21EE13 / 21EE23

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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

I / II Semester B. E. Supplementary Examinations Oct-2023

ELEMENTS OF ELECTRICAL ENGINEERING

Time: 03 Hours ***Maximum Marks: 100***

Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2 is compulsory. Choose any one full question from 3 or 4, 5 or 6, 7 or 8 and 9 or 10.

PART-A

1	1.1	Name two non-conventional source of energy that is used most in India and why?	02
	1.2	A $3-phase, 50Hz, 6$ pole star connected alternator has 360 conductors per phase and flux per pole is $0.5Wb$. Calculate the e.m.f generated if the winding factor is 0.97 and the coils are full pitched.	02
	1.3	What are the components of a solar PV standalone system?	02
	1.4	What is power factor? Why power factor improvement is required?	02
	1.5	A balanced 3-phase start connected load draws power from 400V supply. The two wattmeter's read $3kW$ and $2kW$. Calculate line current in the circuit.	02
	1.6	What is the difference between MCB and $ELCB$?	02
	1.7	A $50kVA, 1000/200V$ transformer takes $4A$ at $0.2\,p.f$ when the secondary is open. Determine core loss and magnetizing component of current.	02
	1.8	What is slip of an induction motor? What is the value of the slip when the motor is at standstill?	02
	1.9	Why a shunt motor should not be turned on with its field winding open?	02
	1.10	What are the advantages of $BLDC$ motor over induction motors?	02

PART-B

2	a	With a neat sketch, explain the constructional features of smooth cylindrical rotor alternator?	05
	b	Explain the following. i) I-V and P-V characteristics of solar PV ii) Block diagram of smart grid.	08
	c	A $12V$ battery of capacity $500Ah$ is connected to a solar panel. If battery discharge duration is $10hours$, then calculate the power of the battery and energy stored in the battery.	03
3	a	Derive an expression for the current drawn by a pure inductor. Explain with the help of a power diagram that the value of an average power drawn by the inductor during one cycle is zero.	05

	b	An alternating voltage is represented by the equation $v = 100\sin 520t\ V$. Calculate its: i) rms value ii) average value iii) form factor iv) peak factor v) frequency vi) voltage when $t = 0.0015\ sec$.	06
	c	With phasor representation and circuit diagram, derive an expression for measurement of power by two-wattmeter method.	05
		OR	
4	a	Derive the power dissipated in a series RC circuit and also draw the waveforms of voltage, current and power.	05
	b	Three identical coils are connected in a star to a $400V, 3-phase, 50Hz$ supply and each coil takes $300W$. If the power factor is 0.8, calculate i) line current ii) impedance iii) resistance and inductance of each coil.	06
	c	Prove that in a balanced star connected system, the line voltage is 1.732 times of phase voltage and the line current is same as phase current.	05
5	a	A household uses the following electric appliances: i) refrigerator of rating $400W$ for 24hours each day ii) two electric fans of rating $80W$ each for 12hours each day iii) six electric bulbs of $18W$ for 6hours each day Calculate the electricity bill of the household for the month of April if the cost per unit of electric energy is $Rs.3.50$.	05
	b	Explain the merits and demerits if conduit wiring.	05
	c	With a neat sketch, explain the process of plate earthing.	06
		OR	
6	a	With the help of block diagram, explain the working of UPS.	06
	b	Define the term 'Fuse' and mention the requirements for a good fuse. Also explain how fuse is different from MCB.	05
	c	Estimate Total Daily Energy Requirement for the following loads and also compute the electricity bill for the month of July assuming average cost $Rs.4.50$ per unit.	05

Name of the appliances	*Power rating (W)*	*Average daily usage (Hrs.)*	*No. of appliances*
CFL	25	7	4
FAN	50	6	2
TV	150	6	1
COMPUTER	200	5	1
GYSER	2000	1	1

7	a	Explain the working of capacitor start capacitor run 1-phase induction motor. Also, draw the phasor diagram.	06
	b	A $50kVA$ transformer has an efficiency of 98% at full load, $0.8p.f$ and an efficiency of 96.9% at one fourth of full load, $0.8p.f$. Determine i) The iron loss and full load copper loss ii) Losses at maximum efficiency iii) Fraction of full load corresponding to maximum efficiency.	06
	c	The slots on the rotor of an induction motor are usually skewed. Justify.	04
		OR	
8	a	With a neat sketch, explain the constructional features of 1-phase shell type transformer.	06
	b	A $3-phase$, $50Hz$ induction motor runs at $965\ RPM$ at full load. Calculate i) The number of motor poles ii) The slip and frequency of the rotor currents iii) The speed of the stator field with respect to rotor and with respect to the rotor field.	06
	c	Core type transformer is used for high voltage application. Justify.	04
9	a	Explain the constructional features, working principle and applications of DC motor.	09
	b	With a neat circuit, explain construction and working principle of stepper motor.	07
		OR	
10	a	Explain the characteristics T_a/I_a and N/I_a of DC series and shunt motor. Justify the nature of the curves.	09
	b	With a neat circuit, explain the construction and working principle of $BLDC$ motor.	07

