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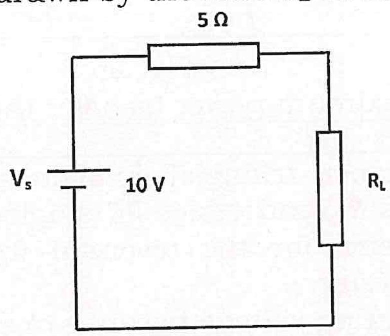
RV COLLEGE OF ENGINEERING®
(An Autonomous Institution affiliated to VTU)
I / II Semester B. E. Examinations Oct/Nov 2023
Common to all programs
BASICS OF ELECTRICAL ENGINEERING

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. 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	The maximum power drawn by the load R_L in Fig. 1.1 will be?  Fig. 1.1	02
	1.2	The resistance of the two coils is 25ohms when connected in series, and 6 ohms when connected in parallel. Determine the individual resistances of the two coils.	02
	1.3	Define a) Form factor b) Peak factor.	02
	1.4	A $50-Hz$ sinusoidal current has peak factor 1.4 and form factor 1.1. Its average value is $20A$. The instantaneous value of current is $15A$ at $t=0$. Write the equation of current.	02
	1.5	In a balanced 3-phase system, power is measured by two wattmeters and the ratio of two wattmeter readings is 2:1. Determine the power factor of the system.	02
	1.6	State the differences between a core-type and a shell-type transformer.	02
	1.7	Why the rotor slots in a three-phase induction motor are purposely given a slight skew?	02
	1.8	List the types of single-phase induction motor.	02
	1.9	Mention the characteristics of fuse.	02
	1.10	What is an electric shock? Write safety precautions to avoid electric shock.	02

PART-B

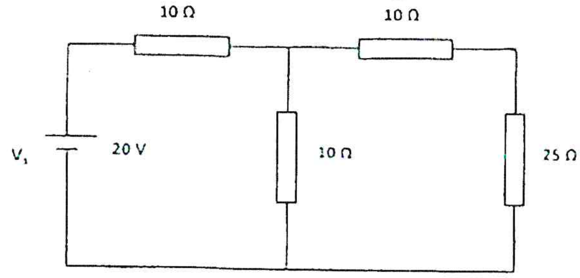
<table>
<tr><td>2</td><td>a</td><td>Use Thevenin's theorem to determine the current through and the voltage across the 25Ω resistor given in Fig. 2a.


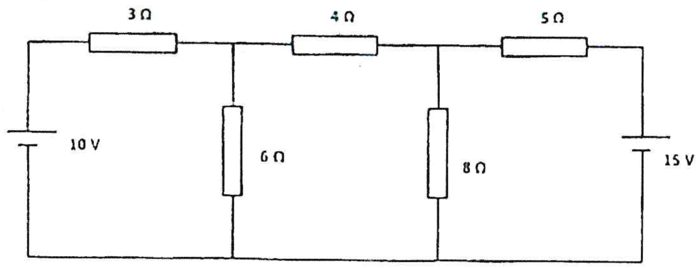
Fig. 2a</td><td>06</td></tr>
<tr><td></td><td>b</td><td>A network is arranged as shown in Fig. 2b. Determine the current in each resistance.


