



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC-27001-2005 Certified)

WINTER– 2014 Examinations

Subject Code: 17507

Model Answer

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Important suggestions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
- 4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1 a)	Attempt any THREE of the following:	12 Marks
i)	State two advantages and two disadvantages of: 1) Group drive and 2) Individual drive.	
Ans:	Advantages of Group Drive:- (Any Two Advantages Expected: 1/2 each) 1. <u>Initial Cost</u> – A cost of single motor of large capacity is less than cost of number of small capacity motors for same H.P. e.g. cost of 10HP motor is much less than that of 10 no.of motors of 1HP 2. <u>Diversification of load</u> – All the machines and tools may not work at a time, so we can select main motor of slightly small capacity (HP) than the total requirements of individual machines. 3. <u>over load capacity</u> – Group drive has higher over load capacity. E.g. 100% overload on individual machine would cause only 8 to 10 % overload on main motor. 4. <u>Space required</u> – Less 5. <u>Maintenance cost</u> – Maintenance cost of single motor of large capacity is less than maintenance cost of number of small motors of total HP.	



6. Efficiency and Power Factor –

If group drive is run at nearly equal to full load than Efficiency and Power Factor of group drive will be higher

Disadvantages of Group Drive:- (Any Two disadvantages Expected: 1/2 each)

1. Flexibility:-

Flexibility is lost due to common shaft for number of machines.

2. Safety:- - It is less safe.

3. Reliability:-

Its reliability is less at the time of breakdown and maintenance of single large motor, Because, all the machines operations are required to be shut down at the time of breakdown and maintenance of single large motor.

4. Mechanical power transmission losses:-

Considerable power loss takes place for transfer of mechanical energy from shaft to machine.

5. Speed control:-

Speed control of individual machine is difficult, it requires special arrangement.

6. Addition / Alteration:-

Possibility of addition or alteration in existing system is limited.

7. Efficiency and Power Factor:- –

If group drive is run at reduced load then Efficiency and Power Factor of group drive will be less.

Advantages of Individual Drive:- (Any Two Advantages Expected: 1/2 each)

1. Flexibility:-

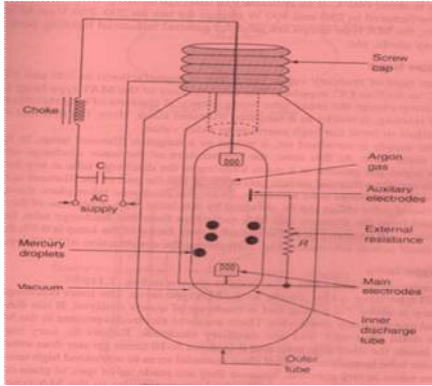
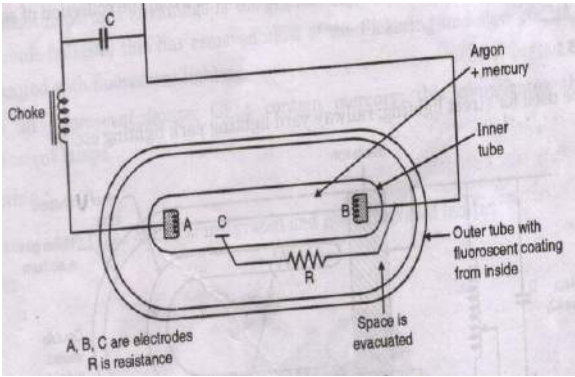
It has more flexibility that is machine can be placed in any desired position and can be shifted whenever needed.

2. Safety:- - Working conditions are more safe.



	<p>3. <u>Reliability</u>:-</p> <p>It has high reliability, because breakdown of single motor causes only one machine operation required to be shut down and not all machines.</p> <p>4. <u>Speed control</u>:-</p> <p>Speed control is easily possible.</p> <p>5. <u>Addition / Alteration</u>:-</p> <p>Possibility of addition or alteration in existing system is easily possible.</p> <p>6. <u>Efficiency and Power Factor</u>: –</p> <p>If it is run at full load than Efficiency and Power Factor of group drive will be high.</p> <p>If there is no load it can be stopped thus no load losses can be eliminated.</p> <p><u>Disadvantages of Individual Drive</u>:- (Any Two disadvantages Expected: 1/2 each)</p> <p>1. <u>Initial Cost</u> –</p> <p>Initial cost is high.</p> <p>2. <u>Diversification of load</u> –</p> <p>Diversification of load on individual machine is not possible.</p> <p>3. <u>Over load capacity</u> – Over load capacity is less.</p> <p>4. <u>Space required</u> – More</p> <p>5. <u>Maintenance cost</u> –</p> <p>Maintenance cost is more as number of drives are more.</p> <p>6. <u>Efficiency and Power Factor</u> –</p> <p>If it is run at reduced load then Efficiency and Power Factor of individual drive will be less.</p> <p>7. <u>Mechanical power transmission losses</u>:-</p> <p>Considerable power loss takes place for transfer of mechanical energy from shaft to machine</p>
ii)	State the causes of failure of heating element.
Ans:	<p><u>Following of the different causes of failure of heating element:</u></p> <p>i) Formation of hot spot: (Each Causes: 1 Mark, Total: 4 Mark)</p> <p>Hot spot on heating element is the point which is at higher temperature than remaining heating element portion. So there is possibility of breaking of heating element</p>



	<p>at hot spot.</p> <p>ii) Due to oxidization: At high temperature material gets oxidized which may cause failure of heating element.</p> <p>iii) Due to corrosion: If heating element is directly exposed to chemical fumes then there is possibility of rusting of heating element which causes failure of heating element.</p> <p>iv) Mechanical consideration/Failure: Measure heating element alloy contain iron which is brittle. Due to frequent heating & cooling of heating element, it may break (fail) due to small mechanical injury also.</p>
iii)	<p>Describe with neat diagram construction and working of high pressure mercury vapour discharge lamp.</p>
Ans:	<p>➤ Figure mercury vapour discharge lamp :- (1 Mark)</p> <div style="display: flex; align-items: center; justify-content: center;">OR</div> <p>Construction:- (1.5 Mark)</p> <ul style="list-style-type: none">➤ It consists of an inner bulb generally of silicon, to withstand high temperatures.➤ The bulb contains a small quantity of mercury and argon.➤ It is protected by outer glass, this may be cylindrical or elliptical.➤ The space between the two bulbs is filled with nitrogen at a pressure of half atmosphere.➤ The discharge tube has three electrodes, namely two main electrodes A and B and one starting electrode.➤ The starting electrodes are connected through a resistance of about 10-30 k ohm to the main electrode, located at the far end.➤ The electrodes are of tungsten wire helices filled with electron emissive materials, usually barium and strontium carbonates mixed with thorium.



OR Student may write

The construction & connection diagram is as shown in figure. As per this construction there are following components.

- **Choke:** The choke is acting as the ballast. At the time of supply voltage variation of current flowing through the inner tube is maintained constant to keep uniform light intensity. Sometimes choke can be designed for to get the higher voltages & to apply the inner tube of mercury vapour lamp.
- **Starting resistance/limiting resistance:** Whenever current flows through the starting resistance there is a I^2R loss which is converted into heat. If the temperature of this heat goes near about 600°C then there will be heating effect & inert gases ionization will be start.
- **Auxiliary electrode & Main electrode:** It is made by high resistive element. The ionization is taking place through the inert gases whenever current flows from auxiliary electrode to main electrode.
- **Inner Tube:** The various inert gases e.g. Argon, Nitrogen etc with mercury powder are filled in the inner tube at low pressure or high pressure.
- **Outer Tube:** The function of outer tube is to make the vacuum surrounding the inner tube to avoid thermal dissipation or to maintain 6000°C surrounding the inner tube.
- **Power factor improvement Capacitor:** The function of power factor improvement capacitor is to improve the power factor 0.5 to 0.95

Working:-

(1.5 Mark)

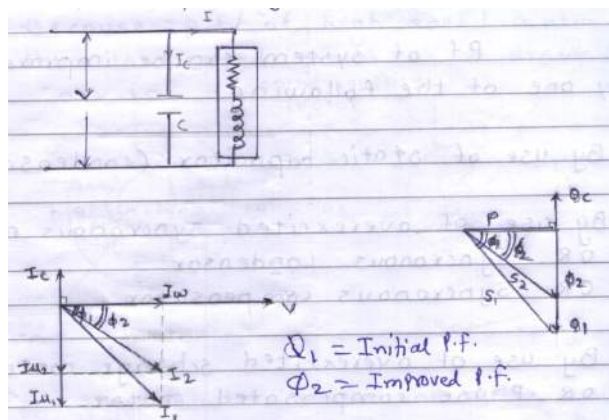
- When supply is switched on an initial discharge lamp is established in the Argon gas between main electrode A and aux. electrode C
- The heat is produced due to the discharge through gas which causes warming up of inner lamp
- Thus mercury gets vaporized and increasing its pressure and thus the light output.
- It takes about 5-7 min. for the mercury arc to buildup & give full light output.
- After 3-4 min. mercury vapors is greenish blue light.
- If the supply interrupted, the lamp must cool down and the vapour pressure be reduced before it will start. It takes approximately 3-4 min.
- The efficiency of this type of lamp is 30-40 lumens/W.

Mercury lamps are available in 125W; 250W & 400W rating for use 250V AC Supply.



iv) Describe the static capacitor method of power factor improvement.

Ans: (1 Marks for any one figure, Vector diagram 1 Mark, Formula 1 Mark & advantages & disadvantages (Any one) – 1 Mark: Total 4 Marks)



Observation:

- From above vector diagram & power triangle calculations, if capacitor is connected across load then following observations are observed.

S.No.	Parameter	Effect
1	Magnetizing current ($I\mu$)	Reduces
2	Power factor	Improves
5	Total current	Reduces
4	Lagging reactive power (KVar)	Reduces

➤ **Advantages of Static Capacitor: (Expected any one)**

1. Initial cost is low.
2. Low operating cost.
3. Low maintenance cost.
4. Losses are very less (less than 0.5%)than that of rated value
5. Noise less operation as it is a static piece.



	<p>6. Less space is required. Therefore can be installed near load.</p> <p>7. Greater reliability.</p> <p>8. KVAR (leading) rating can be adjusted easily as per load condition.</p> <p>➤ Disadvantages of Static Capacitance: (Expected any one)</p> <p>1. It has short life as compared to synchronous condenser.</p> <p>2. Capacitors get easily damaged if the voltage exceeds than its rated value. Once the capacitors are damaged its repair is uneconomical.</p> <p>3. When capacitor is switched OFF then precaution is taken before making it ON. In between OFF and ON time, time should be kept to discharge the capacitor, otherwise capacitor may fail.</p> <p>4. Switching current of capacitor is many times that of rated current; therefore cable size should be double of the normal current carrying capacity, so its cost increases.</p> <p>5. When there is no load or system is lightly loaded at that time capacitor bank must be made OFF otherwise voltage across transformer increases.</p>
Q.1b)	Attempt any ONE of the following : 06 Marks
i)	Describe any six factors governing selection of a motor for a particular application.
Ans:	<p style="text-align: center;">(Any Six Factors Expected Each Point: 1 Mark: Total :6 Marks)</p> <p style="text-align: center;">Following Factors governing / or are considered while selecting electric drive (Motor) for particular application:</p> <p>1. Nature of supply:</p> <p style="padding-left: 40px;">Whether supply available is</p> <ul style="list-style-type: none">➤ AC,➤ Pure DC➤ OR rectified DC. <p>2. Nature of Drive (Motor):</p> <p style="padding-left: 40px;">Whether motor is used to drive</p> <ul style="list-style-type: none">➤ Individual machine



- OR group of machines.

3. Nature of load:

- Whether load required light or heavy starting torque
 - OR load having high inertia, require high starting torque for long duration.
 - OR Whether load torque increases with speed ($T \propto N$)
 - OR decreases with speed ($T \propto 1/N$)
 - OR remains constant with speed ($T = N$)
 - OR increases with square of speed ($T \propto N^2$)

4. Electric Characteristics of drive:

- Starting,
- running,
- speed control
- Braking characteristics of electric drive should be studied and it should be matched with load requirements.

5. Size and rating of motor:

- Whether motor is short time
- OR continuously
- OR intermittently running
- OR used for variable load cycle.
Whether overload capacity, pull out torque is sufficient.

6. Mechanical Considerations:

- Types of enclosure,
- Types of bearing,
- Transmission of mechanical power,
- Noise
- load equalization

7. Cost:

- Capital,
- running
- And maintenance cost should be less.



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ii)	Compare A.C. welding with D.C. welding on the basis of 1)Equipment, 2)Operating efficiency, 3)Cost, 4)No-load voltage, 5)Heating and 6)Arc stability			
Ans:	(Each Point: 1 Mark: Total :6 Marks)			
	Sr.No.	Points	AC Welding	DC Welding
	1	Supply equipment used	Welding Transformer	DC differential Compound Generator, or Rectifier
	2	Efficiency	High, 85%	Low, 65%
	3	Cost:	Low	High
	4	No –Load Voltage	72 to 100 volt	50 to 60 volt
	5	Heating	Not Uniform	Uniform
	6	Arc Stability	Use of series Reactor OR Less arc stability	D.C Differential component. Generator has dropping characteristics. OR More arc stability
Q.2	Attempt any FOUR of the following :			16 Marks
a)	State the factors to be considered for selection of shape and size of the car of elevator.			
Ans:	The size and shape of elevator car depends are following two factors:			
	(Each factor : 2 Marks, Total : 4 Marks)			
	i) No. of passenger to be carried: While selecting the size of car it is a usual practice to allow.			
	➤ A Space of 2 Sq.ft/ person.			
	➤ Average weight of passenger is assumed 68 kg/person.			
	➤ Thus the maximum load capacity of elevator is considered 34 kg/sq.ft			
	➤ There should be wide frontage and shallow depth			
	ii) Limitation in the building design:			
	➤ Shape of elevator depends on space available in building.			
b)	State two advantages and two applications of dielectric heating.			
Ans:	Advantages of Dielectric Heating:- (Any Two advantages Expected: 1 Mark Each)			
	1) This is only method for heating non-metallic material.(Di-electric)			
	2) Bad conductor of heat material can be heated by this method (for e.g. porcelain)			
	3) As no flame, arc appears in the process, so material like plastic, wood cotton etc			



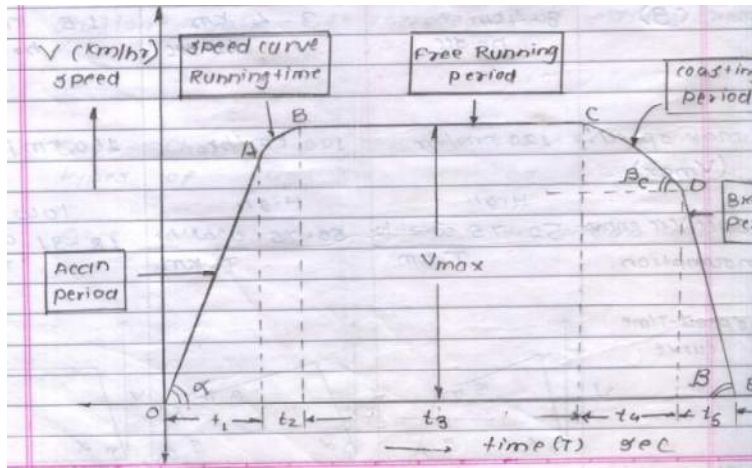
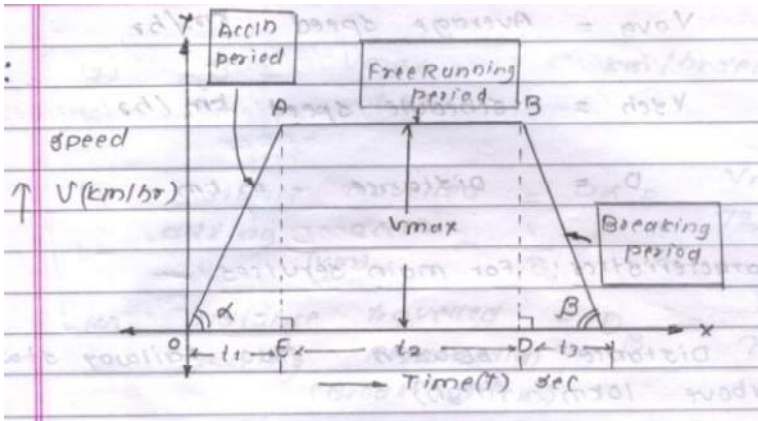
heated safely.

- 4) As heat is produced inside material to be heated due to dielectric loss, so efficiency of such type of heating is high.
- 5) Time required for heating is less as there is no heat transfer loss. Uniform heating is possible.
- 6) Temperature control is easy by simply controlling voltage & frequency.
- 7) Low attention is required.
- 8) Clean and convenient method.

Applications of Dielectric Heating:- (Any Two Application Expected: 1 Mark Each)

- 1) In food processing industry, dielectric heating is used for Baking of cakes & biscuits in bakeries. Cooking of food without removing outer shell (eg-boiled egg) and pasteurizing of milk.
- 2) For Rubber vulcanizing.
- 3) In Tobacco manufacturing industry for dehydration of tobacco.
- 4) In wood industry for manufacturing of ply wood.
- 5) In plastic Industry for making different types of containers.
- 6) In cotton industry for drying & heating cotton cloths for different processes.
- 7) In tailoring industry for producing threads.
- 8) For manufacturing process of raincoats & umbrellas.
- 9) In medical lines for sterilization of instruments & bandages.
- 10) For heating of bones & tissues of body required for certain treatment to reduce pains & diseases.
- 11) For removal of moisture from oil.
- 12) For quick drying gum used for book binding purpose.
- 13) In foundry for heating of sand, core, which are used in molding processes.



c)	Draw a typical speed time curve for main traction line service. Show different time periods on it.																						
Ans:	Typical speed time curve for main traction line service:		(4 Marks)																				
<div></div> <div>OR</div> <div></div>																							
d)	Compare electric locomotive over diesel locomotive on the basis of: (i) Centre of gravity, (ii) Running / maintenance cost, (iii) Starting time and (iv) Regenerative braking.																						
Ans:	(1 Mark each point, Total 4 Points)																						
<table><tr><th>Sr.No.</th><th>Point</th><th>Electric locomotive</th><th>Diesel locomotive</th></tr><tr><td>1</td><td>Centre of gravity</td><td>Lower level</td><td>Higher level</td></tr><tr><td>2</td><td>Running/Maintenance cost</td><td>Less</td><td>More</td></tr><tr><td>3</td><td>Starting Time</td><td>Quick /less/start at any time</td><td>Quick/It take more time</td></tr><tr><td>4</td><td>Regenerative Braking</td><td>Possible</td><td>Not possible</td></tr></table>				Sr.No.	Point	Electric locomotive	Diesel locomotive	1	Centre of gravity	Lower level	Higher level	2	Running/Maintenance cost	Less	More	3	Starting Time	Quick /less/start at any time	Quick/It take more time	4	Regenerative Braking	Possible	Not possible
Sr.No.	Point	Electric locomotive	Diesel locomotive																				
1	Centre of gravity	Lower level	Higher level																				
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3	Starting Time	Quick /less/start at any time	Quick/It take more time																				
4	Regenerative Braking	Possible	Not possible																				



e)	Describe the following terms with respect to traction mechanics: (i) Average speed and (ii) Schedule speed.
Ans:	<p style="text-align: right;">(Each Description: 2 Mark, Total:4 Marks)</p> <p>i) Average Speed: - It is defined as distance covered between two stops divided by actual time of run is known as average speed. OR</p> $V_{av} = \frac{3600D}{T}$ <p>Where T = is actual time of run in sec OR</p> $\text{Average Speed} = \frac{\text{Distance between stops or stations}}{\text{Actual time of run}}$ <p>ii) Schedule Speed: - It is defined as distance covered between two stops divided by schedule time is known as schedule speed. OR</p> $\text{Schedule Speed} = \frac{\text{Distance between stops or stations}}{(\text{Actual time of run}) + (\text{Stop time})} \quad \text{OR}$ $\text{Schedule Speed} = \frac{\text{Distance between stops or stations}}{\text{Schedule time}}$
Q.3	Attempt any TWO of the following : 16 Marks
a)	What is electric braking? State the advantages of electric braking. Compare Rheostatic and Regenerative braking.
Ans:	<p>Electric Braking: (2 Mark) It is necessary to stop the vehicle when mechanical working is over or when required within reasonable time. OR To reduce the speed of train electrical system is used for braking e.g. Plugging, dynamic braking & Regenerative braking.</p> <p>Advantages of electric Braking: (Any Four advantages Expected: 1 Mark each, Total: 4 Mark)</p> <p>Following are the advantages & disadvantages of electrical braking over mechanical braking system.</p> <p>1. It is most reliable braking system.</p> <p>Because in mechanical braking heat is produced at break block & break shoes, which may be source of failure of break.</p>



In Electrical braking (dynamic) heat is produced at convenient place (external rheostat) which is not harmful to braking system

2. Breaking actuation time is small as higher value of braking retardation is obtained.
3. Electrical braking is smooth & gradual.

Where as if mechanical breaks are not correctly adjusted then there are chances of sudden braking which is discomfort able to passenger.

4. Life of braking system is more.

Because mechanical braking provides metal dust due to friction, No such dust is formed in electrical braking.

5. There is less wear & tear of brake shoes, break block etc. so there is less maintenance cost.
6. Higher speeds are possible even when train is going down the gradient, as breaking system is reliable.
7. Trains having heavy loads can be stopped even when train going up the gradient.
8. Higher speeds of train is possible as braking system is reliable so pay load capacity increases.
9. In case of electric regenerative braking we can utilize 60 to 80% of kinetic energy to generate electricity which is not possible with mechanical braking.

Compare Rheostatic and Regenerative braking.

(Any Two point expected: 1 Mark each, Total: 2 Mark)

S.No	Rheostatic Braking	Regenerative Braking
1	In this method at the time of braking armature is disconnected from supply & connected across external resistance at that time field winding supply remain as it is.	In this method at the time of braking motors are made to work as a generator & electrical energy is fed back to supply line.
2	Generated EMF is less than supply voltage	Generated EMF is more than supply voltage
3	Rheostatic braking is used in any track position.	Regenerative braking is possible when the train going down the gradient or Regenerative braking is not possible on plane track
4	It is simple in operation	It is complicated in operation
5	Kinetic Energy is wasted	80 % kinetic energy is utilized



