Total number of printed pages:2 **Programme(UG)/4th Semester/UEE401**

2023

Electrical Machines

Full Marks : 100

Time : Three hours

*Answer **any five** questions.*

1.	a)	What is ideal transformer?	5
	b)	Why leakage reactance is included in the equivalent circuit of the transformer?	5
	c)	A 1-phase transformer has 180 and 90 turns respectively in its secondary and primary windings. The respective resistances are 0.233 Ω and 0.067 Ω. Calculate the equivalent resistance of (a) the primary in terms of the secondary winding, (b) the secondary in terms of the primary winding, and (c) the total resistance of the transformer in terms of the primary.	10
2.	a)	Derive an expression for the E.M.F. induced in a transformer winding. Show that E.M.F. per turn in primary is equal to the E.M.F. per turn in the secondary.	5
	b)	Draw and explain the no-load phasor diagram of a 1-phase real transformer. Discuss how primary leakage flux is accounted for in the phasor diagram.	5
	c)	In a 25-kVA, 2000/200 V transformer the iron and copper losses are 350 W and 400 W respectively. (a) Calculate the efficiency on unity power factor at full load and half load. (b) Determine the load for maximum efficiency and the iron loss, copper loss in this case.	10
3	a)	Draw neat diagram of a 4-pole DC machine. Label all its parts.	5
	b)	Develop the circuit model of a DC machine.	5
	c)	A 4-pole, 500 V shunt motor has 720 wave-connected conductors on its armature. The full-load armature current is 60 A, and the flux per pole is 0.03 Wb. The armature resistance is 0.2 Ω and the contact drop is 1 V per brush. Calculate the full-load speed of the motor.	
4.	a)	Derive the generated E.M.F. expression for a DC machine.	5
	b)	A DC shunt machine develops an open circuit E.M.F. of 250 V at 1500 r.p.m. Find its developed torque for an armature current of 20 A.	5

	c)	A DC shunt generator gives an open-circuit voltage of 240 V. When loaded, the terminal voltage falls to 220 V. Determine the load current in case armature circuit and field winding resistances are 0.1 Ω and 50 Ω respectively. Neglect the effect of armature reaction.	10
5	a)	What is rotating magnetic field? Discuss it with proper diagram.	5
	b)	Derive the expression of rotor frequency of an induction motor.	5
	c)	A 3-phase, 50 Hz induction motor has a full load speed of 960 rpm. Calculate (a) Number of the poles (b) Slip frequency (c) Speed of rotor field (i) with respect to rotor structure, (ii) with respect to stator structure and (iii) with respect to stator field.	10
6	a)	What is air gap power?	5
	b)	Describe the working principle of an induction motor.	5
	c)	A 3-phase, 400 V, 50 Hz induction motor takes a power input of 35 kW at its full-load speed of 980 r.p.m. The total stator losses are 1 kW and the friction and windage losses are 1.5 kW. Calculate (a) slip (b) rotor ohmic losses (c) shaft power (d) shaft torque and (e) efficiency	10
7	a)	Why is capacitance connected to a single phase induction motor?	5
	b)	A 100 kVA, 2400/240 V, 50 Hz single-phase transformer has an exciting current of 0.64 A and core loss of 700 watts when its high voltage side is energised at rated voltage and frequency. Calculate the two components of the exciting current.	5
	c)	When a single phase winding is excited by an alternating current, a pulsating mmf wave is produced. Show that this stationary mmf wave can be resolved into two constant amplitude travelling waves rotating in opposite directions at synchronous speed.	10