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REVISION 2021

THIRD SEMESTER DIPLOMA EXAMINATION IN ENGINEERING AND TECHNOLOGY

ELECTRIC CIRCUIT AND NETWORK THEORY

Answer Key- Set 2

Time: 3 hours

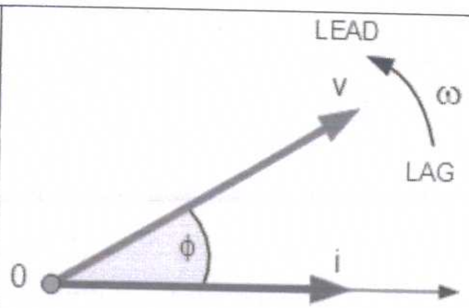
Maximum Marks:75

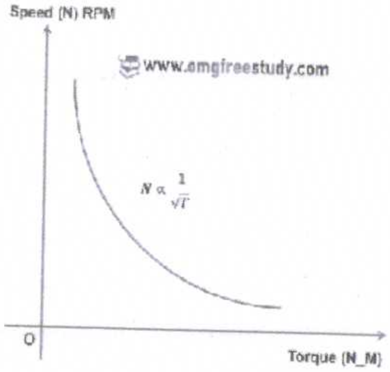
Part A

Question Number	Answer	Split up	Total
1.	Fleming's Right hand rule	1	1
2.	series	1	1
3.	0	1	1
4.	1 A	1	1
5.	Average	1	1
6.	Henry	1	1
7.	minimum	1	1
8.	core	1	1
9.	Zero	1	1

Part B

1	• It is used in applications requiring rapid variations in speed without the motor getting overheated. • Used in Industries performing packaging, factory automation, material handling, printing converting, assembly lines. • Used in many other demanding applications robotics, CNC machinery or automated manufacturing. • used in radio controlled airplanes to control the positioning and movement of elevators. • In robots because of their smooth switching on and off and accurate positioning. • In the aerospace industry to maintain hydraulic fluid in their hydraulic systems. • used in many radio controlled toys. • used in electronic devices such as DVDs or Blue ray Disc players to extend or replay the disc trays. • used in automobiles to maintain the speed of vehicles	Any three	3
2.	Phasor is a rotating vector, is a scaled line whose length represents an AC quantity that has both magnitude and direction. A complete sine wave can be constructed by a single vector rotating anti-clockwise at an angular velocity of $\omega = 2\pi f$, where f denotes the frequency of the waveform.	2+1	3

			
3.	1. Split phase induction motor. 2. Capacitor-start inductor motor. 3. Capacitor-start capacitor-run induction motor (two-value capacitor method. Used to both start and run the motor). 4. Permanent split capacitor (PSC) motor. 5. Shaded pole induction motor.	Any three	3
4.	Mean value of $i_2 = \frac{1}{\pi}\int_0^{\pi} i^2\, d\theta$ $(I_{RMS})^2 = \frac{1}{\pi}\int_0^{\pi} I_m^2 \, Sin^2\,\theta . d\theta = \frac{(I_m)^2}{\pi}\int_0^{\pi} Sin^2\,\theta . d\theta$ $= \frac{(I_m)^2}{\pi}\int_0^{\pi} \frac{1}{2}(1\text{-}Cos\ 2\theta)d\theta = \frac{(I_m)^2}{2\pi}\left[\theta - \frac{Sin\,2\theta}{2}\right]_0^{\pi}$ $= \frac{(I_m)^2}{2\pi}\left[\left(\pi - \frac{Sin\ 2\pi}{2}\right) - \left(\frac{0 - Sin\ 2 \times 0}{2}\right)\right]$ $= \frac{(I_m)^2}{2\pi}\ [(\pi - 0) - (0-0)] = \frac{I_m^2}{2}$ $I_{RMS} = \frac{I_m}{\sqrt{2}} = \mathbf{0.707\ I_m}$ Similarly $E_{RMS} = \frac{E_m}{\sqrt{2}} = \mathbf{0.707\ E_m}$	3	3
5.	The various effects armature reaction can be summarised as 1) The armature reaction always results in reduction of generated e.m.f. due to decrease in value of flux per pole. 2) The iron losses in the teeth and pole shoes are determined by the maximum value of flux density at which they work. Due to distortion in main field flux the maximum density at load increase above no load. Thus iron losses are observed to be more on load than on no load. 3) Due to the armature reaction the maximum value of gap flux density increases. This will increase the maximum voltage between adjacent commutator segments at load. If this	Any three -3	3

	voltage exceeds beyond 30 V the sparking may take place between adjacent commutator segments.		
6.	 Speed - Torque Characteristics We know that, $T \propto I_a^2$ and $N \propto \frac{1}{I_a}$ $I_a \propto \sqrt{T}$ and $N \propto \frac{1}{\sqrt{T}}$ This shows that the speed decreases with increase in the value of torque with increase in load.	3	3
7.	When current supplied to the field winding, it produces the magnetic flux. It called excitation. According to the way, the coils are excited , there are two types of DC machine. Separately Excited DC machine: This requires two DC sources. One source connected with the field winding. This source used for excitation. Another source is connected with the armature winding. Here, the field winding is physically separated from the armature winding. But both windings are mutually connected with the magnetic field. Self-Excited DC machine: There is a physical connection between the field winding and the armature winding. The field winding connected in various types with the armature winding.	3	3
8.	**Iron Losses** in a Transformer are of two types – Eddy current loss and hysteresis loss. Iron losses mainly occur through the alternating flux within the transformer's core. Once this loss occurs within the core then it is called core loss. **Copper losses** occur because of the Ohmic resistance in the windings of the transformer.	Any three	3

	Stray Losses can occur because of the occurrence of the leakage field. As compared with copper and iron losses, the percentage of stray losses are less, so these losses can be neglected. **Dielectric Loss** mainly occurs within insulating material of the transformer. Eg .oil is an insulating material.		
9.	The three important components of an electrical transformer are a magnetic core, primary winding, and secondary winding. An enclosure protects the internal components from dirt, moisture, and mechanical damage	3	3
10.	$v = -\left(-L\frac{di}{dt}\right)$ or $V_m \mathrm{Sin}\omega t = L\frac{di}{dt}$ or $di = \frac{V_m}{L}\sin\omega t\, dt$ ……….. (3) $\int di = \int \frac{V_m}{L}\sin\omega t\, dt$ or $i = \frac{V_m}{\omega L}(-\cos\omega t)$ or $i = \frac{V_m}{\omega L}\sin(\omega t - {}^{\pi}/_{2}) = \frac{V_m}{X_L}\sin(\omega t - {}^{\pi}/_{2})$ ……….. (4) This shows that the current lags by an angle 90 degrees.	3	3

Part C:

1.	According to FLEMI average induced EMF in Primary coil is e1 (avg.) = -N1 (dϕ/dt) volt Secondary coil is e2 (avg.) = -N2 (dϕ/dt) volt where N1 & N2 are number of turns in primary and secondary winding respectively. (-) sign represents according to lenz's law. dϕ/dt means change in flux with time.	7	7

	$d\phi/dt = \phi m/(T/4) = \phi m/(1/4f) = 4f*\phi m$ e1 = -N1(4f*ϕm) volt e2 = -N2(4f*ϕm) volt This is the average value and in AC system we deal with with rms value. Form factor = (rms / avg.) = 1.11 So rms = 1.11*avg. Now e1 (rms) = -(4.44*N1*f*ϕm) volt e2 (rms) = -(4.44*N2*f*ϕm) volt This is the emf equation of transformer.		
2.	$$Q = 2\pi \times \frac{\text{maximum energy stored}}{\text{Energy dissipated/cycle}}$$ In the case of an inductor, The maximum energy stored = $1/2\ LI^2$ Energy dissipated per cycle = $(I/\sqrt{2})^2 \times R \times T$ The quality factor $$Q = 2\pi \times \frac{1/2\,(LI^2)}{\frac{I^2}{2} R \times \frac{1}{f}}$$ $$Q = 2\pi \times \frac{\frac{1}{2} L \left(\frac{V}{\omega L}\right)^2 R}{\frac{V^2}{2} \times \frac{1}{f}}$$ $$= \frac{2\pi f L R}{\omega^2 L^2} = \frac{R}{\omega L}$$	7	7

	In terms of capacitor, $$Q = 2\pi \times \frac{1/2\,(CV^2)}{\frac{V^2}{2R} \times \frac{1}{f}}$$ $$= 2\pi f CR = \omega CR$$		
3	Consider a single loop DC generator (as shown in the figure), in this a single turn loop 'ABCD' is rotating clockwise in a uniform magnetic field with a constant speed. When the loop rotates, the magnetic flux linking the coil sides 'AB' and 'CD' changes continuously. This change in flux linkage induces an EMF in coil sides and the induced EMF in one coil side adds the induced EMF in the other. The EMF induced in a DC generator can be explained as follows • When the loop is in position-1, the generated EMF is zero because, the movement of coil sides is parallel to the magnetic flux. • When the loop is in position-2, the coil sides are moving at an angle to the magnetic flux and hence, a small EMF is generated. • When the loop is in position-3, the coil sides are moving at right angle to the magnetic flux, therefore the generated EMF is maximum. • When the loop is in position-4, the coil sides are cutting the magnetic flux at an angle, thus a reduced EMF is generated in the coil sides. • When the loop is in position-5, no flux linkage with the coil side and are moving parallel to the magnetic flux. Therefore, no EMF is generated in the coil. • At the position-6, the coil sides move under a pole of opposite polarity and hence the polarity of generated EMF is reversed. The maximum EMF will generate in this direction at position-7 and zero when at position-1. This cycle repeats with revolution of the coil. It is clear that the generated EMF in the loop is alternating one. It is because any coil side (say AB) has EMF in one direction when under the influence of N-pole and in the other direction when under the influence of S-pole. Hence, when a load is connected across the terminals of the generator, an alternating current will flow through it. Now, by using a commutator, this alternating emf generated in the loop can be converted into direct voltage. We then have a DC generator.		

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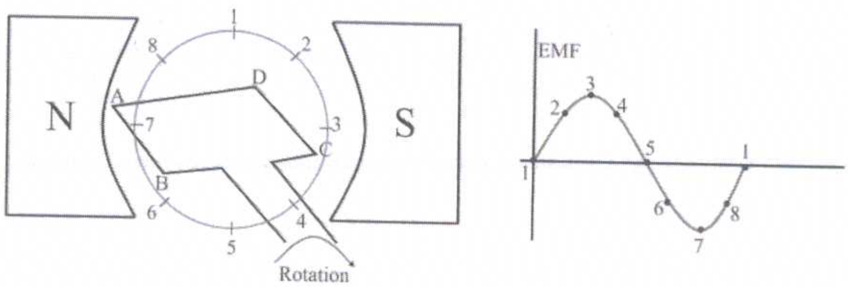
<td>
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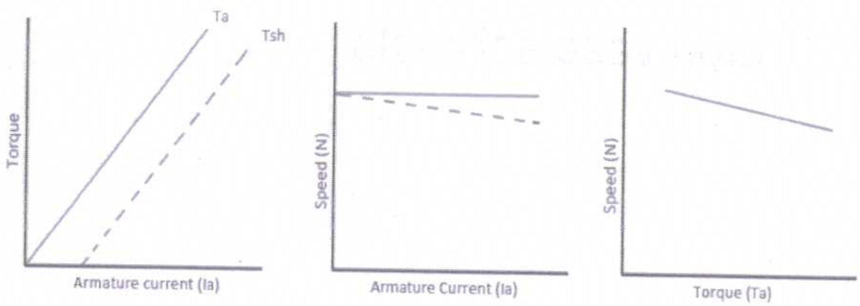
<td>4.</td>
<td>Torque is proportional to armature current. Hence, the Ta-Ia characteristic for a dc shunt motor will be a straight line through the origin..
Speed Vs. Armature Current (N-Ia)
As flux ϕ is assumed to be constant, we can say N $\propto$ Eb. But, as back emf is also almost constant, the speed should remain constant. But practically, ϕ as well as Eb decreases with increase in load. Back emf Eb decreases slightly more than ϕ, therefore, the speed decreases slightly.


Characteristics of DC shunt motor</td>
<td>Exp :4
Fig :3</td>
<td>7</td>
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<td>5.</td>
<td>On the stator, there are teeth on which coils are wired, while the rotor is either a permanent magnet or a variable reluctance iron core By energizing one or more of the stator phases, a magnetic field is generated by the current flowing in the coil and the rotor aligns with this field. By supplying different phases in sequence, the rotor can be rotated by a specific amount to reach the desired final position.
At the beginning, coil A is energized and the rotor is aligned with the magnetic field it produces. When coil B is energized, the rotor rotates clockwise by 60° to align with the new magnetic field. The same happens when coil C is energized. In the pictures, the colors of the stator teeth indicate the direction of the magnetic field generated by the stator winding.</td>
<td>Exp :4
Fig:3</td>
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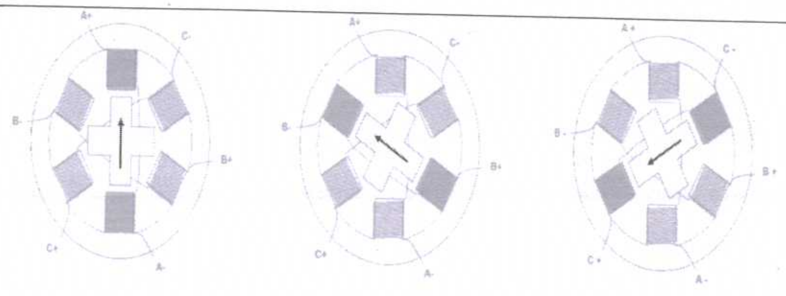
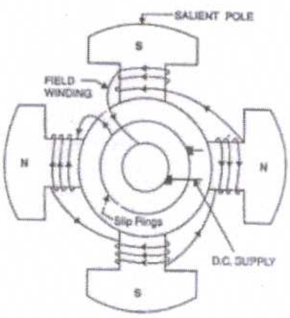
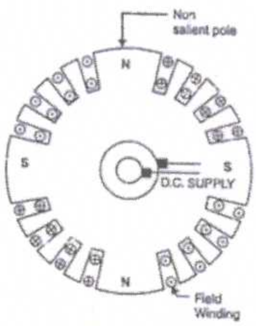
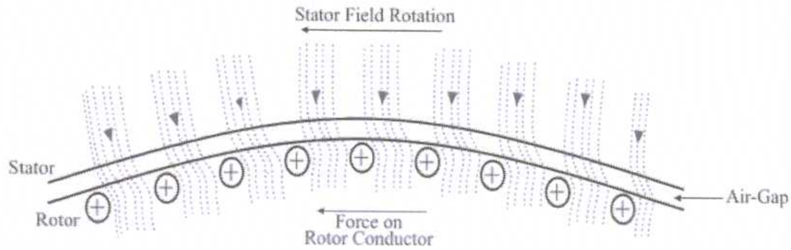
			
6.	**An alternator** consists of field poles placed on the rotating fixture of the machine. An alternator is made up of two main parts: a rotor and a stator. The rotor rotates in the stator, and the field poles get projected onto the rotor body of the alternator. The armature conductors are housed on the stator. It has a stationary armature winding and a rotating field. There are mainly two types of rotors used in construction of alternator: 1. Salient pole type: The poles appear to be projecting or protruding in this type. The salient pole type of rotor is generally used for slow speed machines having large diameters and relatively small axial lengths. The poles, in this case, are made of thick laminated steel sections riveted together and attached to a rotor with the help of joint. 2. Cylindrical rotor type: The cylindrical rotor type machine has a uniform length in all directions, giving a cylindrical shape to the rotor thus providing uniform flux cutting in all directions. The rotor, in this case, consists of a smooth solid steel cylinder, having a number of slots along its outer periphery for hosting the field coils.  Fig. 1. Salient Pole Rotor  Fig. 2. Cylinderical Rotor	Exp:3 Figure :4	7

7.	the current flowing through the 20 Ω resistor to due 20 V voltage source is 0.4 A. the current flowing through the circuit when only 4 A current source is 1.6 A. $I = I_1 + I_2$ Substituting the values of I_1 and I_2 in the above equation, we get I = 0.4+1.6 = 2 A Therefore, the current flowing through the resistor is 2 A.	3 3 1	7
8.	Current in the circuit = 1A Vth = 4V Tth = 3.34 ohms $I_L = \frac{4}{6+3.34} = \frac{4}{9.34} = 0.43 Amp$	2 2 2 1	7

<table>
<tr><td>9.</td><td>A three phase induction motor has a stator and a rotor. The stator carries a 3-phase winding called as stator winding while the rotor carries a short circuited winding called as rotor winding. The stator winding is fed from 3-phase supply and the rotor winding derives its voltage and power from the stator winding through electromagnetic induction. 3-phase induction motor is fundamentally based on electromagnetic induction.

When the stator winding is connected to a balanced three phase supply, a rotating magnetic field (RMF) is setup which rotates around the stator at synchronous speed (Ns).
The RMF passes through air gap and cuts the rotor conductors, which are stationary at start. Due to relative motion between RMF and the stationary rotor, an EMF is induced in the rotor conductors. Since the rotor circuit is short-circuited, a current starts flowing in the rotor conductors.
Now, the current carrying rotor conductors are in a magnetic field created by the stator. As a result of this, mechanical force acts on the rotor conductors. The sum of mechanical forces on all the rotor conductors produces a torque which tries to move the rotor in the same direction as the RMF.


</td><td>Exp: 5 + Fig:2</td><td>7</td></tr>
<tr><td>10.</td><td>A universal motor works on either DC or single phase AC supply. When the universal motor is fed with a DC supply, it works as a DC series motor. (see working of a DC series motor here). When current flows in the field winding, it produces an electromagnetic field. The same current also flows from the armature conductors. When a current carrying conductor is placed in an electromagnetic field, it experiences a mechanical force. Due to this mechanical force, or torque, the rotor starts to rotate.
When fed with AC supply, it still produces unidirectional torque. Because, armature winding and field winding are connected in series, they are in same phase. Hence, as polarity of AC changes periodically, the direction of current in armature and field winding reverses at the same time.
Thus, direction of magnetic field and the direction of armature current reverses in such a way that the direction of force experienced by armature conductors remains same. Thus, regardless of AC or DC supply, universal motor works on the same principle that DC series motor works.</td><td>Exp :4 Fig :3</td><td>7</td></tr>
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	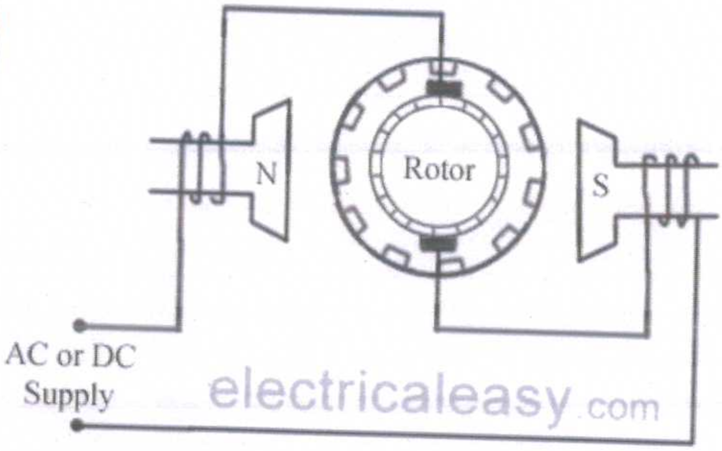		
11.	Time period: Time taken to complete one full cycle of a waveform **Frequency: No of cycles per second . Unit Hz** Indicate T and f in a sine wave The **RMS (Root Mean Square)** of an alternating current (AC) is the value of direct current (DC) when flowing through a circuit or resistor for the specific time period and produces same amount of heat which produced by the alternating current (AC) when flowing through the same circuit or resistor for a specific time. It has a value equal to .707 Im for a sine wave. The ratio of the root mean square value to the average value of an alternating quantity (current or voltage) is called **Form Factor. It is 1.11 for a sine wave.**	1 1 1 2 2	7

12.	$L=500\times10^{-6}H$; $C = 80/\pi^2 \times10^{-12}$ F; R = 62 (i) Resonant frequency is (i) Resonant frequency is $f_r = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{500\times10^{-6}\times\frac{80}{\pi^2}\times10^{-12}}}$ $= \frac{1}{2\sqrt{40,000\times10^{-18}}}$ $= \frac{10,000\times10^{3}}{4}$ $f_r = 2500\ KHz$ (ii) Q–factor $= \frac{\omega_r L}{R} = \frac{2\times3.14\times2500\times10^{3}\times500\times10^{-6}}{628}$ $Q = 12.5$ Q =12.5	3+4	7