b)	Describe the construction and working of direct arc heating furnace. Compare direct arc furnace with indirect arc furnace on the basis of: (i) Temperature, (ii) Size, (iii) Applications and (iv) Power requirement.
Ans:	<p>1. Direct Arc Furnace:</p> <p>Direct arc furnace explained on following points: (Any one Figure expected)</p> <div data-bbox="349 569 883 600">a) Bottom Conducting direct arc Furnace</div> <div data-bbox="979 569 1317 600">b) 1-ph direct arc Furnace</div> <div data-bbox="326 621 829 968"></div> <div data-bbox="889 621 1373 968"></div> <p style="text-align: center;">OR</p> <p>Construction of Arc Furnace: (Construction: 2 Mark)</p> <p>Direct arc furnace consists of following main parts.</p> <ul style="list-style-type: none">i) Heating Chamber:<ul style="list-style-type: none">➤ Heating chamber is spherical in shape for providing minimum refractory material and for easy rocking.➤ It has two openings, one is for pouring the charge and another is for taking out molten metal. Both openings are closed during operation.➤ The wall of heating chamber is made from refractory material to withstand heating chamber at high temperature and also to reduce heat loss.ii) Furnace transformer:iii) Series reactor:iv) Automatic current regulator:v) Circuit breaker:vi) Rocking arrangementvii) Electrode:viii) Connecting lead:



Working of Arc Furnace:

(Working: 2 Mark)

- When very high voltage is applied across any two electrodes separated by small air gap then air between two electrodes gets ionized and ionized and as air is conducting, so current starts flowing from one electrode to another electrode in the form of spark (arc). OR The arc is produced between the electrode and charge and due to this heat is developed.
- This arc produces heat energy which is utilized for melting the charge.
- Once arc is struck between two electrodes then low voltage is sufficient to maintain the arc.

Compare direct arc furnace with indirect arc furnace on the basis of:

(1 Mark each point: Total 4 Marks)

Sr.No.	Point	Direct Arc Furnace	Indirect Arc Furnace
1	Temperature	High	Less
2	Size	More	Less
3	Applications	1. Used for continuous and large production of high quality steel. 2. For Ferro-alloy manufacturing	It is suitable for melting non-ferrous metals for e.g. Copper, Brass, bronze, gun metal etc.
4	Power requirement	Less	More

c)

(i) Suggest suitable electric drive for following application: 1) Paper mills, 2) Stone crusher, 3) Textile mills and 4) Electric traction.

Ans:

(Each Drive: 1 Mark, Total: 4 Marks)

Sr.No	Application	Suitable Electric Drive (Each anyone expected)
1	Paper mills	DC Shunt motor, Synchronous motor, Scharge Motor
2	Stone crusher	D.C series Motor, 1-Ph AC Series Motor, Slip-ring induction motor, Double squirrel cage I.M
3	Textile mills	Group drive, Scharge Motor
4	Electric traction	Individual drive operated in parallel / D.C series Motor, 1-Ph AC Series Motor, Multiple speed motor

OR

- i) Paper Mills:** - Group Drive
- ii) Stone Crusher:** - Individual drive
- iii) Textile Mills:** - Group Drive
- iv) Electric Traction:** - Individual drive



c)	<p>(ii) Draw the curve and estimate suitable H.P. of motor having following duty cycle:</p> <p>1) Rising load from 200 to 400 H. P. - 4 minute</p> <p>2) Uniform load of 300 H.P. - 2 minute</p> <p>3) Regenerative braking from 50 to zero H.P. - 1 minute</p> <p>4) Idle for - 1 minute</p>
Ans:	<p>i) Load rising from 200 to 400 HP :- 4 min</p> <p>ii) Uniform load of 300 HP :- 2 min</p> <p>iii) Regenerative braking from 50 to zero : 1 min</p> <p>iv) idle for : 1 min</p> <div style="text-align: center;"> </div> <p style="text-align: right;">or Equivalent fig----- (1/2 Mark)</p> $HP = \sqrt{\frac{\frac{1}{3} (H_1^2 + H_1 H_2 + H_2^2) \times t_1 + H_3^2 t_2 + \frac{1}{3} H_4^2 t_3}{T}} \text{----- (1 Mark)}$ <p>Where, $T = t_1 + t_2 + t_3 + t_4$</p> <p style="text-align: center;">$T = 4 + 2 + 1 + 1$</p> <p style="text-align: center;">$T = 8 \text{ min.} \text{----- (1 Mark)}$</p> $HP = \sqrt{\frac{\frac{1}{3} (H_1^2 + H_1 H_2 + H_2^2) \times t_1 + H_3^2 t_2 + \frac{1}{3} H_4^2 t_3}{8}} \text{----- (1/2 Mark)}$ $HP = \sqrt{\frac{\frac{1}{3} (200^2 + 200 \times 400 + 400^2) \times 4 + 300^2 \times 2 + \frac{1}{3} 50^2 \times 1}{8}} \text{----- (1/2 Mark)}$ $HP = \sqrt{\frac{1662500}{24}}$ <p style="text-align: right;">$HP = 263 \text{ HP} \text{-----Answer----- (1/2 Marks)}$</p> <p>Nearest standard rating of motor is to be selected.</p>



