CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET202	DC MACHINES AND TRANSFORMERS	PCC	2	2	0	4

Preamble : The purpose of the course is to provide the fundamentals of DC generators, DC motors and transformers and giving emphasis to applications in engineering field.

Prerequisite : Basics of Electrical Engineering

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Acquire knowledge about constructional details of DC machines
CO 2	Describe the performance characteristics of DC generators
CO3	Describe the principle of operation of DC motors and select appropriate motor types for different applications
CO 4	Acquire knowledge in testing of DC machines to assess its performance
CO 5	Describe the constructional details and modes of operation of single phase and three phase transformers
CO6	Analyse the performance of transformers under various conditions

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2			2							3
CO 2	3	2				2						3
CO 3	3	2	2			2						3
CO4	3	3				2						3
CO5	3					2						3
CO6	3					2						3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	10	10	30
Apply	10	10	30
Analyse	10	10	20
Evaluate			
Create			

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 5 marks for each question. Students should answer all questions. Part B contains five sections;each section shall have 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 10 marks.

Part A: 10 Questions x 5 marks=50 marks, **Part B:** 5 Questions x 10 marks =50 marks

Course Level Assessment Questions

CO1:

1. Describe the functions of individual parts of DC machines.
2. Develop simplex lap and wave windings for different pole and slot configurations.
3. Explain in detail why equaliser rings are required in lap windings.

CO2:

1. Describe different types of DC generators.
2. Derive the EMF equation of a DC machine.
3. Draw the open circuit and load characteristics of DC generators.
4. Explain the condition for voltage build up.
5. Explain armature reaction in DC machines and solutions to overcome its effects.
6. Analyse parallel operation of DC generators.

CO3:

1. Derive the torque equation of a DC motor.
2. Why starters are used in DC motors?
3. Explain types of speed control in DC motor.
4. Explain regenerative braking in DC motor.
5. What are the losses associated with DC motor?
6. Select suitable type of DC motor for specific applications.

CO4:

1. Describe the principle of Swinburn's test for testing of DC motor and perform the calculations.
2. Describe the principle of Hopkinson's test for testing of DC motor.
3. Describe the principle of retardation test for separation of losses in a DC motor.

CO5:

1. Derive the EMF equation of single-phase transformer.
2. Derive the condition for maximum efficiency in a transformer.
3. Explain the difference between power transformer and distribution transformer.
4. Explain the current rating and kVA rating of auto transformers.
5. Explain in detail no load and on load tap changing.
6. Draw the various three phase transformer connections.
7. Explain the stabilization by tertiary winding.

CO6:

1. Draw the equivalent circuit of single-phase transformer referred to primary side.
2. Explain no load and short circuit test on a single-phase transformer.
3. Explain Sumpner's test on transformers.
4. What are the necessary condition for parallel operation of a single phase and three phase transformers?

Model Question paper

QP CODE:

PAGES: 2

Reg. No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EET 202

Course Name: DC MACHINES AND TRANSFORMERS

Max. Marks: 100 **Duration: 3 Hrs**

PART A

Answer all questions. Each Question Carries 3 marks

1. Compare Lap and Wave Windings in DC machines.
2. Explain the need of Dummy Coils in DC machines.
3. What is armature reaction and mention two methods to eliminate it in DC machines.
4. What are the necessary conditions for voltage build up in a DC shunt generator.
5. Explain the significance of Back emf in a DC motor. Write down the voltage equation of a DC shunt motor.
6. Discuss the different types of armature speed control in DC shunt motor.
7. Derive the emf equation for a single phase Transformer.
8. How the rating of a transformer is specified? Justify.
9. Discuss the operation of open delta (V-V) configuration of transformers.
10. Discuss the need and working of on-load tap changers.

PART B

Answer any one full question from each module. Each question carries 14 marks.

Module 1

11. a) Discuss the need of Equalizer rings. **(5)**
    b) Obtain the front and back pitch of a progressive simplex double layer wave winding for a 4 pole dc generator with 30 armature conductors. **(9)**
12. Explain the construction of a DC machine with neat diagram. **(14)**

Module 2

13. Explain different types of DC generator with neat circuit diagram and necessary equations. **(14)**
14. Two DC shunt generators with induced emfs of 120V and 115V, armature resistance of 0.05Ω and 0.04Ω and field resistances of 20Ω and 25Ω respectively are in parallel supplying a total load of 25kW. Calculate the load shared by each generator? **(14)**

Module 3

15. Draw the circuit diagram and explain the experimental procedure to conduct Hopkinson test on DC machine. **(14)**
16. A DC machine is rated at 5kW, 250V, 2000rpm and Ra=1Ω. Driven at 2000rpm, the no load power input to the armature is 1.2A at 250V with field winding (Rsh) = 250Ω, excited by Ish =1A. (i) Estimate efficiency as a generator delivering. (ii) Estimate the efficiency as a motor taking 5kW from supply. **(14)**

Module 4

17. a) Derive the condition for maximum efficiency and the load current at which max. Efficiency occurs in a single phase transformer. **(8)**
    b) Discuss the significance of all day efficiency of transformers. **(6)**

18. A 20kVA, 250/2500V single phase transformer gave the following test results.
    OC Test (LV side): 200V, 1.4A, 105W
    SC Test (HV side): 120V, 8A, 320W
    Draw the equivalent circuit of single phase transformer referred to LV side. **(14)**

Module 5

19. Explain Auto transformer with neat diagram and Derive an expression to justify thesaving of copper in auto transformer with respect to an ordinary two winding transformer with same rating. **(14)**
20. Explain Dy11 and Yd1 vector groupings of three phase transformers with phasor and winding connection diagrams. **(14)**

Syllabus

Module 1

Constructional details of dc machines - armature winding- single layer winding, double layer winding- lap and wave, equalizer rings, dummy coils, MMF of a winding, EMF developed, electromagnetic torque - numerical problems.

