

### Scoring Indicators

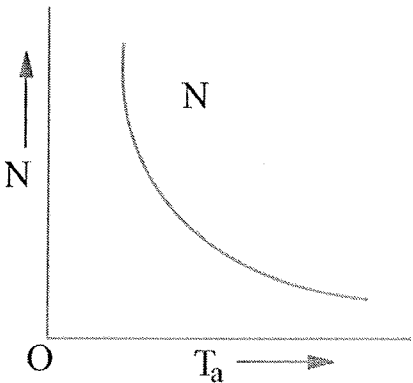
**COURSE NAME : ELECTRIC CIRCUIT AND NETWORK THEORY**

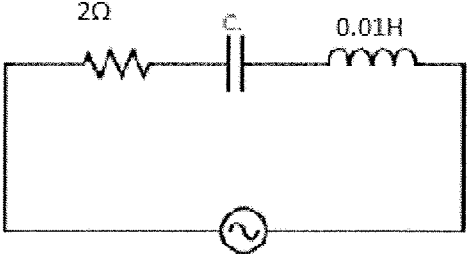
**COURSE CODE :3041**

**QID : 2110220228**

Q No	Scoring Indicators	Split score	Sub Total	Total score
<b>PART A</b>				<b>9</b>
I. 1	Sine Wave, Square Wave, Triangular wave etc		1	
I. 2	Increases		1	
I. 3	Linear, bilateral, active networks having more than one source		1	
I. 4	$K = \frac{V_2}{V_1} = \frac{N_2}{N_1}$		1	
I. 5	Output in kWh in 24 hrs / Input in kWh in 24 hrs		1	
I. 6	The torque required		1	
I. 7	Flux per pole		1	
I. 8	The number of field poles and on the speed at which the field poles are rotated.		1	
I. 9	Universal motor		1	
<b>PART B</b>				<b>24</b>
II. 1	(i)Ratio between RMS value and Average value of an alternating quantity (Current or Voltage) is known as Form Factor. (ii) When a waveform reaches a complete set of positive and negative value it is called one cycle. (iii)Number of cycles per second of an alternating quantity is known as time period.	(i) (1)  (ii)(1)  (iii) (1)	3	
II. 2	Elementary Theory of an Ideal Transformer An ideal transformer is one which has no losses i.e.its windings have no ohmic resistance,there is no magnetic leakage and hence which has no copper losses and core losses.In other words, an ideal transformer consists of two purely inductive		3	

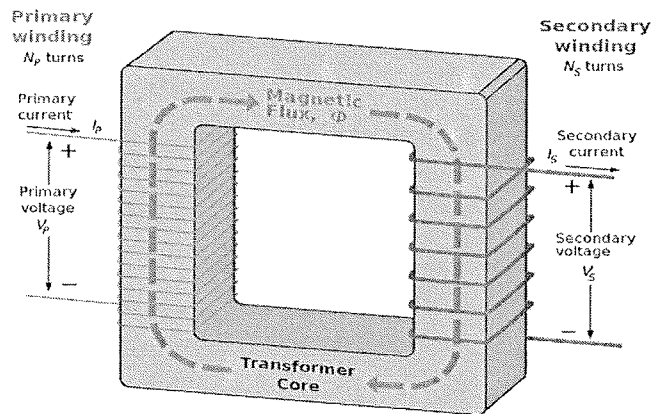


	 <p>When speed is high, torque is low and vice-versa.. It is because an increase in torque requires an increase in armature current. The result is that flux is strengthened and hence the speed drops.</p>	Expn (1)		
II. 7	<p>Working Principle of Alternator is based upon Faraday's law of electromagnetic induction.</p> <p>The current is induced in the conductor inside a magnetic field when there is a relative motion between that conductor and the magnetic field.</p>		3	
II. 8	<p>The armature reaction simply shows the effect of armature field on the main field. The armature reaction represents the impact of the armature flux on the main field flux. The armature field is produced by the armature conductors when current flows through them. And the main field is produced by the magnetic poles. The armature flux reduces the magnitude of the main field flux.</p>		3	
II.9	<p>The auto transformers are used</p> <ol style="list-style-type: none"> <li>1 as starters for induction motors and synchronous motors which are known as auto transformer starters.</li> <li>2 In labs for obtaining a continuously varying voltage.</li> <li>3 in voltage stabilizers as regulating transformers</li> <li>4 as booster transformer to raise the voltage in AC feeders</li> </ol>		3	
II.10	<p>Maximum power transfer theorem states that the DC voltage source will deliver maximum power to the variable load resistor</p>	Theorem 1	3	

	<p>only when the load resistance is equal to the source resistance. The condition for maximum power dissipation across the load is <math>R_L=R_{Th}</math></p> <p>maximum amount of power transferred to the load is</p> $P_{LMax}=V_{Th}^2/4R_L=V_{Th}^2/4R_{Th}$	1		
	<b>PART C</b>			42
III. 1	<p>(i)</p>  <p><math>X_L=2\pi f L</math>  <math>=2\pi * 50*0.01H</math>  <math>=3.142\Omega</math></p> <p>Maximum current occurs at resonance  When <math>X_L=X_C = 3.142</math>  <math>X_C =1/2\pi fC</math>  <math>C=1/2\pi * 50*3.142</math>  <math>C=1013 \mu F</math></p> <p>At resonance <math>Z=R</math>  <math>I=V/R=100 \text{ 'A}</math></p> <p>(ii) Voltage across capacitor = <math>IX_C= 100*3.142=314.2 \text{ V}</math></p>	(i)4	7	
III. 2	<p>(a) <math>R= 50\Omega</math>  <math>X_L = 2*3.14*50*0.05=15.7 \Omega</math></p> <p>(b)</p> $Z = \sqrt{(R^2 + X_L^2)}$ $= 52.4 \Omega$ <p>(c) <math>I=V/R</math>  <math>=250/52.4= 4.77 \text{ A}</math></p>	(3)  (2)  (2)	7	

III. 3	<p>1. Iron Losses Iron losses are caused by the alternating flux in the core of the transformer as this loss occurs in the core it is also known as Core loss. Iron loss is further divided into hysteresis and eddy current loss.</p> <p>a) Hysteresis Loss The core of the transformer is subjected to an alternating magnetizing force, and for each cycle of emf, a hysteresis loop is traced out. Power is dissipated in the form of heat known as hysteresis loss .</p> <p>b) Eddy Current Loss When the flux links with a closed circuit, an emf is induced in the circuit. Since the core is made of conducting material, these EMFs circulate currents within the body of the material. These circulating currents are called Eddy Currents.</p> <p>2. Copper Losses (Ohmic Losses) These losses occur due to ohmic resistance of the transformer windings. If <math>I_1</math> and <math>I_2</math> are the primary and the secondary current, <math>R_1</math> and <math>R_2</math> are the resistance of primary and secondary winding ,then the copper losses occurring in the primary and secondary winding will be <math>I_1R_1</math> and <math>I_2R_2</math> respectively. Therefore, the total copper losses will be</p> <p>3. Stray Loss The occurrence of these stray losses is due to the presence of leakage field. The percentage of these losses are very small as compared to the iron and copper losses so they can be neglected.</p> <p>4. Dielectric Loss Dielectric loss occurs in the insulating material of the transformer that is in the oil of the transformer, or in the solid insulations. When the oil gets deteriorated or the solid insulation gets damaged the efficiency of the transformer gets affected.</p>	<p>Name of losses 2</p> <p>Explanation 5</p>	7	
III. 4	<p>The transformer is a static device which is used to transfer electrical energy from one ac circuit to another ac circuit. Input to a transformer and output from a transformer both are alternating quantities (AC). The primary winding is connected to the single – phase ac supply, an ac current starts flowing through it. The ac primary current produces an alternating flux</p>	<p>Constructional factors (2)</p>	7	

( $\Phi$ ) in the core. Most of this changing flux gets linked with the secondary winding through the core. The varying flux will induce voltage into the secondary winding according to the Faraday's laws of electromagnetic induction. Voltage level change but frequency i.e. time period remains same. There is no electrical contact between the two windings, an electrical energy gets transferred from primary to the secondary.



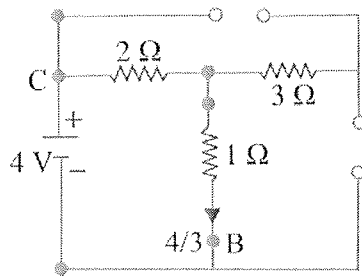
Working (3)

Fig (3)

III. 5

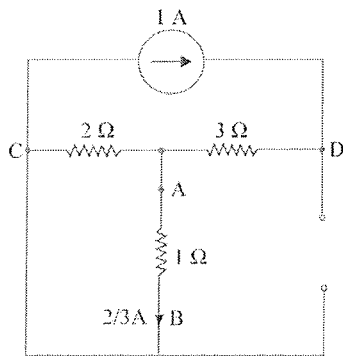
1. By Superposition Theorem : One source acts at a time. Current through A-B (1 ohm) is to be calculated due to each source and finally all these contributions added.

Due to 4-V source :



1-ohm resistor carries a current of  $4/3$  amp from A to B

Due to 1-A source:

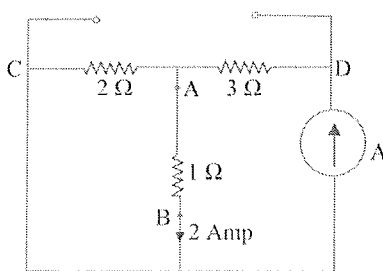


$2/3$  Amp from A to B

7

2

2

	<p style="text-align: center;">Due to 3-A source:</p>  <p style="text-align: right;">2 Amp from A to B</p> <p style="text-align: center;">Total current = 4 amp from A to B</p>	2  1		
III. 6	<p>1. Matrix - method for mesh analysis can be used. Mark three loops as shown, in Fig. Resistance- matrix should be evaluated for current in 5- ohm resistor. only, <math>i_3</math> is to be found. <math>R_{11} = 3</math>, <math>R_{22} = 6</math>, <math>R_{33} = 9</math>, <math>R_{12} = 1</math>, <math>R_{23} = 2</math>, <math>R_{13} = 2</math>. Voltage - source will be a column matrix with entries serially as : + 8 volts, + 10volts, + 12volts.</p> $\Delta = \begin{vmatrix} 3 & -1 & -2 \\ -1 & 6 & -2 \\ -2 & -2 & 9 \end{vmatrix}$ $= 3 \times (54 - 4) + 1 (-9 - 4) - 2 (2 + 12) = 109$ $\Delta_3 = \begin{vmatrix} 3 & -1 & 8 \\ -1 & 6 & 10 \\ -2 & -2 & 12 \end{vmatrix} = 396$ $i_3 = \Delta_3 / \Delta = 396 / 109 = 3.633 \text{ amp.}$	3 mesh equation (3)  Matrix equation (2)  Solution (2)	7	
III. 7	<p>For one revolution of the conductor, Let, <math>\Phi</math> = Flux produced by each pole in weber (Wb) <math>P</math> = number of poles in the DC generator. Total flux produced by all the poles <math>= \phi \times P</math> And, Time taken to complete one revolution <math>= 60/N</math> Where <math>N</math> = speed of the armature conductor in rpm. According to Faraday's law of induction, the induced emf of the armature conductor is denoted by "e" which is equal to rate of cutting the flux. Therefore,</p>		7	

$$e = \frac{d\phi}{dt} \text{ and } e = \frac{\text{total flux}}{\text{time take}}$$

Induced emf of one conductor is

$$e = \frac{\phi P}{60} = \phi P \frac{N}{60}$$

Let us suppose there are Z total numbers of conductor in a generator, and arranged in such a manner that all parallel paths are always in series. Then,

Z/A = number of conductors connected in series Induced emf of DC generator

E = emf of one conductor × number of conductor connected in series.

$$E = \phi P \frac{N}{60} \times \frac{Z}{A} \text{ volts}$$

III. 8

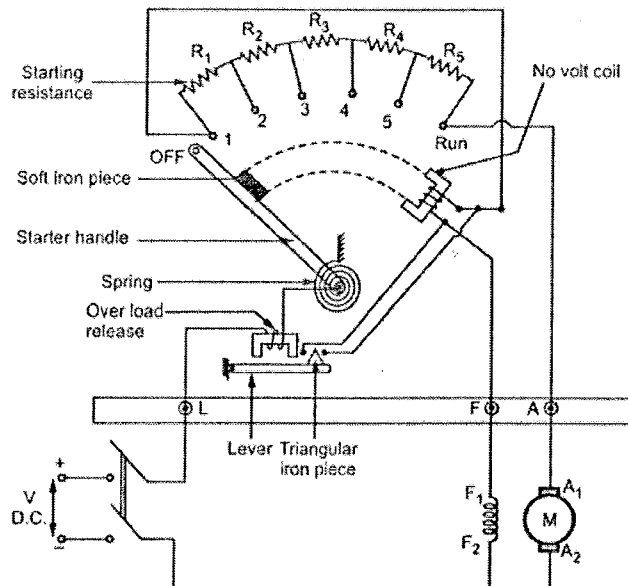
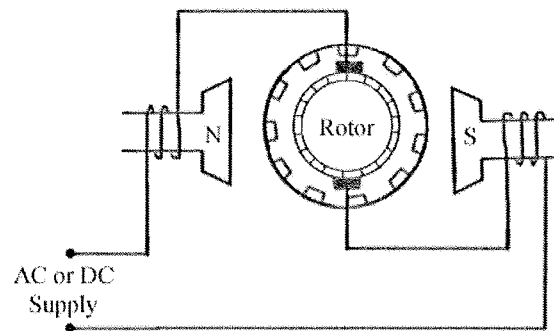


Fig (4)

DC motor based 3 point starter mainly includes three terminals namely L, A, and F. Here, L (line terminal) is connected to the positive supply, A (armature terminal) is connected to the windings of an armature terminal, and F (field terminal) is connected to the winding of field terminal. At first when a DC

7

	<p>supply is turned ON by H-handle in the OFF position, then the handle will move CLK wise direction to the stud1. The winding of the shunt field is directly associated across the voltage supply as the total resistance, in the beginning, is included in series with the armature circuit.</p> <p>If the voltage supply is unexpectedly disrupted, then the no-volt discharge coil is demagnetized as well as the H-handle goes back to the OFF location in the pull of the spring. If no-volt coil were not utilized, then there will be a supply failure. The H-handle would stay on the last stud. If the voltage supply is returned, then the DC motor will be openly allied across the supply, resulting in an extreme armature current.</p>	Expn (3)		
III. 9	<p>As the flux per pole is <math>\phi</math>, hence, in one revolution, each stator conductor cut a flux of,</p> $d\phi = P\phi$ <p>And the time taken to complete one revolution is, <math>dt = 60/N</math></p> <p>Therefore, according electromagnetic induction, the average EMF induced in one stator conductor is given by,</p> $\text{EMF per conductor} = d\phi/dt = P\phi N/60$ <p>Since there are Z conductors in series per phase, thus,</p> $\text{EMF per phase} = \text{EMF per conductor} \times Z$ <p>Speed of the rotor, <math>N = 120f/P</math></p> $\therefore \text{EMF per phase} = P\phi Z/60 \times 120f/P$ $= 2f\phi Z$ <p>Since, one turn has two conductors, i.e., <math>Z = 2</math> and hence the expression for the average induced EMF per phase can be written as,</p> $\text{EMF per phase} = 4f\phi T$		7	
III. 10		Fig(3)	7	



A universal motor is modified form of a DC motor and is widely used in home appliances like mixers and in machine tools.

If AC single phase supply is connected to a DC series motor, the motor gives circular rotation. During one-half cycle of current, it would pass through series winding as well as armature winding in a certain direction. Its magnitude, of course, would vary from zero to maximum and then back to zero. Electromagnetic torque will be produced throughout this half cycle. This torque will act to produce rotation of the armature in the same direction throughout all of the half cycles.

Now during the next half cycle, the current through both the series winding as well as armature winding is reversed. Since current in both armature and field have been reversed, the torque developed in this half cycle will tend to produce rotation of armature in the same direction as throughout the preceding half cycle. It means the direction of the armature is a circular rotation type.

Torque in DC series motor,  $T \propto \phi_s I_a$

where  $\phi_s$  is the series field winding flux and  $I_a$  is the armature current.

Workin  
g  
(4)

	<p>Also, <math>T \propto (-\phi_s)(-I_a)</math> for lower half cycle.</p> <p>Or <math>T \propto \phi_s I_a</math></p>			
<p>III. 11</p>	<p>A single-phase induction motor is an AC motor, that converts the electrical energy into mechanical energy to perform some physical work.</p> <div data-bbox="383 638 1117 1220" data-label="Diagram"> <p style="text-align: center;"><b>Single Phase Motor</b></p> </div> <p>In these types of ac motors, a single-phase AC supply provided to the stator winding. This causes a magnetic field that pulses in a sinusoidal manner. After some time the field polarity reverses and the alternating current may not provide the required winding to the motor. But if the motor is driven by external means, the motor will rotate with limited speed.</p>	<p>Fig (3)</p> <p>Expn (4)</p>	<p>7</p>	
<p>III. 12</p>			<p>7</p>	