COURSE CODE: 21EE23 **COURSE:** ELEMENTS OF ELECTRICAL ENGG. UG

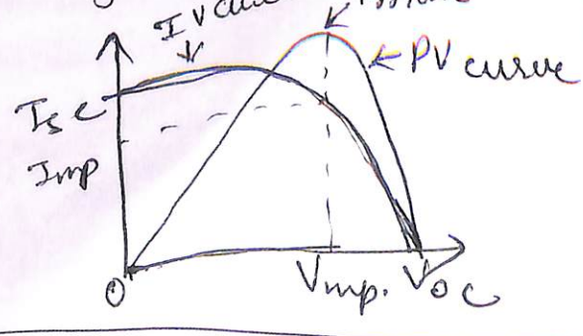
Question No	PART - A	Marks
1.1	Solar and wind as both are available in abundance and easy to harness.	(2M)
1.2	$E_L = \sqrt{3} E_{ph} = \sqrt{3} \times 2.22 f \phi_m Z_{ph} k_p k_d$ $= \sqrt{3} \times 1938 \times 0.6 = 33.56$ KV	(1M) (1M)
1.3	PV panel, battery, charge controller, MPPT, inverter.	(2M)
1.4	Power factor is measure of how effectively incoming power is used in electrical s/m. It is ratio of Real power to apparent power. By improving power factor, ~~power~~ loss & ~~power~~ cost can be reduced.	(1M) (1M)
1.5	$\phi = \tan^{-1}\left(\sqrt{3}\frac{(W_1 - W_2)}{W_1 + W_2}\right) = 19.1°$ $I_L = \frac{P}{\sqrt{3} V_L \cos\phi} = \frac{5\,KW}{\sqrt{3} \times 400 \times \cos(19.1)} = 7.63A$	(1M) (1M)
1.6	MCB is commonly used at residential properties to sense abnormal conditions like short ckts & overload. whereas, ELCB is a vltg operated device that is used for the detection of current leakage.	(2M)

Question No		Marks
1.7	$I_w = I_0 \cos\phi_0 = 4 \times 0.2 = 0.8A$ — (1M) $I_u = I_0 \sin\phi_0 = 4 \times 0.979 = 3.916A$ — (1M)	
1.8	Difference between the synchronous speed (N_s) & the speed of the rotor (N) is defined as slip of an I.M. It is expressed as a fraction of N_s. $S = \frac{N_s - N}{N_s}$ — (1M) At standstill, $S = \frac{N_s - 0}{N_s} = 1$ — (1M)	
1.9	In shunt motor $N \propto \frac{E_b}{\phi}$, if field wdg. is open $\phi = 0$. but in practice, the flux is not zero. Due to some residual flux motor runs at dangerous high speed & may destroy. — (2M)	
1.10	The BLDC motors requires less energy & it is 6% more energy efficient as these motors have less static friction and heat loss. — (2M)	

PART-B

2a. neat sketch of smooth cylindrical rotor — (2.5M)

Explanation — (2.5M)

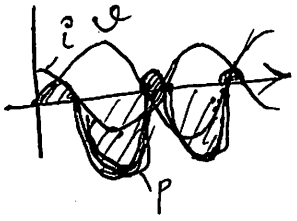


b. Characteristics — 2M

Explanation — 2M.

COURSE CODE: **COURSE:**

Question No		Marks
2b.	Block diagram — 2M Explanation — 2M	
2c.	Discharge current $= \frac{500\,Ah}{10h} = 50\,A$ — (1M) $P = VI = 12 \times 50 = 600$ Watts. — (1M) $E = 12\,V \times 500\,Ah = 6\,kWh$ — (1M)	
3a.	Expression for $P = 0$ — (4M) Power diagram — (1M)	
b.	i) $V_{r.m.s} = \frac{V_m}{\sqrt{2}} = 70.7\,V$ — (1M) ii) $V_{AV} = V_{r.m.s}/1.11 = 63.7\,V$ — (1M) iii) Form factor $= V_m/V = 1.11$ — (1M) iv) Peak factor $= V/V_{AV} = 1.414$ — (1M) v) $2\pi f = \omega \Rightarrow f = \frac{\omega}{2\pi} = \frac{520}{2\pi} = 82.8\,Hz$ — (1M) vi) voltage at $0.0015\,s = 100 \sin 520 \times 0.0015 = 70.35\,V$ — (1M)	
3c.	$P_Y = 3 V_{ph} I_{ph} \cos\phi = 3 \frac{V_{ph}^2 \cos\phi}{Z_{ph}} = 3 \frac{(V_L/\sqrt{3})^2 \cos\phi}{Z_{ph}}$ $\therefore P_Y = \frac{V_L^2 \cos\phi}{Z_{ph}}$ — eqn (i) — (2) Same load in Δ, $P_\Delta = \frac{3 V_{ph}^2 \cos\phi}{Z_{ph}}$ here, $V_{ph} = V_L$ $\therefore P_\Delta = \frac{3 V_L^2 \cos\phi}{Z_{ph}}$ — eqn (ii) —	

