NANDHA ENGINEERING COLLEGE
(Autonomous)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

17EEC04 - ELECTRICAL MACHINES I

UNIT – 1

BASIC CONCEPTS OF ROTATING MACHINES

S.No	Part – A	Marks	CO	BTL	Topic in Syllabus
1	State the principle of electromechanical energy conversion.	**2**	**CO1**	**U**	Principles of electromechanical energy conversion
2	Draw the general block diagram of an electromechanical energy conversion device.	**2**	**CO1**	**R**	Principles of electromechanical energy conversion
3	Write energy balance equations for generating and motoring actions.	**2**	**CO1**	**U**	Principles of electromechanical energy conversion
4	Draw the power flow diagram of an electric machine.	**2**	**CO1**	**An**	Principles of electromechanical energy conversion
5	Catalog the two types of magnetic systems and state their examples.	**2**	**CO1**	**U**	Single and multiple excited systems
6	Write the examples for singly excited and doubly fed magnetic systems.	**2**	**CO1**	**R**	Single and multiple excited systems
7	Identify the term singly excited systems?	**2**	**CO1**	**U**	Single excited systems
8	Portray multiple excited systems?	**2**	**CO1**	**U**	Multiple excited systems
9	Define co energy.	**2**	**CO1**	**An**	Concept of co energy
10	State the significance of co energy	**2**	**CO1**	**U**	Concept of co energy
11	Draw i-λ characteristic curve with variable x.	**2**	**CO1**	**R**	Concept of co energy
12	Write the expression for mechanical force	**2**	**CO1**	**Ap**	Single and multiple excited

	developed by armature for rotational systems.				systems
13	Write the generated voltage equation in DC machine.	**2**	**CO1**	**Ap**	Generated voltage in DC machine
14	Write the torque equation in DC machine.	**2**	**CO1**	**Ap**	Torque in DC Machines

S.No	Part – B	Marks	CO	BTL	Topic in Syllabus
1	Explicate flow of energy in electro mechanical devices.	**8**	**CO1**	**An**	Principles of electromechanical energy conversion
2	Elucidate the energy balance equations for motoring and generating actions.	**8**	**CO1**	**U**	Principles of electromechanical energy conversion
3	Derive the expressions for mechanical force developed of an attracted type armature relay excited by an electric source.	**16**	**CO1**	**Ap**	Single excited systems
4	Obtain the expressions for multiple excited systems of an electric machine.	**16**	**CO1**	**Ap**	Multiple excited systems
5	For a particular relay excited by a voltage source the i and λ are related as $i=2\lambda^3+8\lambda^2+6\lambda(1-2x)^2$ where $x<1/2$. Find the force on the armature as a function of λ and x	**6**	**CO1**	**E**	Single excited systems
6	Two coupled coils have self and mutual inductance of $L_{11} = 2+1/(2x)$, $L_{22} = 1+1/(2x)$. $L_{12}=L_{21}= 1/(2x)$ over certain range of linear displacement x the first coil is excited by a constant current of 20A and the second by a constant current of -10A. Find (i) Mechanical work done if x changes from 0.5 to 1m (ii) Energy supplied by each electrical source in part(1).	**16**	**CO1**	**E**	Multiple excited systems
7	Discuss in detail about the energy stored in magnetic systems.	**8**	**CO1**	**An**	Concept of co energy
8	Derive the expressions for co energy density of an electro mechanical energy conversion device.	**8**	**CO1**	**E**	Concept of co energy
9	Derive an expression for the generated	**8**	**CO1**	**Ap**	Generated voltage in DC machines

	voltage in DC machines.				
10	Derive an expression for the torque developed in a DC machine.	**8**	**CO1**	**Ap**	Torque in DC Machines

UNIT – 2

DC GENERATORS

S.No	Part – A	Marks	CO	BTL	Topic in Syllabus
1	What is mean by pole shoe? Write its function.	**2**	**CO2**	**U**	Constructional details
2	Why the armature core in DC machines is constructed with laminated steel sheets instead of solid steel sheets?	**2**	**CO2**	**U**	Constructional details
3	Why commutator is employed in DC machines? Or Mention the functions of commutator.	**2**	**CO2**	**U**	Constructional details
4	Compare shunt field windings with series field windings.	**2**	**CO2**	**R**	Constructional details
5	Compare lap windings with wave windings of DC generator.	**2**	**CO2**	**R**	Constructional details
6	Write down the emf equation for DC generator.	**2**	**CO2**	**R**	Emf equation
7	Classify the types of DC generators based on their excitation.	**2**	**CO2**	**U**	Methods of excitation
8	Define critical field resistance of DC shunt generator.	**2**	**CO2**	**R**	Self and separately excited generators
9	Draw the circuit model of DC shunt generator and write its voltage equation.	**2**	**CO2**	**R**	Self and separately excited generators
10	Define armature reaction.	**2**	**CO2**	**R**	Armature reaction
11	Mention the various methods of minimizing the effects of armature reaction.	**2**	**CO2**	**U**	Armature reaction
12	Define Commutation.	**2**	**CO2**	**R**	Commutation