Fig. 2b</td><td>06</td></tr>
<tr><td></td><td>c</td><td>State and prove maximum power transfer theorem for dc networks.</td><td>04</td></tr>
<tr><td>3</td><td>a</td><td>What is an impedance triangle? Explain and draw the impedance triangle for a series RL and series RC single-phase a.c. circuits. Also, deduce an expression for the resonant frequency of a series RLC single-phase a.c. circuit.</td><td>08</td></tr>
<tr><td></td><td>b</td><td>A sinusoidal alternating voltage has an r.m.s value of $100V$. Find the
i) Instantaneous value of $0.0125s$ after passing through maximum positive value and
ii) The time measured from a positive maximum value when the instantaneous voltage is $70.7V$.</td><td>08</td></tr>
<tr><td colspan="4">OR</td></tr>
<tr><td>4</td><td>a</td><td>Derive the expression for Average value and rms value of a sinusoidal waveform.</td><td>08</td></tr>
<tr><td></td><td>b</td><td>A coil and a non-inductive resistor are connected in series across a $200V, 50\ Hz$ supply. The voltage across the coil and resistor are $120V$ and $140V$ respectively. If the supply current is $0.5A$, calculate:
i) The resistance and inductance of the coil
ii) The power dissipated in the coil
iii) The power factor of the coil
iv) The power factor of the circuit.</td><td>08</td></tr>
<tr><td>5</td><td>a</td><td>The three arms of a three-phase load each comprise an inductor of resistance 25Ω and of inductance $0.15\ H$ in series with a $120\mu F$ capacitor. The supply is $415\ V, 50\ Hz$. Calculate the line current and the total power in watts, when the three arms are connected in:
i) star
ii) delta.</td><td>08</td></tr>
</table>

	b	Give reasons: i) Copper loss is called as variable loss and iron loss is called as Constant loss. ii) The rating of transformer is in kVA. iii) Transformer cannot be excited by DC supply.	08
		OR	
6	a	A single-phase transformer working at unity power factor has an efficiency of 90% at both half load and the full-load of $500W$. Determine the efficiency at 75% full load and the maximum efficiency.	08
	b	Derive the relationship between the line and phase values of voltage in a three-phase start connected system with the aid of a phasor diagram.	08
7	a	Explain the concept of rotating magnetic field of an Induction motor. Draw the torque-slip characteristics of a three-phase induction motor.	08
	b	Describe the construction of a single-phase induction motor with the aid of a diagram.	08
		OR	
8	a	Explain the working principle of a single-phase induction motor. Discuss why single-phase induction motors do not have a starting torque.	08
	b	Compare between Squirrel cage and slip ring induction motor. A 12-pole, 3-phase alternator is coupled to an engine running at 500 r.p.m. It supplies an induction motor which has a full-load speed of 1440 r.p.m Find the slip and the number of poles of the motor.	08
9	a	In a residential house, the following load are connected: i) Six lamps of $40W$ each, switched on for 5 hours a day. ii) Two fans of $60W$ each, switched no for 12 hours a day. iii) One $100\ W$ heater working for 2 hours per day. iv) One refrigerator of $250W$ working for 10 hours per day. If each unit of energy costs $Rs. 1.90$, what will be the total cost in the month of September?	08
	b	Illustrate the concept of power generation, transmission, and distribution system with block diagrams.	08
		OR	
10	a	What are the types of earthing? Explain with diagram any one type of earthing.	08
	b	Explain the working of Miniature Circuit Breaker with neat diagram. Mention its merits and demerits.	08

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Question No	PART – A	Marks
1.1	$P_{L(max)} = \frac{V_{th}^2}{4R_{th}} = \frac{10\times10}{4\times5} = 5W$	2M
1.2	$R_1 + R_2 = 25 \Rightarrow R_2 = 25 - R_1$	
	$\frac{R_1R_2}{R_1+R_2} = 6 \Rightarrow \frac{R_1R_2}{25} = 6 \Rightarrow R_1R_2 = 150$	
	$\Rightarrow R_1(25-R_1) = 150 \Rightarrow 25R_1 - R_1^2 = 150$	
	$\Rightarrow R_1^2 - 25R_1 + 150 = 0 \quad \cancel{\Rightarrow R_1^2 - 30R_1 + 5R_1 + 150 = 0}$	
	$\cancel{\Rightarrow R_1(R_1-30)+5(R}$	2M
	$R_1 = 15\Omega \; ; R_2 = 10\Omega$	
	or $R_1 = 10\Omega \; ; R_2 = 15\Omega$	
1.3	Form factor for a particular waveform is defined as the ratio of the rms value to the average value.	1M
	$\therefore K_f = \frac{\text{r.m.s value}}{\text{average value}}$	
	Peak factor for a given waveform is defined as the ratio of the peak value and the rms value.	1M
	$K_p = \frac{\text{peak value}}{\text{r.m.s. value}}$	
1.4	$K_f = 1.1 = \frac{\text{RMS value}}{20} \Rightarrow \text{RMS value} = 22A$	
	$K_p = 1.4 = \frac{\text{Peak value}}{22} \Rightarrow \text{Peak value} = 30.8A$	
	$\omega = 2\pi f = 2\times3.14\times50 = 314$	2M
	$I = I_0 \sin(\omega t + \phi) \Rightarrow 15 = 30.8\sin(\phi)$	
	$\Rightarrow \sin\phi = 0.487 \Rightarrow \phi = 29.14°$	
	$\Rightarrow I = 30.8\sin(314t + 29.14°)$	