Question No		Marks
	Compare eqn. (i) & (ii), we get. $\boxed{P_D = 3P_Y}$ —	(1M)
4a.	Power in RL ckt = $VI\cos\phi$. derivn —	(3M)
	Waveform V, I & P  —	(2M)
b.	$E_{ph} = E_L/\sqrt{3} = 231V = V_{ph}$	
	$P_{ph} = V_{ph} I_{ph} \cos\phi = 300$ W.	
	$\therefore I_{ph} = I_L = \frac{300}{V_{ph}\cos\phi} = 1.623A$ —	(2M)
	$Z_{ph} = \frac{V_{ph}}{I_{ph}} = 142.5\Omega$ —	(1M)
	$R_{ph} = Z_{ph}\cos\phi = 114\Omega$	(1M)
	$X_{ph} = Z_{ph}\sin\phi = 85.5\Omega$ or $L_{ph} = 0.272H$ —	(2M)
c.	Derivation for $V_L = \sqrt{3}V_{ph}$ & $I_L = I_{ph}$ for Y connected s/m. —	(4M)
	circuit connection —	(1M)
5a.	Daily Energy Consumption :	
	$= 400 \times 24 + 2 \times 80 \times 12 + 6 \times 18 \times 6$	
	$= 12,168$ Whr $= 12.168$ kWh. —	(3M)
	Electricity bill for the month of June	
	$= 12.168 \times 30 \times 3.5 =$ Rs ~~1095.12/-~~ 1277.64/- —	(2M)

Question No		Marks
5b.	Advt/Merits: 1) No risk of fire & good protection 2) Aesthetic in appearance 3) Shock-proof with proper earthing & bonding 4) Waterproof & troubleshooting is easy. 5) Earthing & continuity is assured. Demerits: 1) Expensive 2) Need good skill workmanship. 3) Risk of short ckt under wet condn. Any 3 Merits + Demerits —	(5M)
5c	Sketch of plate earthing —	(3M)
	Explanation —	(3M)
6a.	Block diagram of UPS —	(3M)
	Explanation —	(2M)
6b.	Defn. of fuse —	(1M)
	Requirements of a good fuse —	(2M)
	Difference in fuse & MCB —	(2M)
6c	Daily Energy Consumption = 5.2 kWhs. —	(3M)
	Monthly Energy Consumption for the month of July = 5.2 × 31 × 4.5 = Rs 725.4/—	(2M)

Question No		Marks
7a.	Working principle phasor diagram	– (4M) – (2M)
7b.	i) For full load $x=1, \eta=0.98, \cos\phi=0.8$ $W_i + W_{cu} = 816.33\,W$ For $x=\frac{1}{4}$, 0.8 p.f, $\eta = 0.969$ $W_i + \frac{W_{cu}}{16} = 319.92$ After solving, we get- $W_i = 286.826\,W$ $W_{cu} = 529.5\,W$	– (1M) – (1M) – (2M)
	ii) at max η; $W_i = W_{cu} = 286.826$ Watt.	– (1M)
	iii) $x = 50\sqrt{\frac{W_i}{W_{cu}}} = 36.8$ KVA.	– (1M)
7c.	In order to eliminate magnetic locking b/n stator & rotor and to reduce magnetic helm. The skewed rotor slots increases the length of the Cu bar there by increasing the resistance of the rotor bars hence the starting torque & starting current drawn can be improved.	– (4M)
8a.	Sketch of 1ϕ shell type Transformer Expln:	– (3M) – (3M)
8b.	As $N = 965$ r.p.m, if $P=4$ then $N_s = 1500$ r.p.m $P=6$ then $N_s = 1000$ r.p.m Hence $P=6$ is correct as it is nearer to 965 rpm	– (2M)

Question No		Marks
	(ii) Slip = 0.035 $f_r = sf = 1.75$ Hz } —	(2M)
	iii) relative speed b/n stator field & rotor ~~field~~. = 1000 − 965 = 35 r.p.m relative speed w.r.t rotor field = 0 } —	(2M)
8c.	At high voltage, heavy insulation is required. In core type winding, putting insulation is easier. The placement of LV wdg. near to the core reduces the need of insulating material required. The major advantage is that it is easier to dismantle for repair & maintanence. Also, the natural cooling is very efficient in core type trfr. —	(4M)
9 a.	Construction + Explanation + Application = 4M + 3M + 2M	
b.	Sketch + working principle = 3M + 4M.	
10a.	Charact. of d.c series motor with Justification " " " shunt motor " " 3 charact. of each (3×2=6) + 3M for Justification.	(9M)
b.	Sketch + Working Principle	(3M+4M)

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