13	Name the methods of improving commutation.	**2**	**CO2**	**U**	Commutation
14	Mention the applications of DC series generator.	**2**	**CO2**	**R**	Applications
15	State the conditions for paralleling of two DC generators.	**2**	**CO2**	**R**	Parallel operation

S.No	Part – B	Marks	CO	BTL	Topic in Syllabus
1	Explicate the construction and working principle of DC generator.	**16**	**CO2**	**U**	Constructional details
2	Derive the expression for induced EMF in DC generator.	**8**	**CO2**	**An**	Emf equation
3	Discuss the process of self-excitation in a DC machine. What condition must be fulfilled for self excitation of the machine?	**8**	**CO2**	**R**	Methods of excitation
4	Elucidate the load characteristics of DC shunt, series and compound generators with neat graphical illustration.	**16**	**CO2**	**An**	Characteristics of series, shunt and compound generators
5	Enlighten the concepts of armature reaction in a DC generator.	**8**	**CO2**	**An**	Armature reaction
6	Summarize the effects of armature reactions in a DC generator with its minimizing methods.	**16**	**CO2**	**R**	Armature reaction
7	Write in detail about demagnetizing and cross magnetizing effect of armature reaction in DC generator.	**16**	**CO2**	**U**	Armature reaction
8	Explain the process of commutation in a DC machine.	**12**	**CO2**	**U**	Commutation
9	A 100 kW DC shunt generator driven by a belt from an engine runs at 750RPM and is connected to 230V DC mains. When the belt breaks, it continues to run as a motor drawing 9 kW from the mains. At what speed would it run. Choose armature resistance = 0.018 Ω and field resistance = 115 Ω.	**16**	**CO2**	**E**	Methods of Excitation

10	A 6 pole lap wound armature rotated at 350 rpm is required to generate 300V. The useful flux per pole is 0.05wb. If the armature has 120 slots. Calculate the number of conductor per slot.	**8**	**CO2**	**E**	Emf equation

UNIT – 3

DC MOTORS

S.No	Part – A	Marks	CO	BTL	Topic in Syllabus
1	State working principle of DC motor.	**2**	**CO3**	**R**	Principle of operation
2	Define back Emf.	**2**	**CO3**	**R**	Back Emf
3	State the significance of back Emf.	**2**	**CO3**	**R**	Back Emf
4	Write the torque equation of a DC motor.	**2**	**CO3**	**U**	Torque equation
5	Write the torque and speed equations of DC shunt motor.	**2**	**CO3**	**U**	Torque equation
6	Why the series motor has never started in no-load?	**2**	**CO3**	**An**	Torque equation
7	Classify the types of motors.	**2**	**CO3**	**R**	
8	Mention the various characteristics of DC motors.	**2**	**CO3**	**U**	Characteristics of series, shunt and compound motor
9	What is the necessity of starter?	**2**	**CO3**	**An**	Types of starters
10	List out the starters used for DC motors.	**2**	**CO3**	**R**	Types of starters
11	State the functions of NVR and OLR coils in starters.	**2**	**CO3**	**U**	Types of starters
12	State the advantages of four point starter over three point starter.	**2**	**CO3**	**U**	Types of starters
13	Write down the applications of DC shunt motors.	**2**	**CO3**	**U**	Applications
14	Name various methods of speed control of DC motor.	**2**	**CO3**	**R**	Speed control of DC shunt motors.