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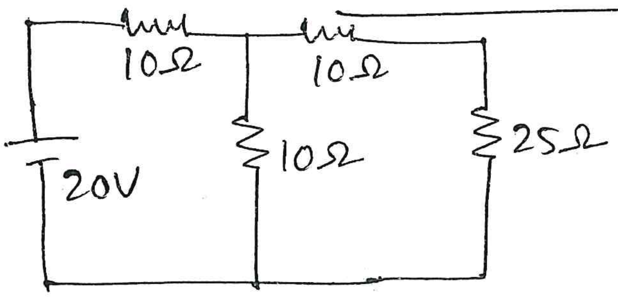
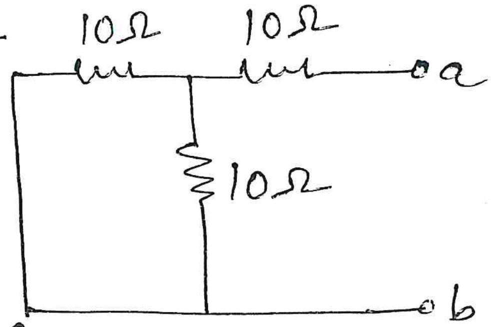
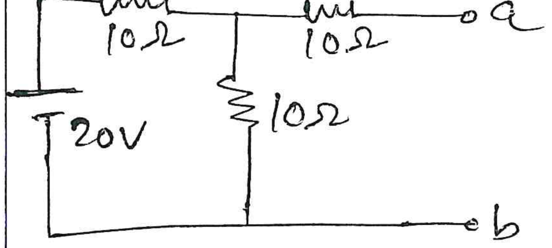
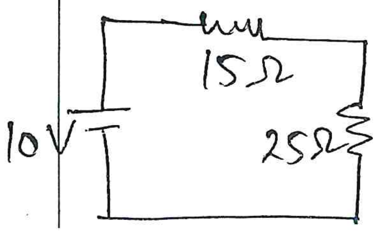
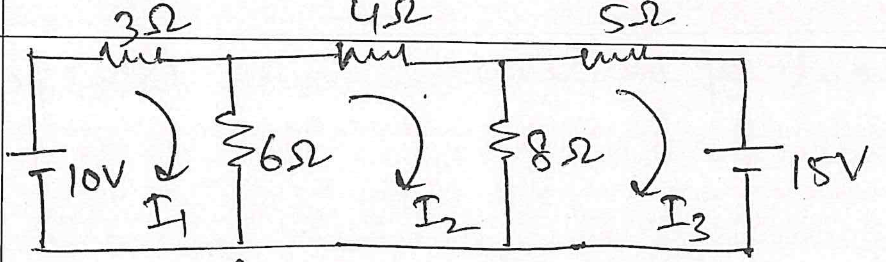
Question No		Marks
1.5	$P_1 = 2P_2$; $\tan\phi = \sqrt{3}\,\frac{P_1 - P_2}{P_1 + P_2} = \sqrt{3}\,\frac{2P_2 - P_2}{2P_2 + P_2} = \frac{1}{\sqrt{3}}$ $\Rightarrow \phi = 30^\circ$, $\cos\phi = \cos 30^\circ = 0.866$ (lag)	2M
1.6	Differences between a core-type and a shell type t/f (at least 4 differences)	2M
1.7	1. More uniform torque is produced and the noise is reduced during operation. 2. The locking tendency of the rotor is reduced.	2M
1.8	1. Split-phase motor 2. Capacitor-start motor 3. Capacitor start capacitor run motor 4. Shaded-pole motor	2M
1.9	Characteristics of fuse	2M
1.10	Definition of electric shock Safety precautions to avoid electric shock	1M 1M
	PART-B.	
2 a)	 	2M
	 $R_{th} = 10 + \frac{10 \times 10}{10+10} = 15\Omega$ $V_{th} = 10V$	2M
	 $I = \frac{10}{15+25} = 0.25A$ Voltage across 25Ω resistor	2M

