Model Question Paper I

FUNDAMENTALS OF ELECTRICAL ENGINEERING

Time: 3 Hour *Max.Marks: 75*

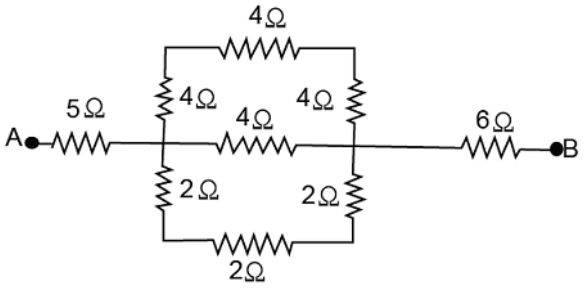
PART A

I. Answer **all** questions in one word or one sentence. Each question carries 1 mark.

1	Define form factor	M1.03	R
2	State Kirchoff's current law	M1.02	R
3	List any two applications of single phase induction motor	M2.03	R
4	State the necessity of starter in DC motors.	M2.04	R
5	State the principle of heat production from electric power	M3.03	R
6	State the purpose of laminating the core of transformer	M3.01	U
7	Write any two advantages of autotransformer over two winding transformer	M3.02	R
8	Identify the region of operation when transistor is used as a switch	M4.03	R
9	Draw the waveform of a half wave rectifier	M4.02	U

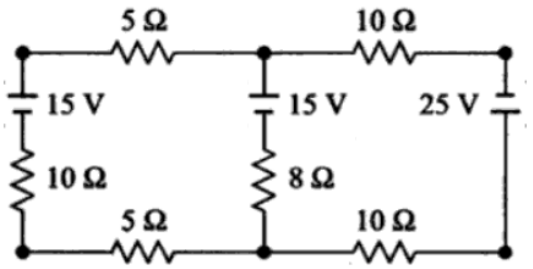
PART B

II. Answer any **eight** questions from the following, each question carries 3 marks.

1	Calculate effective resistance between the points A and B of the given circuit 	M1.02	A
2	A consumer uses a 8 KW geyser, four fans of 100W and ten bulbs of 60 W for 10 hours. Calculate the units (KWh) of electrical energy used.	M1.04	A
3	Show the classification of dc motor on the basis of field winding in a schematic diagram	M2.01	U
4	List the applications of three phase induction motor	M2.02	R
5	Derive the emf equation of a single phase transformer	M3.01	U
6	List the applications of dielectric heating	M3.03	R
7	Illustrate the working of welding transformer	M3.02	U
8	List different types of resistors used in electronics	M4.01	R
9	Draw the V-I characteristics of SCR	M4.03	U
10	Describe the working of PN junction diode in Forward bias	M4.02	U

PART C

Answer ALL questions. Each question carries 7 marks.

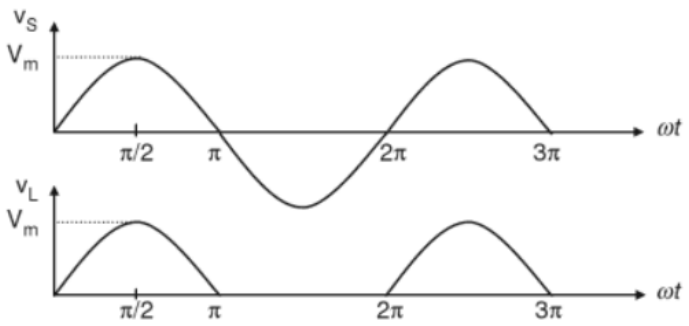
III	Solve the network shown in figure for the current in 8 ohm resistor using Kirchoff's laws 	M1.02	A
	OR		
IV	A residential flat has the following average electrical consumptions per day: a)4 bulbs of 40 W working for 5 hours per day; b)2 fans of 60W working for 8 hours per day; c)1 water heater rated 2kW working for 1hour per day; d)1 water pump of 0.5 kW rating working for 3 hours per day; Calculate the cost of energy per month if 1 unit of energy costs Rs. 3.50/-	M1.04	A
V	Define the following terms : a) Cycle b) Period c) RMS value d) Average value e) Peak factor	M1.03	R
	OR		
VI	Define the following terms: a) Resistance b) Reactance c) Impedance d) Power factor in terms of impedance	M1.03	R
VII	Explain the working principle of DOL starter	M2.04	U
	OR		
VIII	Explain the working principle of three phase induction motor	M2.02	U

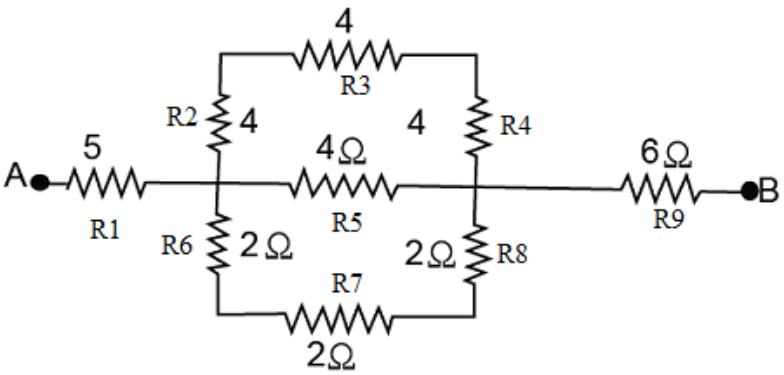
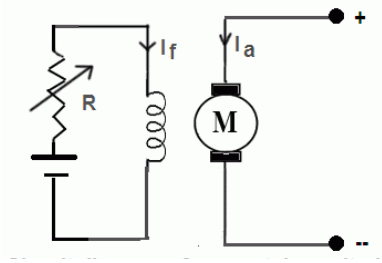
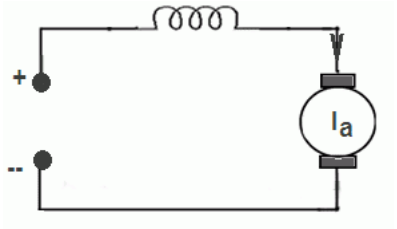
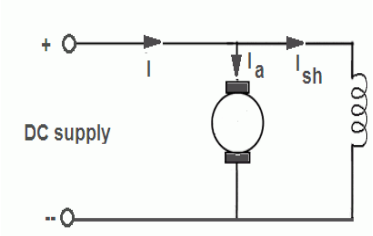
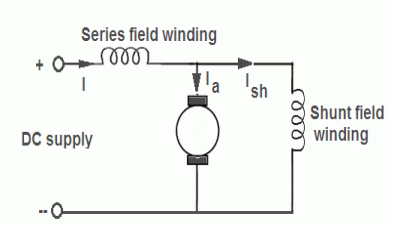
IX	Explain the working of a three point starter with a neat diagram.	M2.04	U
	OR		
X	Explain any one method of starting single phase induction motor with neat diagram	M2.03	U
XI	Describe the working of direct arc furnace	M3.04	U
	OR		
XII	Describe the working principle of single phase transformer	M3.01	U
XIII	Explain the working of transistor as a switch	M4.03	U
	OR		
XIV	Describe the working of full wave bridge rectifier using diodes	M4.02	U