15	Why does a DC motor some time run too fast under load? Give possible causes.	**2**	**CO3**	**An**	Speed control of DC motors

S.No	Part – B	Marks	CO	BTL	Topic in Syllabus
1	Elucidate the constructional details of DC motor.	**10**	**CO3**	**U**	Constructional details
2	Explicate the working principle of DC motor.	**6**	**CO3**	**U**	Principle of operation
3	Derive the torque equation of a DC motor.	**8**	**CO3**	**E**	Torque equation
4	Determine developed torque of 220V, 4-pole series motor with 800 conductors wave-connected supplying a load of 8.2kW by taking 45A from the mains. The flux per pole is 25mWb and its armature circuit resistance is 0.6Ω.	**8**	**CO3**	**E**	Back Emf-Torque equation
5	Illustrate the speed-torque characteristics of DC shunt and series motors.	**12**	**CO3**	**An**	Characteristics of series
6	Summarize the characteristics of various types of DC motors.	**16**	**CO3**	**An**	Characteristics of series
7	With neat sketch explain the construction and working of three point starter	**16**	**CO3**	**U**	Types of starters
8	With neat sketch explain the construction and working of four point starter	**16**	**CO3**	**U**	Types of starters
9	List out the different methods of speed control employed for DC shunt motors and explain.	**16**	**CO3**	**U**	Speed control of DC shunt motors.
10	A 220V, DC shunt motor takes 4A at no-load when running at 700rpm. The field resistance is 100Ω. The resistance of armature at standstill gives a drop of 6 volts across armature terminals when 10 A pass through it. Calculate (i) speed on load (ii) torque in N-m and (iii) efficiency. The normal input of the motor is 8kW	**16**	**CO3**	**E**	Back Emf-Torque equation-Speed equation

UNIT – 4

TRANSFORMERS

S.No	Part – A	Marks	CO	BTL	Topic in Syllabus
1	What is transformer?	**2**	**CO4**	**R**	Constructional details of core and shell type transformers
2	Classify the types of transformers.	**2**	**CO4**	**R**	Constructional details of core and shell type transformers
3	Compare core type transformer with shell type transformer.	**2**	**CO4**	**U**	Constructional details of core and shell type transformers
4	Name the types of windings employed for transformers.	**2**	**CO4**	**R**	Types of windings
5	State working principle of transformer.	**2**	**CO4**	**U**	Principle of operation
6	Write down the emf equation of transformer.	**2**	**CO4**	**U**	EMF equation
7	Define transformation ratio.	**2**	**CO4**	**R**	Transformation ratio
8	Why the transformer rating is expressed in KVA?	**2**	**CO4**	**An**	Principle of operation
9	What happens if DC supply is applied to the transformer?	**2**	**CO4**	**An**	Principle of operation
10	State the properties of an ideal transformer.	**2**	**CO4**	**R**	Transformer on no load
11	Draw the phasor diagram of ideal transformer.	**2**	**CO4**	**U**	Transformer on no load
12	Draw the no-load vector diagram of a transformer.	**2**	**CO4**	**U**	Transformer on no load
13	Define regulation.	**2**	**CO4**	**R**	Regulation

14	State the conditions for parallel operation of single phase transformers.	**2**	**CO4**	**R**	Parallel operation of single phase transformers
15	What is an auto transformer?	**2**	**CO4**	**R**	Auto transformer
16	Mention the difference between ordinary transformers with auto transformer.	**2**	**CO4**	**U**	Auto transformer
17	State the advantages of an auto transformer.	**2**	**CO4**	**R**	Auto transformer
18	Write down the applications of auto transformer.	**2**	**CO4**	**U**	Auto transformer
19	List out the three phase transformer connections.	**2**	**CO4**	**R**	Three phase transformer

S.No	**Part – B**	**Marks**	**CO**	**BTL**	**Topic in Syllabus**
1	Illustrate the construction and working principle of single phase transformer.	**16**	**CO4**	**U**	Constructional details of core and shell type transformers - Principle of operation
2	Derive the emf equation of single phase transformer.	**8**	**CO4**	**E**	EMF equation
3	Deduce the equivalent circuit of a transformer starting from the first principle. (Or) Explain in detail step by step the procedure to draw the equivalent circuit of transformer.	**12**	**CO4**	**An**	Equivalent Circuit
4	A 50KVA, 4400/220V transformer has R1=3.45 ohms, R2 = 0.009 ohms. The value of reactances are X1 = 5.2 ohms, x2 = 0.015 ohms. Calculate for the transformer. (i) Equivalent resistance referred to primary. (ii) Equivalent reactance referred to primary. (iii) Equivalent impedance referred to primary. (iv) Equivalent resistance, reactance and	**16**	**CO4**	**E**	Equivalent circuit

	impedance referred to secondary.				
5	State the use of auto transformer and explain with neat diagram	**8**	**CO4**	**R**	Auto transformer
6	Derive the expression for copper saving in auto transformer.	**8**	**CO4**	**An**	Auto transformer
7	Draw the vector for three phase transformer connections.	**8**	**CO4**	**R**	Three phase transformer

