NAME OF THE EXAMINATIONS: B.E. POWER ENGINEERING FIRST YEAR FIRST SEMESTER - 2024

SUBJECT: BASIC ELECTRICAL ENGINEERING

FULL MARKS: 100

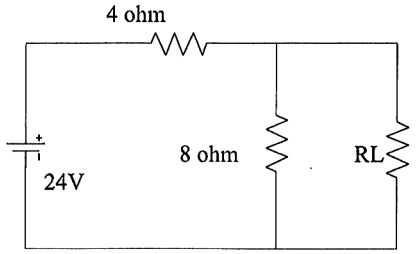
CO1	Describe fundamental theorems of electrostatics, electromagnetics and electrical circuits
CO2	Describe the operating principles of different ac and dc electrical machines and systems
CO3	Apply fundamental concepts of various electrical quantities related to single phase and 3 phase alternating current systems
CO4	Solve numerical problems on electrostatics, electromagnetics and electrical circuits and systems

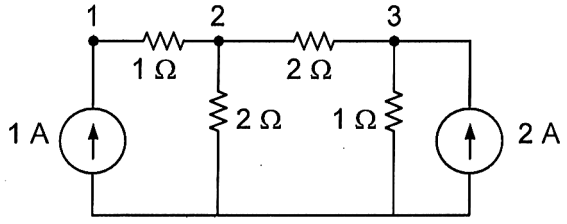
Answer *ALL QUESTIONS*

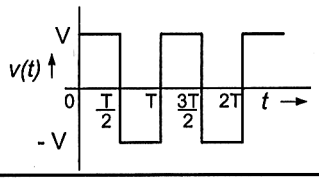
1. *Choose the correct option for any TWENTY questions:* *(20@1 = 20)*

(i)	Energy stored in a capacitor is given by a) $\frac{Q}{2C}$ b) $\frac{Q^2}{2C}$ c) $\frac{1}{2}\times\frac{V^2}{C}$ d) $\frac{Q}{V}$	[CO1]
(ii)	The direction of current induced in a circuit placed in a magnetic field is given by a) Ampere's law b) Faraday's law c) Lenz's law d) Ohm's law	[CO1]
(iii)	"A time-varying flux causes an induced electromotive force". What law does this statement represent? a) Lenz's law b) Faraday's law c) Ampere's law d) Biot-Savart's Law	[CO1]
(iv)	Superposition theorem can be applied only to circuits having a) non-linear elements b) linear bilateral elements c) passive elements d) resistive elements	[CO1]
(v)	In Thevenin's theorem, to find R_{Th} a) all independent current sources are short circuited and independent voltage sources are open circuited b) all independent voltage sources are open circuited and all independent current sources are short circuited c) all independent voltage and current sources are short circuited d) all independent voltage sources are short circuited and all independent current sources are open circuited	[CO1]
(vi)	In a series R-L-C circuit, the condition for resonance is a) Power factor is zero b) Magnitude of the voltage drops across X_L and X_C are equal c) The currents I_C & I_L are in Phase opposition d) Resultant current is zero	[CO1]
(vii)	In a transformer, electric power is transformed from primary to secondary without change in a) current b) frequency c) voltage d) turns	[CO2]
(viii)	Transformer core is laminated to a) reduce hysteresis loss b) reduce eddy current loss c) reduce copper loss d) reduce all losses mentioned above	[CO2]
(ix)	Commutator in a DC machine is made of a) aluminum b) iron c) copper d) laminated steel	[CO2]
(x)	The number of parallel paths in the armature winding of 8-pole wave connected dc machine is a) 4 b) 16 c) 8 d) 2	[CO2]
(xi)	What happens when the phase sequence of the voltage applied to the stator of a three-phase induction motor is changed a) Motor does not run b) Slip changes c) Direction of rotation is reversed d) Motor gets heated	[CO2]

(xii)	Cylindrical rotor alternators are preferred in thermal power plants because a) They can give high current b) They can give high voltage c) They can run at high speed with less friction d) They generally run a low speed	[CO2]
(xiii)	From the two voltage equations $A = E_m \sin 100\omega t$ and $B = E_m \sin(100\omega t + \pi/6)$, it is obvious that a) A leads B by 30° b) B achieves its maximum value before A does c) B lags behind A d) A achieves its zero value before B does	[CO3]
(xiv)	A complex current wave is given by $i = 5 + 5\sin 100\omega t$ ampere. Its average value computed over a full cycle is: a) 0 A b) 3.54 A c) 5 A d) 7.96 A e) 12.96 A	[CO3]
(xv)	In an AC electrical circuit, if the current lags the voltage by 60^0 the circuit nature is a) R-C b) R-L c) L-C d) purely L	[CO3]
(xvi)	In a R-C series circuit when $Xc = R$, then the phase angle between the applied voltage and circuit current is a) 30^0 b) 45^0 c) 60^0 d) 90^0	[CO3]
(xvii)	If a balanced 3-phase load is connected across a balanced 3-phase supply, the sum of instantaneous values of 3-phase currents is a) I_A-I_B+I_C b) –I_A-I_B-I_C c) I_C-I_A-I_B d) 0	[CO3]
(xviii)	A 3-phase, 4-wire system supplies a balanced star load. The current magnitude in each phase is 5A. The current in the neutral wire will be a) 0 A b) 5 A c) 15 A d) $5\sqrt{3}$ A	[CO3]
(xix)	If two capacitors of 2F and 10F are in series, the net capacitance is a) 12 F b) 1.67 F c) 8 F d) 5 F	[CO4]
(xx)	Self-inductances of two coils are 9 mH and 16 mH. If the coefficient of coupling is 0.4, mutual inductance between the two coils is: a) 4 mH b) 4.8 mH c) 7.6 mH d) 57.6 mH	[CO4]
(xxi)	Q factor of a series resonating circuit consisting of R=10 ohms, L=0.1 H and C=10 μF is a) 0.01 b) 1 c) 10 d) 100	[CO4]
(xxii)	In the measurement of three-phase power by two wattmeter method, if the two wattmeter readings are equal then the power factor of the circuit is a) unity b) zero c) 0.8 lag e) 0.8 lead	[CO4]
(xxiii)	The r.m.s. value of the complex voltage given by $V = 16\sqrt{2}\sin\omega t + 12\sqrt{2}\sin 3\omega t$ is a) $20\sqrt{2}$ b) $28\sqrt{2}$ c) $19\sqrt{2}$ d) 20	[CO4]
(xxiv)	The slip of 400 V, 3-phase, 50 Hz, 4-pole induction motor when rotating at 1440 r.p.m. is a) 2% b) 3% c) 4% d) 5%	[CO4]

2.	Answer *any TWO (2)* questions	[CO 1]	(2@10 = 20)
(a)	State KCL and KVL as applied to electrical circuits.		(4)
	Find the value of load resistance (RL) for which the power source will supply maximum power. Also find the value of maximum power for the network shown below: 		(6)
(b)	What do you mean by coefficient of coupling? Derive an expression of coefficient of coupling involving self-inductances L1 and L2 and Mutual Inductance M between two coils.		(4)
	An iron ring of mean length 50 cm has an air-gap of 1 mm and a winding of 200 turns. The relative permeability of iron is 300. When 1 A current flows through the coil, determine the flux density.		(6)
(c)	Define electric capacitance and derive an expression for the capacitance of a parallel plate capacitor.		(4)
	A capacitor is made of two plates with an area of 10 cm^2 separated by a mica sheet of 1 mm thickness. Find the capacitance taking $\varepsilon_r = 6$ for mica. If one of the plates is moved to provide an air gap of 0.25 mm thickness between the upper plate and mica, calculate the change in the value of capacitance.		(6)

3.	Answer *any TWO (2)* questions	[CO 2]	(2@10 = 20)
(a)	What are ideal voltage sources and ideal current sources? How do they differ from practical sources?		(4)
	Find voltages at the nodes 1, 2, and 3 using Nodal Analysis (KCL). 		(6)
(b)	Why the brushes in a DC machine are made of graphite?		(4)
	A 6-pole lap connected DC generator with 125 coils generates a voltage of 400 V on open circuit when running at 1200 rpm. Find the useful flux per pole. For the same value of the flux per pole, find the voltage at open circuit when the machine runs at 1000 rpm.		(6)
(c)	Show that for a single-phase transformer, $E_p = 4.44 f \phi_m N_p$ where the symbols have their usual meanings.		(4)
	A 55 kVA single phase transformer has primary winding of 460 turns and secondary winding of 160 turns. The input side of transformer is supplied with voltage of 2500 V, 50 hz supply. Calculate secondary voltage, primary and secondary full load current, & maximum value of flux.		(6)

4.	Answer *any TWO (2)* questions	[CO 3]	(2@10 = 20)
(a)	What is resonance? Deduce the expression of frequency in a series RLC circuit at resonance. A coil of resistance 30Ω and inductance 320mH is connected in parallel to circuit consisting of 75Ω is series with 150μF capacitor. The circuit is connected to a 200V, 50Hz supply. Determine supply current and circuit power factor.		(4) (6)
(b)	What is a three-phase balanced A.C. system? Show that in a three-phase balanced AC circuit the sum of the current in the neutral is zero. A 3-phase circuit having load connected in DELTA configuration, has the following values of voltages and impedances: $V_{AB} = 300\angle 30°$, $V_{BC} = 200\angle -60°$, $V_{CA} = 150\angle 150°$, $Z_{AB} = 10\angle 30°$, $Z_{BC} = 10\angle 45°$ and $Z_{CA} = 15\angle -70°$. Calculate the phase and line currents.		(4) (6)
(c)	What do you mean by harmonic signals? What are even and odd harmonics? What are the reasons that cause harmonics to be generated in a real-life signal? Find Fourier series expansion for the following signal.  		(4) (6)

5.	Answer *any FOUR (4)* questions	[CO 4]	(4@5 = 20)
(a)	A parallel plate capacitor has plate area of $0.1m^2$ and plate separation 0.015cm. The dielectric medium between the plates has relative permittivity 3. The capacitor retains a charge of 0.1μC when placed across voltage source. Find the electric flux density, electric field strength and voltage across the plates. Assume the permittivity of space as 8.854×10^{-12} F/m.		(5)
(b)	Two coils A and B are kept in parallel planes such that 70% of the flux produced by coil A links with coil B. Coil A has 10,000 turns. Coil B has 12,000 turns. A current of 4 A in coil A produces a flux of 0.04 mWb while a current of 4 A in coil B produces a flux of 0.08 mWb. Calculate (i) self-inductance of the two coils (ii) mutual inductance (iii) coupling coefficient.		(5)
(c)	A circuit consisting of series combination of elements as resistance of 6Ω, inductance of 0.4H and a variable capacitor is connected across a 100V, 50Hz supply. Calculate (i) value of capacitance at resonance, (ii) voltage drop across capacitor at resonance and (iii) Q-factor of coil.		(5)
(d)	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 one of the two wattmeters tend to show negative reading.		(5)
(e)	The voltage and current in a circuit are respectively $v = 100\sin\omega t + 50\sin(3\omega t + \pi/4)$ $i = 10\sin(\omega t + \pi/3) + 5\sin 3\omega t$ Calculate the active power consumption.		(5)
(f)	A 6-pole, 50 Hz induction motor has no-load speed 980 rpm and full-load speed 960 rpm. Calculate: i) Synchronous speed ii) No-load slip iii) full-load slip iv) Frequency of rotor at full-load		(5)