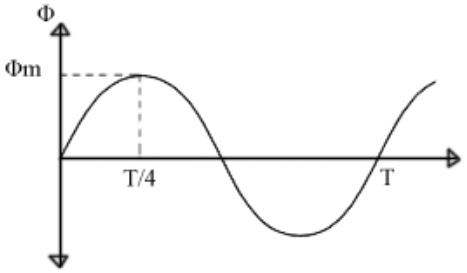
Scoring Indicators

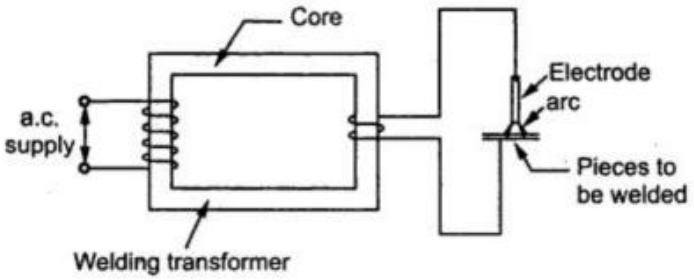
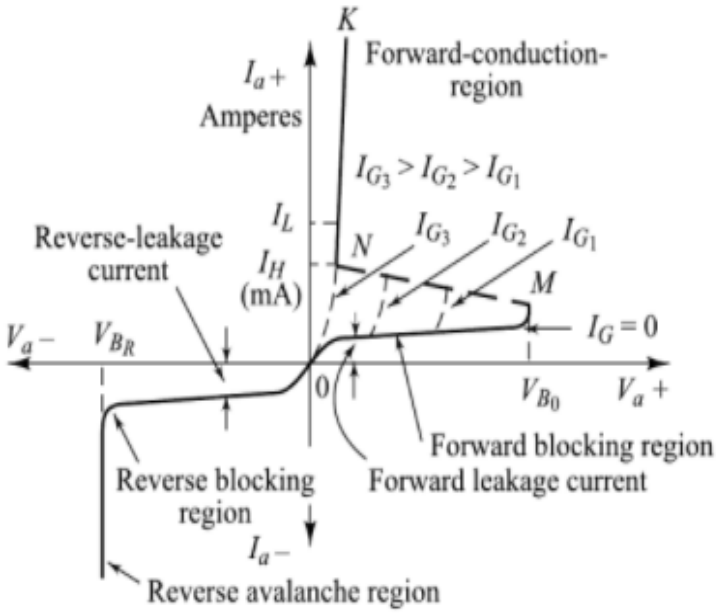
Model Question Paper I

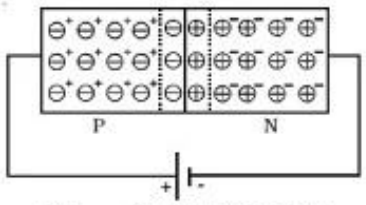
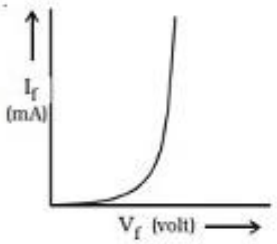
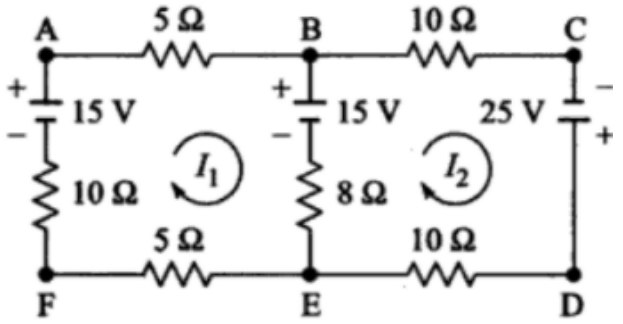
FUNDAMENTALS OF ELECTRICAL ENGINEERING

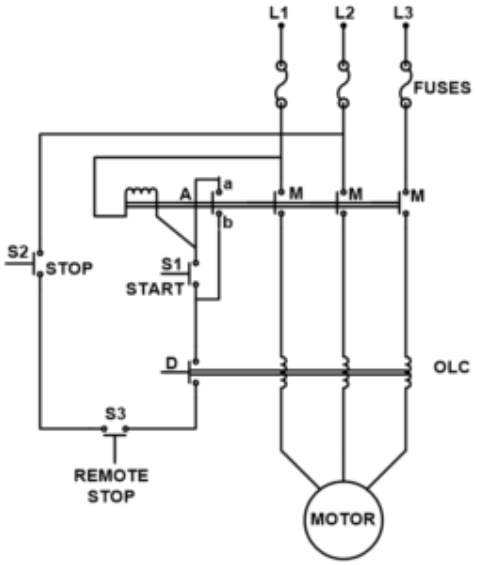
Q No	Scoring Indicators	Split score	Sub Total	Total Score
	PART A			
I. 1	Form factor is defined as the ratio of rms value to average value. Form factor=1.11 for sine wave	1	1	
I. 2	KCL:The algebraic sum of currents entering a node is zero. The sum of currents entering a node is equal to the sum of currents leaving the node.	1	1	
I. 3	Pumps, fan,compressor (Any two)	1	1	
I. 4	At starting back emf=0,current drawn from the supply is very large as the armature resistance is low. To prevent damage due to high starting current,starters are used	1	1	
I. 5	Joules law of heating- The heat generated due to the current flow in an electric wire is proportional to the product of resistance of the wire, time of flow and square of the current passed. By Joules law, Electric heat, $H = I^2Rt$ where I-current ,R-resistance of the element,t-time during which current is passed	1	1	
I. 6	Core is laminated to reduce the eddy current loss	1	1	
I. 7	i. Smaller in size ii.Require less copper iii.More efficient (*Any two*)	1	1	
I. 8	ON-Saturation OFF-Cut off	1	1	
I. 9		1	1	
	PART B			