Question No		Marks

2(b)



$3I_1 + 6(I_1 - I_2) = 10 \Rightarrow 9I_1 - 6I_2 + 0I_3 = 10$ — ①

$4I_2 + 8(I_2 - I_3) + 6(I_2 - I_1) = 0$

$\Rightarrow -6I_1 + 18I_2 - 8I_3 = 0$ — ② **2M**

$5I_3 + 15 + 8(I_3 - I_2) = 0 \Rightarrow 0I_1 - 8I_2 + 13I_3 = -15$ — ③

$$\begin{bmatrix} 9 & -6 & 0 \\ -6 & 18 & -8 \\ 0 & -8 & 13 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ -15 \end{bmatrix}$$

$\Delta = 9(18\times13 - 64) + 6(-6\times13)$

$= 9(234 - 64) + 6(-78) = 1530 - 468$

$= 1062$

$$\Delta_1 = \begin{bmatrix} 10 & -6 & 0 \\ 0 & 18 & -8 \\ -15 & -8 & 13 \end{bmatrix} = 10(18\times13 - 64) + 6(0 - 120)$$

$= 10(234 - 64) - 720$

$= 1700 - 720 = 980$ **2M**

$$\Delta_2 = \begin{bmatrix} 9 & 10 & 0 \\ -6 & 0 & -8 \\ 0 & -15 & 13 \end{bmatrix} = 9(0 - 120) - 10(-78)$$

$= -1080 + 780 = -300$

$$\Delta_3 = \begin{bmatrix} 9 & -6 & 10 \\ -6 & 18 & 0 \\ 0 & -8 & -15 \end{bmatrix} = 9(-18\times15) + 6(90) + 10(48)$$

$= -2430 + 540 + 480$

$= -1410$

$I_1 = \frac{\Delta_1}{\Delta} = \frac{980}{1062} = 0.923\,A$ $\quad I_3 = \frac{-1410}{1062}$ **2M**

$I_2 = \frac{\Delta_2}{\Delta} = \frac{-300}{\ } = -0.282\,A$ $\quad = -1.328\,A$

Question No		Marks
2(c)	Statement of maximum power transfer theorem	2M
	proof	2M
3(a)	Impedance triangle	2M
	Series RL	2M
	Series RC	2M
	Expression for the resonant frequency $X_L = X_C \Rightarrow 2\pi f L = \frac{1}{2\pi f C} \Rightarrow f = \frac{1}{2\pi\sqrt{LC}}$	2M
3(b)	(i) The instantaneous value at $t = 0.0175$ s is $v = 141.4 \sin(2\pi \times 50 \times 0.0175) = -100V$	4M
	(ii) $t_1 = \frac{1}{120}$ s $t_2 = t_1 - 0.005 = \frac{1}{120} - 0.005 = 3.33$ ms	4M
4(a)	Average value of a sinusoidal waveform half-cycle average = 0.637 × maximum value	4M
	RMS value of a sinusoidal waveform r.m.s. value = 0.707 × maximum value	4M
4(b)	(i) R = resistance of the non-inductive resistor R_C = resistance of the coil L = inductance of the coil $R = \frac{140}{0.5} = 280\Omega$; $Z_C = \frac{120}{0.5} = 240\Omega$; $Z = \frac{200}{0.5} = 400\Omega$ $R_C = 42.8\Omega$; $X_L = 236\Omega \Rightarrow L = 0.752H$	2M
	(ii) $P_C = 0.5^2 \times 42.8 = 10.7W$	2M
	(iii) $\cos\phi_C = \frac{42.8}{240} = 0.178$ lagging	2M
	(iv) $\cos\phi = \frac{280 + 42.8}{400} = 0.807$ lagging	2M