UNIT – 5

TESTING OF DC MACHINES AND TRANSFORMERS

S.No	Part – A	Marks	CO	BTL	Topic in Syllabus
1	Catalogue the common losses occurring in DC machines.	**2**	**CO5**	**R**	Losses and efficiency in DC machines and transformers
2	Catalogue the common losses occurring in transformers.	**2**	**CO5**	**R**	Losses and efficiency in DC machines and transformers
3	Draw the power flow diagram for DC generator and DC motor.	**2**	**CO5**	**U**	Losses and efficiency in DC machines and transformers
4	State the condition for obtaining the maximum efficiency of DC machines.	**2**	**CO5**	**R**	Condition for maximum efficiency
5	State the condition for obtaining the maximum efficiency of a transformer.	**2**	**CO5**	**R**	Condition for maximum efficiency
6	Classify a DC machine testing.	**2**	**CO5**	**R**	Testing of DC machines
7	Recall the advantages and disadvantages of Swinburne's test.	**2**	**CO5**	**U**	Swinburne's test
8	Enlighten why Swinburne's test cannot be performed on DC series motor.	**2**	**CO5**	**An**	Swinburne's test
9	Define Retardation test.	**2**	**CO5**	**R**	Retardation test

10	State the advantages and disadvantages of Hopkinson's test?	**2**	**CO5**	**U**	Hopkinson's test
11	Classify a transformer testing.	**2**	**CO5**	**R**	Testing of transformers
12	Define polarity test.	**2**	**CO5**	**R**	Polarity test
13	Mention the purpose of load test in transformer.	**2**	**CO5**	**U**	Load test
14	List out the importance of OC and SC tests on transformer.	**2**	**CO5**	**An**	Open circuit and short circuit tests
15	Define All-Day efficiency.	**2**	**CO5**	**R**	All-Day efficiency

S.No	Part – B	Marks	CO	BTL	Topic in Syllabus
1	Drive the condition to get maximum efficiency of a DC machine.	**8**	**CO5**	**An**	Condition for maximum efficiency
2	Drive the condition to get maximum efficiency of a transformer.	**8**	**CO5**	**An**	Condition for maximum efficiency
3	How will you determine the efficiency of a DC machine when running as a generator and as a motor by conducting Swinburne's test? (or) With the help of neat circuit diagram, explain Swinburne's test and derive the relations for efficiency (both for generator and motor) also state the merits and demerits of this method	**16**	**CO5**	**An**	Swinburne's test
4	A 10kW, 240V shunt motor draws a line current of 5.2 A while running a no-load of 1200 rpm from the mains. It has armature resistance of 0.25 Ω. and a field resistance of 160 Ω. Estimate the efficiency of the motor when it delivers rated load.	**16**	**CO5**	**E**	Swinburne's test
5	Elucidate briefly about brake test. What are the advantages of brake test?	**12**	**CO5**	**U**	Brake test
6	With the help of neat circuit diagram, elucidate Retardation test	**8**	**CO5**	**U**	Retardation test
7	Explicate Hopkinson's test for finding efficiency of a DC machine.	**16**	**CO5**	**U**	Hopkinson's test

8	The Hopkinson's test on two shunt machines gave the following results for full-load. Line voltage = 250V; current taken from supply system excluding field currents= 50A; motor armature current = 380 A; corresponding field currents are 5A and 4.2A. Calculate the efficiency of each machine. Armature resistance of each machine is 0.02 ohm.	**16**	**CO5**	**E**	Hopkinson's test
9	Summarize about testing of transformers with relevant circuit diagrams and expression.	**16**	**CO5**	**U**	Testing of transformers
10	With the neat circuit diagram, elucidate load test on transformer.	**10**	**CO5**	**U**	load test of transformer
11	Describe the method of calculating the regulation and efficiency of a single phase transformer by OC and SC tests. (or) Draw the circuit diagrams for conducting OC and Sc tests on a single phase transformer. Also explain how the efficiency and voltage regulation can be estimated by these tests.	**16**	**CO5**	**An**	Open circuit and short circuit tests
12	Obtain the equivalent circuit of a 200/400V, 50Hz, single phase transformer from the following test data: O.C. test: 200V, 0.7A, 70 W – on L.V side S.C test: 15V, 10A, 85W – on H.V side	**16**	**CO5**	**E**	Open circuit and short circuit tests
13	Find the approximate equivalent circuit of a single phase transformer having the following test readings. O.C. test: 400V, 5.2A, 600 W – on L.V side S.C test: 155V, 50A, 1850W – on H.V side	**16**	**CO5**	**E**	Open circuit and short circuit tests