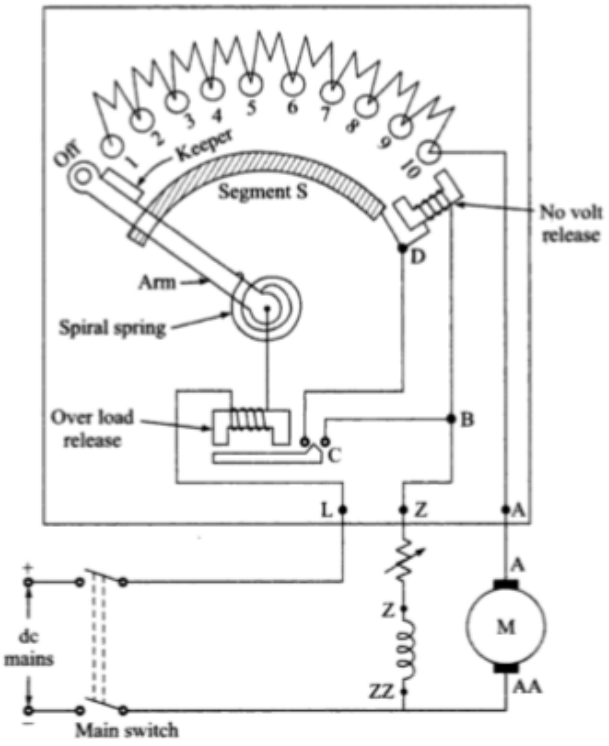
II. 1	 Resistance between A and B =R1+((R2+R3+R4)||(R5)||(R6+R7+R8))+R9 =5+((4+4+4)||4||(2+2+2))+6 =5+12||4|6+6 =5+2+6 =13 Ohm	1.5 1.5	3	
II. 2	Total power, P=1x8000+4x100+10x60=9000 W=9kW Time, t=10 hours Energy= Pt =9x10=90 KWh	1.5 1.5	3	
II. 3	i.Separately excited dc motor ii.Series motor   iii.Shunt motor iv.Compound motor  	3	3	
II.4		0.5X6	3	

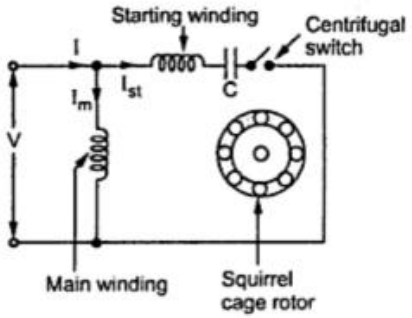
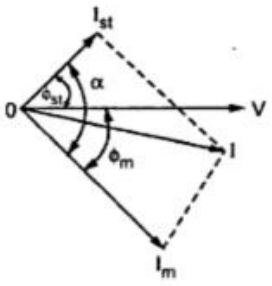
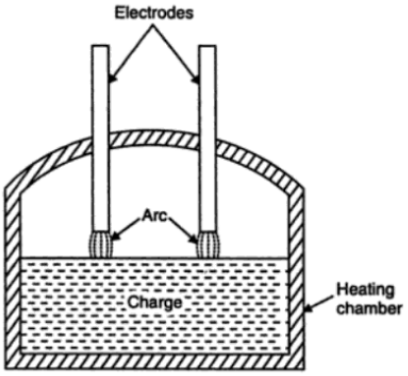
	i. Centrifugal pumps ii.Conveyors iii.Compressors iv.Reciprocating pumps v.Lifts vi.Hoist			
II. 5	 Flux rises sinusoidally to its maximum value Φ_m from 0. It reaches to the maximum value in one quarter of the cycle i.e in T/4 sec (where, T is the time period of the sin wave of the supply = 1/f). Therefore,average rate of change of flux = Φ_m / T/4 = Φ_m / 1/4f= 4f Φ_m Induced emf per turn = rate of change of flux per turn Therefore, average emf per turn = 4f Φ_m RMS value of emf per turn = Form factor X average emf/turn. RMS value of emf per turn = 1.11 x 4f Φ_m = 4.44f Φ_m. RMS value of induced emf in primary winding (E1) = RMS value of emf per turn X Number of turns in primary winding E1 = 4.44f N1 Φm RMS value of induced emf in secondary winding (E2) = E2 = 4.44f N2 Φm	1 1 0.5 0.5	3	
II. 6	i.Preheating of plastic preforms ii.Gluing of wood iii.Baking of foundry course iv.Diathermy v.Sterilization vi.Textile industry	0.5x6	3	
II. 7	Welding transformer is a step down transformer which	1.5	3	

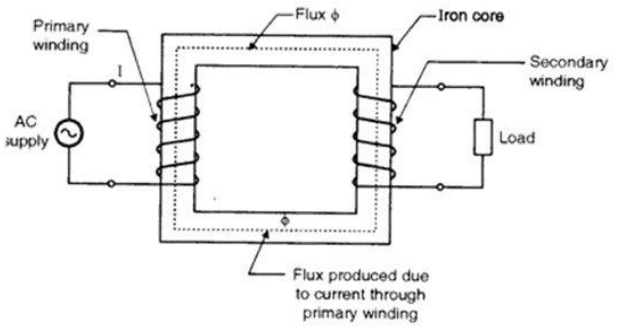
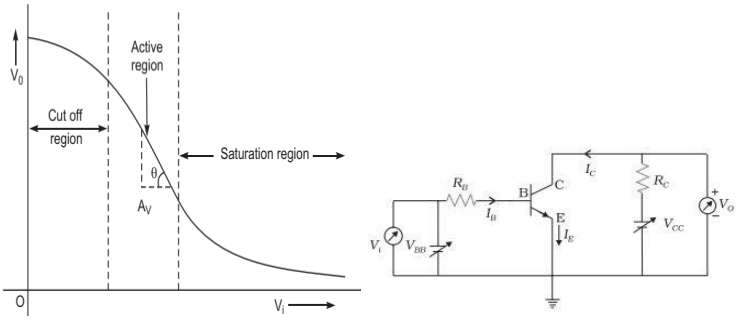
	reduces the voltage from the source voltage to a lower voltage that is suitable for welding. The secondary may have several taps for adjusting the secondary voltage to control the welding current. One end of the secondary is connected to the welding electrode, whereas the other end is connected to the pieces to be welded .If any high current flows, heat is produced due to the contact resistance between the electrode and the pieces to be welded. The generated heat melts a trip of the electrode and the gap between the two pieces is filled.  	1.5		
II. 8	i.Carbon composition ii.Deposited carbon iii.High voltage ink film iv.Metal film v.Metal glaze vi.Wire wound	0.5x6	3	
II. 9	 	3	3	
II. 10		1.5	3	

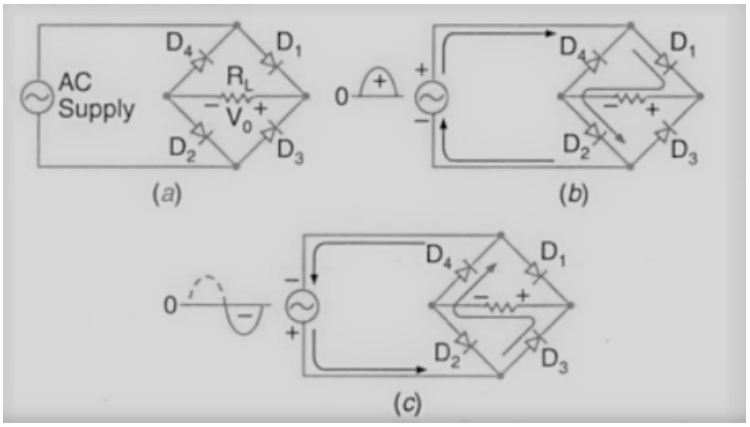
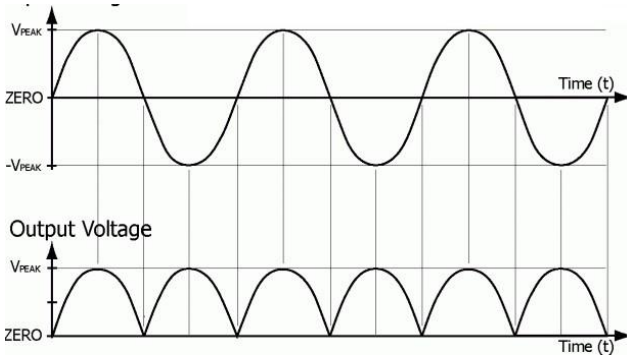
	 Fig Forward biased PN junction diode  In forward bias,a negative voltage is applied to the N-type material and a positive voltage is applied to the P-type material.Holes and electrons get repelled from p and n side respectively and cross the junction. Depletion region narrows. Diode starts conducting forward current when applied voltage is greater than barrier potential.(Knee voltage) Diode acts as a closed switch when forward biased.	1.5		
	PART C			
III	 applying KVL in loop ABEFA,$28I_1-8I_2=0$ applying KVL in loop BCDEB,$7I_2-2I_1=0$ Solving $I_1=0.44A$ $I_2=1.54A$ Current through 8 ohm resistor=$I_2-I_1=1.1$ A from E to B	2 2 1 1 1	7	
IV	Total energy consumed in a day =4x40x5+2x60x8+1x2000x1+1x500x3=5260 Wh=5.26kWh Energy consumed in one month=30x5.26=157.8units Energy bill=3.5x157.8=Rs.552.3	4 1 2	7	

V	a) Cycle-one complete set of positive and negative half cycle b) Period-time taken to complete one cycle c) RMS - root mean square value -equivalent to the value of a dc voltage that causes an equal amount of heat due to the circuit current flowing through a resistance d) Average value-equivalent to the value of a dc current that transfers an equal amount of charge as is transferred by the ac in the same time e) Peak factor-ratio of maximum value to rms value	1 1 2 2 1	7	
VI	a) Resistance,R- It is a property of any material to oppose the flow of the charges flowing through it. b) Reactance,X-I is the opposition to the flow of current from a circuit element due to its inductance and capacitance. c) Impedance,Z-It is the effective resistance of an electric circuit or component to alternating current, arising from the combined effects of ohmic resistance and reactance. d) Power factor-It is the ratio of resistance to Impedance pf=R/Z	2 2 2 1	7	
VII	In DOL starter, an induction motor is connected directly across its 3-phase supply, and the DOL starter applies the full line voltage to the motor terminals.The motor draws a very high inrush current compared to the full load current of the motor (up to 5-8 times higher). The value of this large current decreases as the motor reaches its rated speed.Motor develops starting torque=1.96 times of rated torque.It is used for small motors below 5 HP. A circuit breaker or fuse is used for protection against overcurrent. In order to protect the motor from overloading, an overload relay is used.  	4 3	7	

VIII	Stator winding is supplied with three phase supply.A rotating magnetic field is generated which rotates at synchronous speed Ns=120f/P.When this RMF cuts the rotor conductors,an emf is induced as per Faraday's law of electromagnetic induction. As rotor ends are shorted,rotor current starts flowing. Rotor current opposes the cause,that is relative speed between RMF and rotor.As a result rotor starts rotating in the same direction as that of RMF and tries to catch up with synchronous speed.It settles at a speed,N less than Na. The difference in speed is known as slip.Slip=Ns-N	7	7	
IX	Three point starter has a set of series resistors connected through a number of copper studs over which a handle moves making contacts. Handle is connected to terminal L line.The last end of series resistance is connected to armature A. A copper strip is provided below the series resistors which connects the terminal Z to the field coil of the motor.For starting handle is moved to the first stud and maximum resistance is included in the circuit. The handle makes contact with the copper strip and field is fully excited. Gradually the handle moves forward to other studs so that armature resistance is cut from the circuit.And motor runs at normal speed.Holding coil brings back handle to starting point when the supply is cut off. OLC protects from overload.  	4 3	7	

X	In a single phase induction motor,due to single phase supply only pulsating flux is produced. Therefore the motor is not self starting.For this an extra winding-start winding is connected in parallel to the main winding. Two windings are placed 90 electrical degrees apart.In capacitor start induction motor, a capacitor is added in series with auxiliary winding. This introduces a phase shift of almost 90 degree and ensures high starting torque. During running, the capacitor is removed by a centrifugal switch.  (a) Schematic representation  (b) Phasor diagram	4 3	7	
XI	 In this,charge acts as one of the electrodes and the charge is heated by producing arc between the electrodes and the charge.The arc is in direct contact with the charge and heat is produced by flow of current through the charge itself.The charge can be heated to the highest temperature.Purer product is obtained. Due to high cost , use is restricted to the refining process.	4 3	7	

XII	 The single-phase transformer works on the principle of Faraday's Law of Electromagnetic Induction.It is a static device that transfers electric power in one circuit to another circuit of the same frequency. It consists of primary and secondary windings. When the primary of a transformer is connected to an AC supply, the current flows in the coil and the magnetic field build-up.An alternating flux is produced in the core by the AC primary current.The alternating flux gets linked with the secondary winding through the core.According to Faraday's laws of electromagnetic induction this varying flux will induce voltage into the secondary winding.When a load is connected a current starts flowing in the secondary.	4 3	7	
XIII	 Saturation and cut-off regions are known as the transistor switch's working regions. When a sufficient voltage is applied between the base and emitter, collector to emitter voltage is approximately equal to 0. Therefore, the transistor acts as a short circuit. The collector current VCC / RC flows through the transistor. Similarly, when no voltage or zero voltage is applied at the input, the transistor operates in the cutoff region and acts as an open circuit. In this type of switching connection, load is connected to the switching output with a reference point. Thus, when the transistor is switched ON, current will flow from source to ground through the load.	4 3	7	

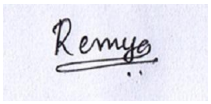
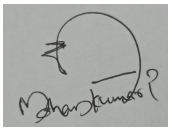
XIV	  When the input voltage is positive,diodes D1 and D2 are forward biased and conduct current in the direction shown in figure b. A voltage is developed across load resistance RL due to this current. When the input voltage is negative the diodes D3,D4 become forward biased and conduct the current in the same direction as during the positive half cycle. During this time D1,D2 are reverse biased. As a result,a full wave rectified output voltage is developed across the resistor.	4 3	7	

Module wise question analysis

Question No	Module				No of questions
	I	II	III	IV	
Part A (1 Mark)	2	2	3	2	9
Part B (3 Marks)	2	2	3	3	10
Part C (7 Marks)	4	4	2	2	12
Total questions	**8**	**8**	**8**	**7**	**31**
Total (Marks)=123	**36**	**36**	**26**	**25**	

Cognitive level wise question analysis

Question No	Cognitive level			No of questions
	Remember	Understand	Apply	
Part A (1 Mark)	6	3	0	9
Part B (3 Marks)	3	5	2	10
Part C (7 Marks)	2	8	2	12
Total questions	**11**	**16**	**4**	**31**
Total (Marks)=123	**29**	**74**	**20**	

Prepared by	Scrutinised by
	
Remya Mohanan Lecturer in EEE Govt.Womens Polytechnic College Thrissur	Mohankumar P HoD EEE Govt Polytechnic College Perinthalmanna

Model Question Paper II

FUNDAMENTALS OF ELECTRICAL ENGINEERING

Time: 3 Hour *Max.Marks: 75*

PART A

I. Answer **all** questions in one word or one sentence. Each question carries 1 mark.

1	State Faraday's law of electromagnetic induction	M1.02	R
2	Write the relation between line voltage and phase voltage in star connection	M1.03	R
3	List any two applications of three phase induction motor	M2.02	R
4	During starting, the motor windings are connected in star configuration in star delta starter. Identify the reason behind this.	M2.04	U
5	Define voltage transformation ratio of single phase transformer	M3.01	R
6	List any two applications of dielectric heating.	M3.03	R
7	Write the function of a welding transformer	M3.02	U
8	List different types of capacitors used in electronics	M4.01	R
9	Draw the V-I characteristics of an ideal diode	M4.02	U

PART B

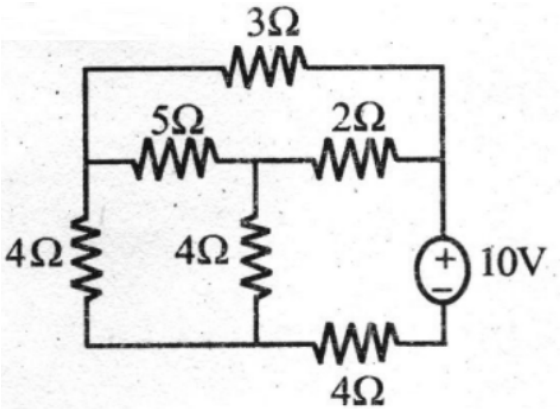
II Answer any **eight** questions from the following, each question carries 3 marks.

1	The two electric lamps each of 40W,230V are connected in series across 230V supply. Calculate the power consumed by each lamp.	M1.04	A
2	A parallel arrangement of 6 ohm and 3 ohm resistor is placed in series with a 8 ohm resistor.If a potential difference of 60 V is applied across the circuit,calculate the current through the 3 ohm resistor.	M1.02	A
3	List the applications of dc motor	M2.01	R
4	Single phase induction motors are not self starting. Give reasons.	M2.03	U
5	Illustrate the working of autotransformer	M3.02	U
6	Enumerate advantages of electric heating	M3.03	R
7	Describe different modes of heat transfer	M3.03	U
8	List various active and passive electronic components	M4.01	R
9	Illustrate the working of chopper circuit	M4.03	U

10	Draw the block diagram of electric drive	M4.04	U

PART C

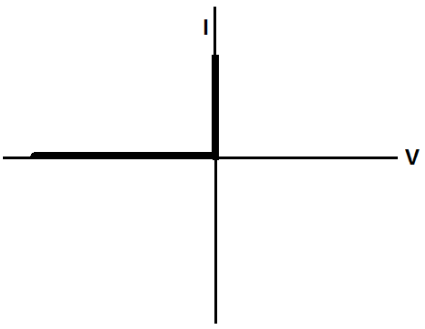
Answer ALL questions. Each question carries 7 marks.

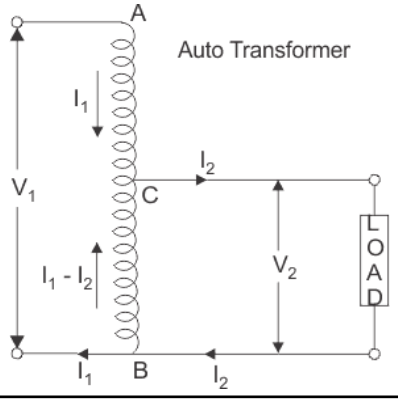
III	Solve the given circuit for the current delivered by the battery using Kirchoff's laws.  	M1.02	A
	OR		
IV	A star connected 10kV three phase alternator supplying 5MW at 0.8 pf. If the total current remains the same,when the load power factor is raised to 0.9. Find the new output power.	M1.04	A
V	a) Draw star and delta connections b) Write the relation between line voltage and phase voltage, , line current and phase current in star and delta connection	M1.03	R
	OR		
VI	Define the following: a) Ohm's law b) Lenz's law c) Statically induced emf d) Dynamically induced emf	M1.02	R
VII	Explain the working of star-delta starter	M2.04	U
	OR		
VIII	Explain the working principle of dc motor	M2.01	U
IX	Explain the necessity of starter in a dc motor	M2.04	U
	OR		
X	Explain the constructional details of a three phase induction motor	M2.02	U
XI	Distinguish between core type and shell type transformer	M3.02	U
	OR		
XII	Describe the principle of induction heating	M3.03	U
XIII	Explain the working of half wave controlled rectifier using SCR	M4.03	U
	OR		
XIV	Explain the three modes of SCR	M4.03	U

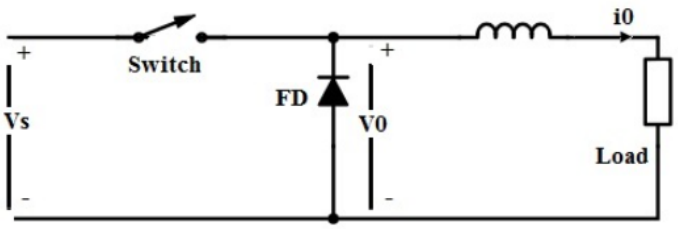
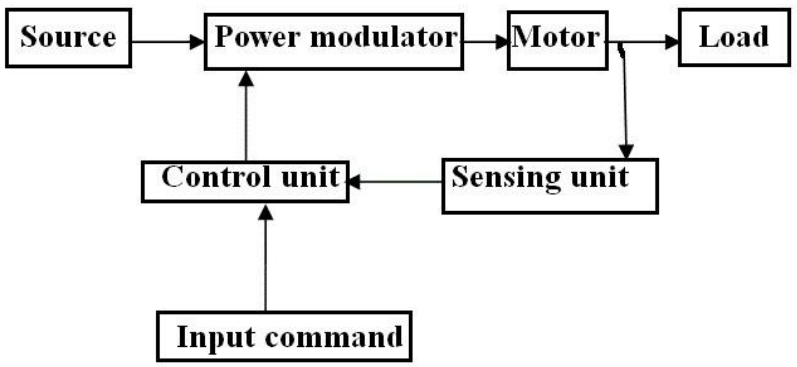
Scoring Indicators

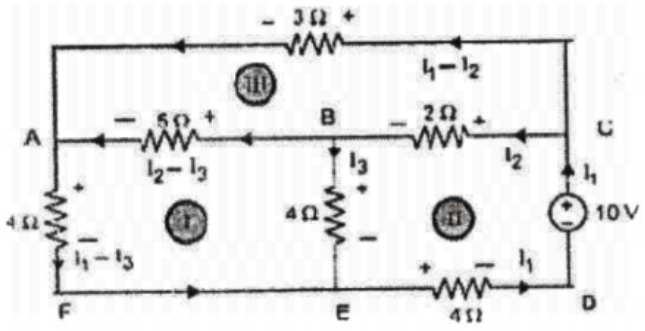
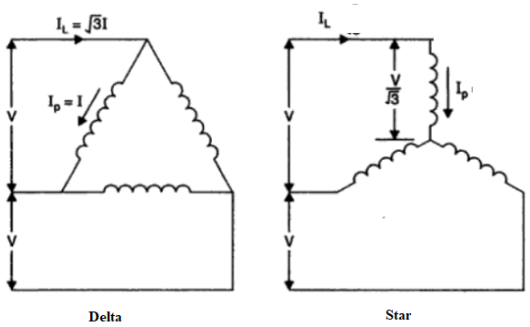
Model Question Paper II

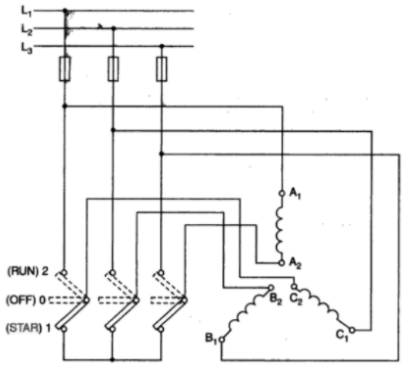
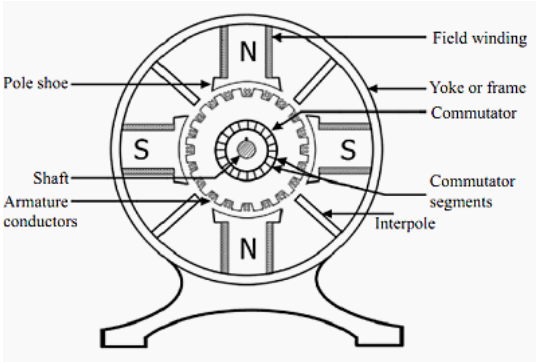
FUNDAMENTALS OF ELECTRICAL ENGINEERING