Module 2

DC generator –principle of operation, EMF equation, excitation,armature reaction– demagnetising and cross magnetising ampere turn,compensating windings, interpoles, commutation,OCC, voltage build upand load characteristics, parallel operation. Power flow diagram– numerical problems.

Module 3

DC motor –back emf, generation of torque,torque equation,performance characteristics – numerical problems.

Starting of dc motors- starters –3point and 4 point starters(principle only).

Speed control of dc motors - field control, armature control. Braking of dc motors. Power flow diagram – losses and efficiency.Testing of dc motors - Swinburne's test,Hopkinson's test, and retardation test.DC motor applications – numerical problems.

Module 4

Single phase transformers –constructional details, principle of operation, EMF equation, ideal transformer,dot convention, magnetising current, transformation ratio, phasor diagram, operation on no load and on load, equivalent circuit, percentage and per unit impedance, voltage regulation. Transformer losses and efficiency, condition for maximum efficiency,kVA rating. Testing of transformers– polarity test, open circuit test, short circuit test, Sumpner's test – separation of losses, all day efficiency.Parallel operation of single-phase transformers– numerical problems

Module 5

Autotransformer – saving of copper –ratingof autotransformers.

Three phase transformer – construction- difference between power transformer and distributiontransformer –Different connections of 3-phase transformers. Y-Y, Δ-Δ,Y-Δ, Δ-Y, V-V. Vector groupings – Yy0, Dd0, Yd1, Yd11, Dy1, Dy11.Parallel operation of three phase transformers.

Three winding transformer – stabilization by tertiary winding. Tap changing transformers - no load tap changing, on load tap changing, dry type transformers.

Text Books

1. Bimbra P. S., Electrical Machinery, 7/e, Khanna Publishers, 2011.
2. Nagrath J. and D. P. Kothari, Theory of AC Machines, Tata McGraw Hill, 2017.

Reference Books

1. Fitzgerald A. E., C. Kingsley and S. Umans, Electric Machinery, 6/e, McGraw Hill, 2003.
2. Langsdorf M. N., Theory of Alternating Current Machinery, Tata McGraw Hill, 2001.
3. Deshpande M. V., Electrical Machines, Prentice Hall India, New Delhi, 2011.
4. B. L. Theraja, Electrical Technology Vol II,S.Chand Publications.
5. A. E. Clayton & N. N. Hancock, The Performance and design of Direct Current Machines,CBS Publishers& Distributors, NewDelhi.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Hours
1	**Constructional details of dc machines**	**8**
1.1	Constructional details of DC machines	2
1.2	Armature winding- single layer	1
1.3	Armature winding- double layer-wave and lap, equaliser rings, dummy coils.	3
1.4	MMF of a winding, EMF developed, electromagnetic torque.	2
2	**DC Generator**	**9**
2.1	DC generators- principle of operation, EMF equation, methods of excitation –separately and self-excited – shunt, series, compound machines.Numerical problems	3
2.2	Armature reaction – effects of armature reaction, demagnetising and cross magnetising ampere-turns, compensating windings,interpoles. Numerical problems.	3
2.3	Load characteristics, losses and efficiency power flow diagram. Parallel operation – applications of dc generators. Numerical problems.	3
3	**DC Motor**	**10**
3.1	DC motor– principle of operation, back emf, classification– torque equation. Numerical problems.	2

3.2	Starting of DC motors – necessity of starters. Numerical problems. Types of starters – 3 point and 4 point starters(principle only).	2
3.3	Speed control – field control, armature control- Numerical problems. Braking of dc motors (Description only)	2
3.4	Losses and efficiency – power flow diagram. Numerical problems	1
3.5	Swinburne's test - Numerical problems.	1
3.6	Hopkinson's test, separation of losses – retardation test. Applications of dc motors.	2
4	**Single phase Transformer**	**10**
4.1	Transformers – principle of operation, construction, core type and shell type construction.	1
4.2	EMF equation, transformation ratio, ideal transformer,transformer with losses, phasor diagram - no load and on load operation. Numerical problems.	2
4.3	Equivalent circuit, percentage and per unit impedance, voltage regulation. Numerical problems.	2
4.4	Transformer losses and efficiency, Condition for maximum efficiency, all day efficiency – Numerical problems.	2
4.5	Dot convention – polarity test, OC & SC test, Sumpner's test,separation of losses. Numerical problems.	2
4.6	kVA rating of transformers,parallel operation of single phase transformers	1
5	**Autotransformer & Three phase transformer**	8
5.1	Autotransformer – ratings, saving of copper.Numerical problems.	2
5.2	Three phase transformer construction, three phase transformer connections, power transformer and distribution transformer.	2
5.3	Vector groupings Yy0, Dd0, Yd1, Yd11, Dy1, Dy11.	1
5.4	Three winding transformer – tertiary winding. Percentage and per unit impedance. Parallel operation.	2
5.5	On load and off load tap changers, dry type transformers.	1