NAME OF THE EXAMINATIONS: B.E. POWER ENGINEERING FIRST YEAR FIRST SEMESTER - 2023

SUBJECT: BASIC ELECTRICAL ENGINEERING

TIME: 3 HOURS | FULL MARKS: 100

Answer ***Q1*** and ***any six*** questions from the rest

1. ***Choose the correct option for any TEN questions:*** ***(10@1 = 10)***

(i) Three resistors, each of R ohms, are connected to form a triangle. The resistance between any two terminals will be: [CO1]
   a) 3R
   b) 2R/3
   c) 3R/2
   d) R

(ii) Application of Norton's theorem to a circuit produces: [CO1]
   a) equivalent current source and resistance in parallel
   b) equivalent current source and resistance in series
   c) equivalent current source
   d) equivalent resistance

(iii) A conductor of length L carrying a current I is placed parallel to a magnetic field of flux density B. The force experienced by the conductor is: [CO1]
   a) BIL
   b) BI^2L
   c) $\frac{1}{2}BIL$
   d) Zero

(iv) Two sinusoidal currents are given by the equations : [CO3]
$i_1 = 10 \sin(\omega t + \pi/3)$ and $i_2 = 15 \sin(\omega t - \pi/4)$.

The phase difference between them is _____ degrees.
   a) 15
   b) 60
   c) 75
   d) 105

(v) In an electrical circuit, if the current lags the voltage by 60^0 the circuit nature is [CO2]
   a) R-C
   b) R-L
   c) LC
   d) purely L

(vi) A 3-phase, 4 wire system supplies a balanced star load. The current in each phase is 5A. The current in the neutral wire will be [CO3]
   a) 5 A
   b) 15 A
   c) 0 A
   d) $5\sqrt{3}$ A

(vii) What is the RMS value of the complex voltage given by: [CO4]
$V = 16\sqrt{2}\sin\omega t + 12\sqrt{2}\sin 3\omega t$
   a) 20
   b) $28\sqrt{2}$
   c) $19\sqrt{2}$
   d) $20\sqrt{2}$

(viii) The core of a DC motor armature is laminated to reduce [CO2]
   a) eddy current loss
   b) copper loss
   c) hysteresis loss
   d) friction loss

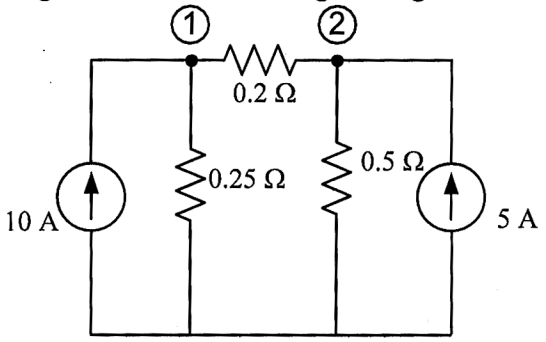
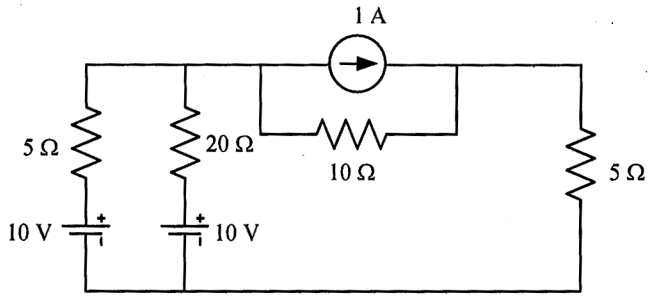
(ix) In a Transformer, electric power is transferred from primary to secondary without change in [CO2]
   a) current
   b) turns
   c) frequency
   d) voltage

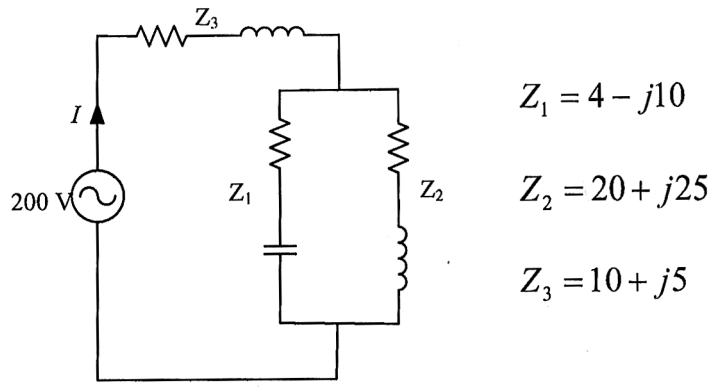
(x) At standstill, the slip of a 3-phase induction motor is given by [CO2]
   a) S = -1
   b) S = 0.5
   c) S = 0
   d) S = 1

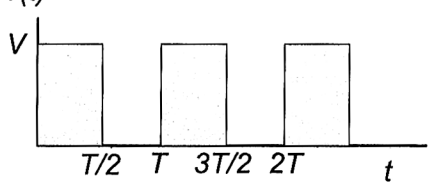
(xi) For any medium, the electric flux density D is related to electric intensity E by the equation [CO1]
   a) $D=E/\varepsilon_0\varepsilon_r$
   b) $D=\varepsilon_0\varepsilon_r E$
   c) $D=\varepsilon_0 E$
   d) $D=\varepsilon_0 E/\varepsilon_r$

(xii) If three capacitors having capacitances of 1 F are in parallel across the voltage source of 10 V, the net capacitance of the circuit is [CO4]
   a) 3 F
   b) 0 F
   c) 1/3 F
   d) 9 F

Answer *any six* questions from Q2 – Q10

2.	(a)	State & prove Maximum Power transfer Theorem for D.C networks	(5)	[CO1]
	(b)	Find the voltages at node 1 and 2 in Fig. 1 using Nodal Analysis.  Fig. 1	(4)	[CO4]
	(c)	Find the current through 5 Ω Resistor in Fig. 2 using Thevenin's Theorem.  Fig. 2	(6)	[CO4]
3.	(a)	State and explain Faraday's law of electromagnetism	(4)	[CO1]
	(b)	An iron ring of mean length 30 cm and cross-sectional area of 3 cm^2 has an air gap of 2 mm in it. A coil with 200 turns is wound on the ring. If relative permeability of iron is 300 when a current of 1 A flows through the coil; find the flux density.	(6)	[CO4]

	(c)	A flux of 0.5 mWb is produced by a coil of 900 turns wound on a ring with a current of 3 A in it. Calculate (i) the inductance of the coil (ii) the e.m.f. induced in the coil when the current is switched off, assuming the current to fall to zero in 1 ms and (iii) the mutual inductance between the coils, if a second coil of 600 turns is uniformly wound over the first coil.	(5)	[CO4]
4.	(a)	What is resonance? Deduce the expression of frequency in a series RLC circuit at resonance.	(5)	[CO3]
	(b)	A resistance of 10 Ω is connected in series with a 50 mH inductance across a 230 V, 50 Hz supply. Calculate (a) current flowing in the circuit (b) phase angle of the current (c) draw phasor diagram.	(4)	[CO4]
	(c)	Find RMS value of source current in the flowing circuit of Fig. 3  Fig. 3	(6)	[CO4]
5.	(a)	Derive expressions for the emf induced in the transformer windings	(5)	[CO2]
	(b)	Explain with reasons as to why transformer core is made up of silicon-steel laminations.	(4)	[CO3]
	(c)	A 20 kVA Transformer has 400 turns on the primary and 40 turns on the secondary winding. The primary is connected to 2kV, 50 Hz supply. Find the full load primary and secondary currents, secondary emf and the maximum flux in the core. Neglect leakage drop and no-load primary current.	(6)	[CO4]
6.	(a)	What is a 3-phase balanced A.C. system? Show that sum of three emf's is zero in a 3-phase balanced AC circuit.	(5)	[CO3]
	(b)	Given a balanced 3–phase, 3-wire system with Y-connected load for which line voltage is 230 V and impedance of each phase is (6 + J8) ohm. Find the (i) line current (ii) active power and (iii) reactive power absorbed by each phase (iv) power factor of the load.	(5)	[CO4]
	(c)	Two wattmeters connected to measure the input to a balanced three-phase circuit indicate 2500 W and 500 W respectively. Find the power factor of the circuit (a) when both readings are positive and (b) when the one of the readings is positive while the other is negative.	(5)	[CO4]
7	(a)	Derive the relationship between the line current and phase current, line voltage and phase voltage for a balanced three-phase STAR connected lagging power factor load connected across the three-phase supply.	(7)	[CO3]
	(b)	A 3-phase, 3-wire, 240-volt, A-B-C phase sequence system supplies a delta-connected 3-phase load in which $Z_{AB} = 25 \angle 90^0$, $Z_{BC} = 15 \angle 30°$, $Z_{CA} = 20 \angle 0^0$ ohms. Find the (i) line currents (ii) active, reactive, and apparent powers (iii) overall power factor of the load.	(8)	[CO4]

8.	(a)	What do you mean by harmonic components of a periodic non-sinusoidal signal? What are even and odd harmonics?	(4)	[CO2]
	(b)	A complex voltage is given by: $e = 60\sin\omega t + 24\sin\left(3\omega t + \frac{\pi}{6}\right) + 12\sin\left(5\omega t + \frac{\pi}{3}\right)$ The corresponding current in the load circuit is given by: $i = 0.6\sin\left(\omega t - \frac{2\pi}{10}\right) + 0.12\sin\left(3\omega t - \frac{2\pi}{24}\right) + 0.1\sin\left(5\omega t + \frac{3\pi}{4}\right)$ Find (i) RMS values of current and voltage (ii) total power supplied and (iii) the overall power factor.	(6)	[CO4]
	(c)	Find Fourier series expansion for the following signal shown in Fig. 4:  Fig. 4	(5)	[CO4]
9.	(a)	Classify DC compound generators according to their mode of connection	(3)	[CO2]
	(b)	What are the differences between cylindrical rotor and salient pole rotor type 3-phase alternators?	(3)	[CO2]
	(c)	The armature of a 4-pole DC machine has 150 turns and rotates at 1200 rpm. The EMF generated on open circuit is 400 V. Find the useful flux per pole when the armature is (i) lap connected (ii) wave connected	(5)	[CO4]
	(d)	A 4 pole, 3 phase, 275kW, 440V, 50 Hz, induction motor is running with a slip of 4%. Find (i) synchronous speed (ii) rotor speed (iii) frequency of the rotor induced emf.	(4)	[CO4]
10.	(a)	State and explain Coulomb's law in Electrostatics and hence define "Coulomb", the unit for electric charge.	(4)	[CO1]
	(b)	Derive an expression for the capacitance of a cylindrical capacitor consisting of the infinitely long axial cylinders of radii R_1 and R_2 ($R_2 > R_1$)	(5)	[CO1]
	(c)	Calculate the capacitance between two parallel plates of the area $0.4m^2$ separated by a di-electric of 0.1 mm thick & of relative permittivity 5. If the voltage across the capacitor is 50 V, find the energy stored in the capacitor & the voltage gradient in the dielectric.	(6)	[CO4]