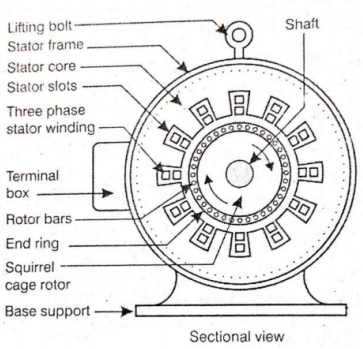
Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			
I. 1	Whenever there is a change in magnetic flux linked with a coil,an emf is induced in the coil. The emf induced is proportional to the rate of change of magnetic flux.	1	1	
I. 2	Line voltage=√3 x Phase voltage	1	1	
I. 3	Lift,crane,hoist,textile industry *(Any two)*	1	1	
I. 4	The line current drawn from the supply in star connection is reduced to ⅓ times the line current in delta connection.Thus we can reduce high starting current.	1	1	
I. 5	$V_2/V_1=N_2/N_1$, V_1- Primary voltage,V_2-Secondary voltage, N_1-No. of turns in primary,N_2-No. of turns in secondary	1	1	
I. 6	Food processing,textile industry, sterilisation,diathermy *(Any two)*	1	1	
I. 7	To provide low voltage,high current in secondary circuit to aid in welding process	1	1	
I. 8	Film capacitor,ceramic capacitor,electrolytic capacitor *(Any two)*	1	1	
I. 9		1	1	
	PART B			
II. 1	Resistance of each lamp=$230^2/40$=1322.5ohm Total resistance in circuit=2x1322.5=2645ohm Current in circuit=230/2645=0.087A Power consumed by each lamp=$0.087^2 X 1322.5$=10W	1 1 1	3	

II. 2	Total resistance=(6||3)+8=10 ohm Total current=60/10=6 A Current through 3ohm resistor= 6x6/(6+3)=4A	1 1 1	3	
II. 3	i.Electric traction ii.Cranes iii.Elevators iv.Rolling mills v.Conveyors vi.Blowers	0.5x6	3	
II. 4	When we apply a single phase AC supply to the stator winding of a single phase induction motor, it produces its flux of magnitude, φm. According to the double field revolving theory, this alternating flux, φm is divided into two components of magnitude φm/2. Each of these components will rotate in the opposite direction, with the synchronous speed, Ns.Now at starting condition, both the forward and backward components of flux are exactly opposite to each other. Also, both of these components of flux are equal in magnitude. So, they cancel each other and hence the net torque experienced by the rotor at the starting condition is zero. So, the single phase induction motors are not self-starting motors.	3	3	
II. 5	In autotransformer,one single winding is used as primary winding as well as secondary winding.The winding AB of total turns N_1 is considered as primary winding. This winding is tapped from point ′C′ and the portion BC is considered as secondary. If V_1 voltage is applied across the primary winding the voltage across the portion BC of the winding, will be, $V_2=V_1N_2/N_1$  	1.5 1.5	3	
II. 6	i.Free from dirt ii.Doesnt produce any flue gas iii.Simple and accurate temperature control is possible iv.Economical v.High overall efficiency vi.Safe and quick response	0.5x6	3	

II. 7	**Conduction**-transfer of heat from one part of a substance to another part of the same substance in physical contact with it without appreciable displacement of molecules forming the substrate **Convection**-transfer of heat within a fluid by mixing of one portion of the fluid with another **Radiation**-transfer of heat through space/matter by means other than conduction or convection that is by means of em waves	1x3	3	
II. 8	**Active component**-transistor, SCR,diode **Passive component**-resistor, capacitor, inductor	0.5x6	3	
II. 9	Chopper is a dc-dc converter that converts fixed dc power to variable power.The chopper acts as an ON/OFF switch that can rapidly connect or disconnect the source to load connection. Continuous DC is given as source to the chopper as Vs and chopped DC is obtained across the load as V0. During the period of TON the load voltage V0 is equal to the source voltage Vs. But when the interval TOFF occurs, output voltage becomes zero.  	1.5 1.5	3	
II.10	 	3	3	

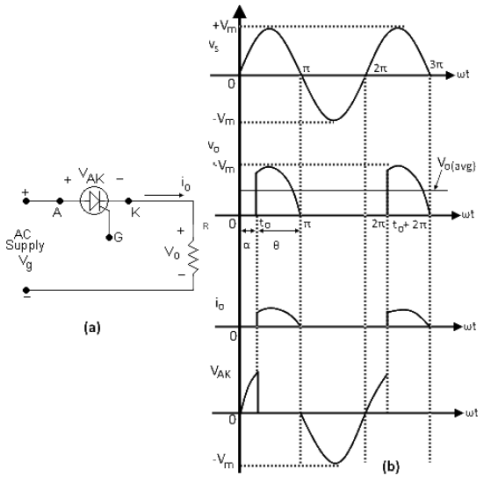
	PART C			
III	 Loop ABEFA, $4I_1+5I_2-13I_3=0$ Loop BCDEB,$4I_1+2I_2+4I_3=10$ Loop ABCA,$-3I_1+10I_2-5I_3=0$ Solving current delivered by battery, I_1= 1.38A.	 2 2 2 1	7	
IV	$5MW=\sqrt{3}V_L I_L \cos\phi=\sqrt{3}x10000xI_Lx0.8$ Line current, I_L=361A New output=$\sqrt{3}$x10000x361x0.9=5627kW	2 2 3	7	
V	a) Delta & star  b) **For Star connection,** i) Line current=Phase current ii) Line voltage =$\sqrt{3}$Phase voltage **For Delta connection,** iii) Line voltage =Phase voltage iv) Line current =$\sqrt{3}$Phase current	1.5x2 1x4	7	

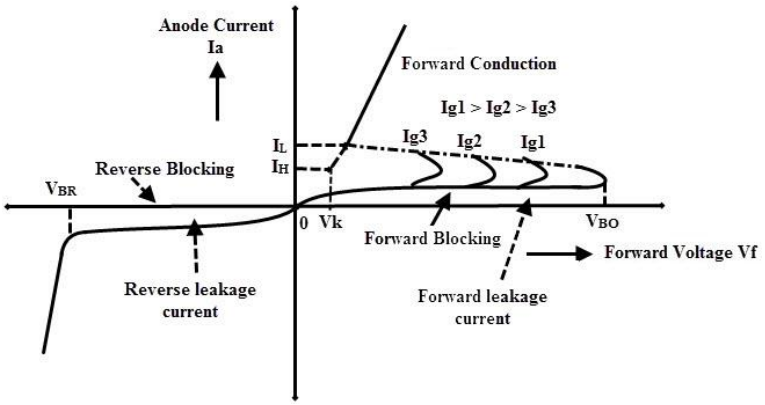
VI	a) Ohms law-At constant temperature, the current through a conductor between two points is directly proportional to the voltage across the two points. V=IR b) Lenz's law-The current induced in a circuit due to a change in a magnetic field is directed to oppose the change in flux and to exert a mechanical force which opposes the motion c) Statically induced emf-The emf induced in a coil due to change of flux linked with it is called statically induced emf. d) Dynamically induced emf-an emf induced in a conductor when the conductor moves across a magnetic field.	2 2 1.5 1.5	7	
VII	 When the switch is in position 1,terminals A2,B2,C2 are short circuited to form star connection and the motor starts rotating. As the motor reaches its rated speed,the switch is moved to position 2and the windings get connected in delta connection.The line current drawn from the supply in star connection is reduced to ⅓ times the line current in delta connection.Thus high starting current is reduced.	4 3	7	
VIII	 DC motor converts electrical energy (DC) into mechanical energy. This is based on the principle that when a current carrying conductor is placed in a magnetic field,it experiences a force whose direction is given by Fleming's left hand rule.When field magnets are excited and armature windings are supplied with direct current ,they experience a force.Each conductor experience a force which collectively produce torque which causes the armature to rotate.	3 4	7	

<table>
<tr><td>IX</td><td>For a dc motor, Ia=V-Eb/Ra. At starting Eb = 0 as it is proportional to speed.Armature current is limited by Ra only which is very small. As a result ,high starting current flows which damages the winding. To prevent this additional resistance is added to the armature circuit by means of starters</td><td>7</td><td>7</td><td></td></tr>
<tr><td>X</td><td>Stator: As its name indicates stator is a stationary part of the induction motor. A stator winding is placed in the stator of the induction motor and the three phase supply is given to it. Stator has stator frame,core,field winding. Stator consists of a steel frame which encloses a hollow cylindrical core made up of thin laminations of silicon steel to reduce hysteresis loss and eddy current loss.
Rotor: The rotor is a rotating part of the induction motor. The rotor is connected to the mechanical load through the shaft.Two types of rotor-slip ring rotor and squirrel cage rotor.
Shaft -for transmitting the torque to the load
 

Sectional view</td><td>4

3</td><td>7</td><td></td></tr>
<tr><td>XI</td><td><table>
<tr><th>Core type</th><th>Shell type</th></tr>
<tr><td>The winding surrounds the core</td><td>The core surrounds the winding</td></tr>
<tr><td>Only one magnetic flux path</td><td>Two magnetic flux path</td></tr>
<tr><td>Used for high voltage level applications</td><td>Used for low voltage level applications</td></tr>
<tr><td>More loss ,less efficient</td><td>High efficiency</td></tr>
<tr><td>Less mechanical protection to winding</td><td>Better mechanical protection to winding</td></tr>
<tr><td>Cylindrical type winding is used</td><td>Sandwich type winding is used</td></tr>
<tr><td>Material requirement is high</td><td>Material requirement is low</td></tr>
</table></td><td>1X7</td><td>7</td><td></td></tr>
</table>

XII	Induction heating process makes use of the currents induced by the electro-magnetic action in the charge to be heated. In fact, induction heating is based on the principle of transformer working. The primary winding which is supplied from an a.c. source is magnetically coupled to the charge which acts as a short circuited secondary of single turn. When an a.c. voltage is applied to the primary, it induces voltage in the secondary i.e. charge. The secondary current heats up the charge in the same way, as any electric current does while passing through a resistance. If V is the voltage induced in the charge and R is the charge resistance, then heat produced = V^2/R. The value of current induced in the charge depends on (i) magnitude of the primary current (ii) turn ratio of the transformer (iii) coefficient of magnetic coupling. **Low-frequency induction furnaces** are used for melting and refining of different metals.Two types: (a)*Core-type Furnaces*-It operates just like a two winding transformer. These can be further subdivided into (i) Direct core-type furnaces (ii) Vertical core-type furnaces and (iii) Indirect core-type furnaces. (b) *Coreless-type Furnaces*-in which an inductively-heated element is made to transfer heat to the charge by radiation For other processes like case hardening and soldering etc., **high frequency eddy current heating** is employed.	7	7	
XIII	 During the positive half cycle SCR is forward biased and conducts when the trigger pulse is applied to the gate.The point at which thyristor starts conducting is known as firing angle. Output voltage is the same as input voltage. When current falls to natural zero,SCR is reverse biased. During negative half cycle SCR blocks the current and output voltage is zero.Average value of load voltage is $V_o = V_m(1 + cos\alpha)/2\pi$	4 3	7	

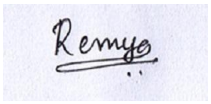
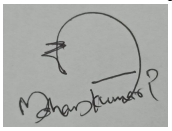
XIV	 **Forward blocking mode**:In this mode of operation, the Silicon Controlled Rectifier is connected such that the anode terminal is made positive with respect to cathode while the gate terminal is kept open. In this state junctions J1 and J3 are forward biased and the junction J2 reverse biased.Due to this, a small leakage current flows through the SCR. SCR acts as an open switch in this mode by blocking forward current flowing through the SCR. **Forward conduction mode:**SCR or thyristor comes into the conduction mode from blocking mode either by applying a positive pulse to the gate terminal or by increasing the forward voltage beyond the break over voltage of the SCR.The avalanche breakdown occurs at junction J2. Therefore the SCR turns into conduction mode and acts as a closed switch thereby current starts flowing through it. **Reverse blocking mode:**In this mode of operation, cathode is made positive with respect to anode. Then the junctions J1 and J3 are reverse biased and J2 is forward biased. This reverse voltage drives the SCR into reverse blocking region results to flow a small leakage current through it and acts as an open switch .	2.5 1.5 1.5 1.5	7	

Module wise question analysis

Question No	Module				No of questions
	I	II	III	IV	
Part A (1 Mark)	2	2	3	2	9
Part B (3 Marks)	2	2	3	3	10
Part C (7 Marks)	4	4	2	2	12
Total questions	**8**	**8**	**8**	**7**	**31**
Total (Marks)=123	**36**	**36**	**26**	**25**	

Cognitive level wise question analysis

Question No	Cognitive level			No of questions
	Remember	Understand	Apply	
Part A (1 Mark)	6	3	0	9
Part B (3 Marks)	3	5	2	10
Part C (7 Marks)	2	8	2	12
Total questions	**11**	**16**	**4**	**31**
Total (Marks)=123	**29**	**74**	**20**	

Prepared by  Remya Mohanan Lecturer in EEE Govt.Womens Polytechnic College Thrissur	Scrutinised by  Mohankumar P HoD EEE Govt Polytechnic College Perinthalmanna