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Question No		Marks
5a)	(i) in star:	
	$Z_p = \sqrt{25^2 + 20.57^2} = 32.4\Omega$	
	$V_p = V_L/\sqrt{3} = 415/\sqrt{3} = 240V$	
	$I_p = \frac{V_p}{Z_p} = \frac{240}{32.4} = 7.4A = I_L$	4M
	$\cos\phi = \frac{25}{32.4} = 0.772 \Rightarrow P = 3V_pI_p\cos\phi = 4113\ W$	
	(ii) in delta:	
	$Z_p = 32.4\ \Omega$; $V_p = V_L = 415V$; $I_p = \frac{415}{32.4} = 12.8A$	
	$I_L = \sqrt{3}I_p = \sqrt{3}\times 12.8 = 22.2A$	4M
	$P = 3V_pI_p\cos\phi = 3\times 415\times 12.8\times 0.772 = 12302\ W.$	
5(b)	(i) $P_{cu} = I^2R$; $P_i = W_e + W_h$	3M
	(ii) Reason of the rating of t/f in kVA	2M
	(iii) Reason of t/f cannot be excited by DC supply.	3M
6(a)	Efficiency at 75% full load =	
	$\frac{500\times 3/4}{500\times\frac{3}{4} + P_i + \left(\frac{3}{4}\right)^2 P_{cu_{fl}}}\times 100 = 90.5\%.$	4M
	Output at maximum efficiency $= 500\sqrt{\frac{18.52}{37.04}} = 353.55W$	
	maximum efficiency $= \frac{353.55}{353.55 + 18.52 + 18.52} = 90.516\%.$	4M
6(b)	$V_L = \sqrt{3}V_{ph}$ phasor diagram — 3M	
	$I_L = I_{ph}$ Proof — 5M	

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Question No		Marks
7 a)	Concept of rotating magnetic field - 6M	
	torque - slip characteristic - 2M	
7 b)	Diagram	3M
	Description of construction	5M
8(a)	working principle	5M
	Reasoning of no starting torque	3M
8(b)(i)	Comparison	4M
(ii)	$f_1 = 50\,Hz$	
	$S = \frac{1500 - 1440}{1500} = 0.04 = 4\%$	4M
	$P = \frac{120 f}{N_s} = 4$	
9(a)	~~Types of tariff of electricity bill~~	~~4M~~
	The total energy consumed per day = 7.14 kwh	4M
	Energy consumed in the month = 214.2 kwh	2M
	Total cost of energy = Rs. 406.98	2M
(b)	block diagram	3M
	Illustration	5M
10(a)	Types of earthing	2M
	Explanation of one type of earthing	6M
10(b)	Diagram	2M
	Working of MCB	4M
	Merits and demerits	2M
	Verified	

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Course Code: 22ES24D	Course Title: BASICS OF ELECTRICAL ENGINEERING

PART-A

Q.No	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10
B T	2	2	1	2	2	1	1	1	1	1
COs	1	1	2	2	2	3	3	3	4	4
Q No	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20
B T										
COs										

PART-B

Question No		B T Levels	Cos addressed	Question No		BT Levels	Cos addressed
2	a	3	1	3	a	2	2
	b	3	1		b	3	2
	c	2	1		c		
	d				d		
4	a	3	2	5	a	5	2
	b	3	2		b	4	3
	c				c		
	d				d		
6	a	3	2	7	a	2	3
	b	3	3		b	3	3
	c				c		
	d				d		
8	a	2	3	9	a	5	4
	b	4	3		b	2	4
	c				c		
	d				d		
10	a	2	4				
	b	2	4				
	c						
	d						

Signature of Scrutinizer: Signature of Chairperson:

Name: Adinata Jain Name: