allowed for all brushes of each polarity for carbon or graphite brushes?	Remembering	1

Long answer questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	Explain the construction of dc machine with neat diagram.	Evaluating	4
2.	What is meant by circuit model of dc machine? Explain them in detail.	Evaluating	4
3.	Explain the various methods of excitation of dc machines.	Evaluating	4
4.	Explain the process of voltage build up in a dc shunt generator?	Remembering	1
5.	A 4-pole generator has a wave-wound armature with 722 conductors, and it delivers 100 A on full load. If the	Remembering	1

	brush lead is 80 calculate the armature demagnetizing and cross magnetizing ampere turns per pole.		
6.	Derive the expression for demagnetizing AT/pole	Applying	3
7.	Draw a developed diagram of 2 layer lap winding for a 4 pole DC generator with 16 coils.	Evaluating	4
8.	What do you understand from the term armature reaction? Describe the role of compensating windings in a dc generator?	Understanding	2
9.	In a DC compound generator the armature, shun-field winding and series field winding resistances are given by 0.6 ohm, 150 ohm and 0.3 ohms respectively. The machine is connected to a load 15 kW, 200 V. Find the i)EMF generated ii) armature current and iii) power generated by armature when the machine is connected in long shunt mode.	Evaluating	1
10.	Distinguish between GNA and MNA. Describe the role of inter poles in a DC generator.	Remembering	1
11.	Draw the load characteristics of DC compound motor and shunt motor.	Applying	3
12.	Explain Methods of excitation in DC machines	Remembering	4

UNIT – II DC Motors

Short answer questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	On what principle does the generator operate?	Remembering	1
2.	Why are cast iron and fabricated steel yoke used in mall and large machines respectively?	Remembering	1
3.	Why the armature of a dc machine is made Of laminated silicon steel?	Remembering	1
4.	What is the function of commutator in a dc machines?	Remembering	1
5.	What for brushes are employed in dc machines?	Remembering	1
6.	What are the different types of armature windings commonly used in dc machines?	Remembering	1
7.	Which type of dc armature requires equalizer rings?	Remembering	1
8.	Write down the emf equation of the dc generator?	Remembering	1
9.	What is the armature reaction?	Remembering	1
10.	What are the methods to reduce the armature reaction?	Remembering	1
11.	What is the commutation? How to improve the commutation in dc generator?	Remembering	1
12.	Name the important parts of dc machine?	Remembering	1
13.	What is rotating torque?	Remembering	1
14.	Obtain an expression for armature torque.	Remembering	1
15.	Mention the application of various dc motor.	Remembering	1
16.	List out the factors that control the speed of a dc motor.	Remembering	1
17.	Give few applications of Ward-Leonard systems.	Remembering	1
18.	Why is starter needed to start the dc motor?	Remembering	1

Long answer questions:

S.No	Question	Blooms	Course

		Taxonomy Level	Outcome
1.	Describe the principle of operation of a dc generator?	Remembering	1
2.	How can induced emf in the armature conductors of a dc generator be made unidirectional?	Remembering	1
3.	With the help of sketches describe the main parts of a dc machine? Explain the main function of each.	Remembering	1
4.	What are the similarities and dissimilarities between lap and wave windings in a dc machine?	Remembering	1
5.	Define: pole pitch, full pitch, short pitch, front pitch, back pitch, resultant pitch, commutator pitch and average pitch.	Remembering	1
6.	Derive an equation for emf in a dc machine.	Remembering	1
7.	What is meant by the armature reaction? How does it affect the main field flux?	Remembering	1
8.	How demagnetizing and cross magnetizing ampere turns per pole are calculated in a dc machine?	Remembering	1
9.	Explain the process of commutation in dc generators with neat sketch. What are the types of commutation possible in a dc machines?	Remembering	1
10.	What are the methods to improve commutation and explain?	Remembering	1
11.	i) Explain the speed-torque characteristics of dc shunt and dc series motors (ii) A 230 V, dc shunt motor, takes an armature current at 3.33 A at rated voltage and at a no-load speed of 1 000 rpm. The resistances of the armature circuit and field circuit are 0.3 Ω and 160 Ω respectively. The line current at full load and rated voltages is 40 A. Calculate, at full load, the speed and the developed torque in case the armature reaction weakens the no-load flux by 4 %.	Understanding	2
12.	Explain the various losses which take place in a dc machine.	Understanding	2
13.	Two separately-excited dc generators are connected in parallel and supply a load of 200 A. The machines have armature circuit\ resistance of 0.05 Ω and 0.1 Ω and induced emf of 425 V and 440 V respectively. Determine the terminal voltages, current and power output of each machine. The effect of armature reaction is to be neglected.	Analyzing	3
14.	Derive an expression for the emf generated in the armature winding of a dc machine.	Remembering	1
15.	A long-shunt compound generator delivers a load current of 50 A at 500 V and has armature, series field and shunt field resistances of 0.05 Ω, 0.03 Ω and 250 Ω respectively. Calculate the generated voltage and the armature current. Allow IV per brush or contact drop.	Analyzing	3
16.	Explain the method of speed control of dc motors with field control.	Understanding	2
17.	Draw the diagram of 3 point starter and explain its working.	Remembering	1
18.	A 440 V dc shunt motor takes 4 A at no load. Its armature and field resistance are 0.4 Ω and 2 220 Ω respectively. Estimate the kW output and efficiency when	Analyzing	3

	the motor takes 60 A on full load.		

UNIT – III Methods of Testing of DC machines

Short answer questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	What are the losses in the rotating electrical machines?	Remembering	1
2.	How do copper losses occur in dc machine?	Remembering	1
3.	What is iron loss where it occurs in dc machines?	Remembering	1
4.	How to minimize the copper and iron losses in electrical machines?	Remembering	1
5.	When does the maximum efficiency of a dc machine take place?	Remembering	1
6.	What is the main drawback of brake test?	Remembering	1
7.	Why Swinburne's test cannot perform on dc series machines?	Remembering	1
8.	What are the losses in the rotating electrical machines?	Remembering	1

Long answer questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	Derive an expression for the emf generated in the armature winding of a dc machine.	Remembering	1
2.	A long-shunt compound generator delivers a load current of 50 A at 500 V and has armature, series field and shunt field resistances of 0.05 Ω, 0.03 Ω and 250 Ω respectively. Calculate the generated voltage and the armature current. Allow IV per brush for contact drop.	Analyzing	3
3.	Two dc generators are connected in parallel to supply a load of 1 500 A. One generator has an armature resistance of 0.5 Ω and an emf of 400 V while the other has an armature resistance of 0.04 Ω and an emf of 440 V. The resistances of shunt fields are 100 Ω and 80 Ω respectively. Calculate the current supplied by the individual generators and the terminal voltage.	Analyzing	3
4.	Derive the condition to obtain maximum efficiency of dc machines.	Remembering	1
5.	A 60 kW, 400 V, dc shunt motor has 4 poles and a wave connected armature of 150 conductors. The flux per pole is 45 mWb. R_a = 0.1 Ω and R_{sh} = 200 Ω. If the full load efficiency is 90.5 %, find the speed, armature torque and useful torque.	Analyzing	3

UNIT – IV Single Phase Transformer

Short Answer Questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	What is the function of Transformer?	Remembering	1
2.	Why is the efficiency of a transformer high as 97%?	Remembering	1
3.	What is the order of magnitude of no-load current?	Remembering	1
4.	Does the flux in a transformer core increases with load?	Remembering	1
5.	Ordinarily, what is the phase relationship between the primary and secondary voltages of a transformer?	Remembering	1
6.	Why the core losses are remain constant in a power transformer from no-load to full load?	Remembering	1
7.	How can iron loss be measured?	Remembering	1
8.	How can copper loss be measured?	Remembering	1
9.	What are the various tests that give the complete parameters of the equivalent circuit of the transformer?	Remembering	1
10.	Why core of transformers is laminated?	Remembering	1
11.	Why silicon content in electrical sheet steel is limited to 4.5 to 5%	Remembering	1
12.	Why mittred core is preferred in large transformers?	Remembering	1
13.	Why LV winding is placed first on the core and then HV winding in case of core type transformer?	Remembering	1
14.	Why circular coils are always preferred over rectangular coils for winding a transformer?	Remembering	1
15.	In what type of transformers sandwich coils are used? What advantages are gained by the of sandwich coils?	Remembering	1
16.	What kind of oil is used in transformers?	Remembering	1
17.	Distribution transformers are designed for lower iron losses, why?	Remembering	1
18.	Why power transformers are designed to have maximum efficiency at or near full load where as distribution transformers are designed to have maximum efficiency at loads quite lower than full load.	Remembering	1
19.	How is magnetic leakage reduced to a	Remembering	1

	minimum in transformers?		
20.	Why is it more difficult to cool a transformer than any other electrical rotating machine?	Remembering	1
21.	Does the flux in a transformer core increases with load?	Remembering	1

Long Answer Questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	Explain the principle and operation of single phase transformer	Evaluating	3
2.	A single phase transformer has 500 turns on the primary and 40 turns on the secondary ending the mean length of the magnetic path in the iron core is 150cm and the joints are equivalent to an air gap of 0.1 mm when a p.d of 3000v is applied to the primary, maximum flux density is 1.2 calculate no load secondary voltage and no load primary current?	Analyzing	4
3.	Explain the construction details of single phase transformer?	Evaluating	5
4.	If a single phase 3 KVA transformer has full load copper losses of 300 watts and full load iron losses of 100 watts then find the efficiency of transformer at half load with 0.8 power factor?	Analyzing	4
5.	Explain the working of a transformer on no load and full load condition and also draw the phasor diagram?	Evaluating	5
6.	A single phase 5KVA transformer has 2000 primary turns and 1000 secondary turns if the flux flowing in core is 0.4 Weber's. If the frequency is 50Hz then calculate the primary and secondary induced voltages?	Analyzing	4
7.	Explain about various losses occurring in a transformer and also specify the minimization techniques?	Evaluating	4
8.	If a single phase 5 KVA transformer has full load copper losses of 500 watts and full load iron losses of 200 watts then find the efficiency of transformer at half load & full load with 0.6 power factor?	Analyzing	4
9.	Draw the equivalent circuit of a single phase transformer?	Applying	3
10.	A single phase 8KVA transformer has 6000 primary turns and 2000 secondary turns if the flux flowing in core is 0.56 Weber's. If the frequency is 50Hz then calculate the primary and secondary induced voltages?	Analyzing	4
11.	Explain the procedure of conducting OC & SC Test on a single phase transformer?	Evaluating	4

12.	By conducting open circuit test and short circuit test on a single phase 100 kva, 11000/440v transformer the test results are as follows OC test: 440V, 1.2A, 500W SC test:110V, 8A, 1000W then find the efficiency and voltage regulation of the given transformer at half load with 0.6 power factor?	Analyzing	4
13.	Explain the procedure of conducting sumpner's test on two single phase transformers?	Evaluating	5
14.	By conducting open circuit test and short circuit test on a single phase 1 KVA, 110/220v transformer the test results are as follows **OC** test: 110V, 0.2A, 50W **SC** test: 30V, 8A, 180W then find the efficiency and voltage regulation of the given transformer at half load with 0.6 power factor?	Analyzing	4
15.	Explain about the conditions to be satisfied, while connecting two transformers in parallel?	Evaluating	5
16.	By conducting sumpners on a single phase 1 KVA, 110/220v transformer the test results are as follows **OC** test: 110V, 0.5A, 90W **SC** test: 69V, 8A, 270W, then find the efficiency and voltage regulation of the given transformer at half load with 0.6 power factor?	Analyzing	4
17.	Compare ideal and practical transformers?	Understanding	2

UNIT–V Testing of Transformers

Short Answer Questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	Derive the expression for amount of copper saved in a single phase transformer?	Remembering	1
2.	A transformer has 500 turns of the primary winding and 10 turns of the secondary winding.	Applying	3
3.	Determine the secondary voltage if the secondary circuit is open and the primary voltage is 120 V. b) Determine the current in the primary and secondary winding, given that the secondary winding is connected to a resistance load 15 Ω?	Applying	3
4.	Explain about various connections available in three phase transformers?	Applying	3

Long Answer Questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	A 500KVA, 1ph, 13.8/4.160kV, 60 Hz transformer has	Remembering	1

	a primary resistance of R_1= 0.8 ohms and secondary resistance of R_2 = 0.04 ohms. The iron loss is 3,000 watts. Calculate the copper loss and the full load efficiency when the transformer's daily load is 3hrs @ full load, 5hrs @ 3/4 load		
2.	Explain about the working of auto transformer?	Applying	3
3.	A transformer has 20 primary windings and 100 s secondary windings. If the secondary voltage is 25v, find the primary voltage?	Applying	3
4.	A single phase 10 kVA, 50 Hz transformer with 1 kV primary winding draws 0.5 A and 55 W, at rated voltage and frequency, on no load. A second transformer has a core with all its linear dimensions 2√ times the corresponding dimensions of the first transformer. The core material and lamination thickness are the same in both transformers. The primary windings of both the transformers have the same number of turns. If a rated voltage of 2 kV at 50 Hz is applied To the primary of the second transformer, then the no load current and power, respectively are?	Applying	3
5.	The single phase, 50Hz, iron core transformer in the circuit has both the vertical arms of cross sectional area 20cm^2 and both the horizontal arms of cross sectional area 10cm^2. If the two windings shown were wound instead on opposite horizontal arms, the mutual inductance will become?	Applying	3
6.	A single-phase, 50 kVA, 250 V/500 V two winding transformer has an efficiency of 95% at full load, unity power factor. If it is re-\configured as a 500 V/750 V autotransformer, its efficiency at its new rated load at unity power factor will be? Explain how the slip is affecting the rotor parameters?	Applying	3

JNTU MULTIPLE CHOICE QUESTIONS:

UNIT-1

1. In DC Generator the critical resistance refers to:

a) Armature b) Field c) Load d) Commutator

2. In DC Generator the residual magnetism will be of the order:

a) 2.5% b) 10% c) 15% d) 20%

3. Sparkless commutation can be achieved by employing

a) Inter poles b) Compensating winding

c) High resistance carbon brushes d) All the above

5. In DC machine, commutator converts

a) dc to ac b) ac to dc c) Both ac to dc and dc to ac d) None of the above

6. Which type of emf is induced in the dc generator?

a) Dynamically b) Static c) Electrostatic d) Magnetic

UNIT-II

7. The induced voltage in a single loop reverses:

a) Once in each revolution b) Once in each half revolution

c) Once in each one quarter revolution d) Once in each two revolutions

8. The yoke of the dc machine is made of:____ magnetic material

a) soft b) hard c) non d) very good

9. The left hand rule is applicable to

a) Generator b) Motor c)Transformer d) a & b

10. The speed of DC series motor is at no-load is

a) Zero b) 1000 rpm c) 3000 rpm d) Infinity

13. Which of the following motor is having high starting torque?

a) DC series motor b) AC series motor)

c) Induction motor d) none

14. The critical resistance of the Dc generator is the resistance

a) Armature b) field c) load d) brushes

GATE

1) A single phase transformer is to be switched to the supply to have minimum inrush current. The switch should be closed at
a) Maximum supply voltage b) zero supply voltge
c) $1/\sqrt{2}$ max supply voltage d) 1/2 max supply voltage

IES

2) A three phase transformer has rating of 20 MVA, 220/33 KV star delta with leakage reactance of 12%. The transformer reactance in ohms referred to each phase of L.V delta connected side is?
a) 23.5 b) 19.6 c)18.5 d)8.7

UNIT- III

1. The desirable property of transformer core material is?
a) Low permeability and low hysteresis loss b) High permeability and high hysteresis loss c) High permeability and low hysteresis loss d) Low permeability and high hysteresis loss

2. A delta/delta transformer is connected to V/V transformer. The ratio of VA rating of V/V connected transformer and delta/delta connected transformer is

a) 57.77% b)100% c)86.66% d)73.2%

3. A 200/100 50 HZ transformer is to be excited at 40 Hz from 100 V side. For the same exciting current the applied voltage should be?

a) 150 V b) 80V c) 100 V d)125V

GATE

1.In a transformer if the iron loss and copper loss are 40.5Kw and 50 KW respectively, then at what fraction of load will the maximum efficiency will occur?

a)0.8 b)0.57 c)0.7 d)0.9

IES

2. Two transformers when operating in parallel will share load depending upon?
   a) Magnetizing current c) p.u impedance b) Leakage reactance d) efficiency

GATE

1. When a transformer is first energized the transient current during first few cycles is
   a) Less than full load current b) Equal to full load current

   c) Equal to no load current d) much higher than full load current

2. A 25 KVA 2000/20, Two winding transformer is connected as auto transformer. The maximum possible KVA rating of AT is
   a) 125 b) 275 c) 375 d) 175

UNIT- IV

1. A 10 KVA 400/200 single phase transformer with %R = 3% and %X= 6% is supplying a current of 50 A to a R load. The value of Load voltage is?
   a)194V b) 390V d)192V d)196V

GATE

2. An AT having K=0.8 supplied a load of 10Kw. The power transferred inductively from primary to secondary is?
   a)10Kw b)8 Kw c)2 Kw d)0

IES

3. Purpose of laminations in a transformer is
a) to reduce hysteresis losses b) to reduce copper losses c) to reduce eddy current losses d)none

UNIT- V

1. slip of an induction motor at starting condition is
a) 1 b) 0 c) -1 d) none

2. If the induction motor is running at synchronous speed then the slip value is
a) 1 b) 0 c) -1 d) none

GATE

3. Slip of an induction generator is
   a) 1 b) 0 c) -1 d) none

4. Core of a transformer should be
   a) Ferro b) paramagnetic c) diamagnetic d)none

IES

5. OC and SC test is conducted on a transformer to find
   a) Iron losses b) copper losses c) total losses d) none

XI. WEBSITES

1 en.wikipedia.org/wiki/Outline ofelectrical_engineering

2 www.ee.iitm.ac.in/

3 ee.iitd.ernet.in/

XII.JOURNALS

IEEE Industry Applications Magazine

IEEE Transactions on Industry Applications

IEEE Transactions on Energy conversion

IEEE Transactions on Power Systems

IEEE Transactions on Distribution Systems

XIII. LIST OF TOPICS FOR STUDENT SEMINAR

1. Energy balance
2. Action of commutator
3. Methods of improving commutation
4. Methods of Excitation
5. Load sharing
6. D.C Motors Principle of operation
7. 3 pointand4 point starters
8. Swinburne's test& Hopkinson's test

XIV. STUDENT PROJECTS:

1. DC generator construction and working principle.
2. DC generator armature reaction and commutation, commutation improving techniques..
3. Testing of DC machines.
4. DC motor speed control applications to industry
5. Ward- Leonard speed control applications
6. Parallel operation of transformers
7. Scott connection and their application to real time system

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