Q.4 a)	Attempt any THREE of the following:	12 Marks
i)	Define electric welding. State the factors deciding selection of electric welding system.	
Ans:	Meaning of electric Welding: <p>It is the process of joining two similar or dis-similar metals by application of heat <u>with</u> or without application of <u>pressure</u> and addition of <u>filler material</u>.</p> <p>Following Factors are considered while selecting of electric welding system:</p> <p>(Any Three factors Expected:1 Mark each: Total 3 Marks)</p> <p>1) <u>Type of Material</u>:- Whether similar metal is to be welded or dis-similar metal is to be welded.</p> <p>2) <u>Property of Material</u>:- Whether ferrous or non-ferrous metal is to be welded.</p> <p>3) <u>Thickness of job</u>:- It is also depends on thickness of job to be welded. e.g. for thick material- Arc welding is used. And for thin material – Resistance welding is used.</p> <p>4) <u>Temperature required</u>:- Whether job required high or low temperature to weld the job. e.g. For high Temperature - Arc welding is used. And for low Temperature – Resistance welding is used.</p> <p>5) <u>Pressure required</u>:- If job is need of pressure at the time of welding in that case resistance welding is used. And if pressure is not required Arc welding is used.</p> <p>6) <u>Type of Supply Available</u>:- Whether AC or DC or both supply are available.</p> <p>7) <u>Application</u>:- In case of mass production, resistance welding is used & for repair work Arc welding is used.</p>	(1 Mark)



ii)	State and explain laws of illumination.
Ans:	<p>Laws of illumination: -</p> <p style="text-align: right;">(Each Figure 1 Mark & Statement of each law 1 Mark, Total: 4 Mark)</p> <p>a) Inverse Square Law :-</p> <div data-bbox="641 514 1156 835"></div> <p style="text-align: right;">or Equivalent fig.</p> <p>Illumination is inversely proportional to the Square of distance between source and plain of the surface. $E \propto \frac{1}{r^2}$</p> <p>b) Lambert's cosine law :-</p> <div data-bbox="626 1010 1101 1339"></div> <p style="text-align: right;">or Equivalent fig.</p> <p>The illumination of a surface is directly proportional to cosine of angle made by the normal to the illuminated surface with the direction of the incident flux.</p> <p>$E_B = E_A \cos^3 \phi_1$, $E_C = E_A \cos^3 \phi_2$, $E_D = E_A \cos^3 \phi_3$ and so on.</p>
iii)	Define the following terms related to illumination: 1) Utilization factors 2) Maintenance factors 3) Depreciation factor and 4) Luminous efficiency
Ans:	<p style="text-align: right;">(Each Definition: 1 Mark, Total: 4 Marks)</p> <p>1) Utilization factor:-</p> <p>It is defined as the ratio of total lumens reaching the working plane to the total lumens given out by the lamp.</p>



	<p>2) Maintenance factor:-</p> <p>It is defined as the ratio of illumination under normal working conditions to the illumination when everything is clean. OR</p> $\text{Maintenance factor} = \frac{\text{Illumination under normal working condition}}{\text{Illumination under everything is clean}}$ <p>3) Depreciation Factor:</p> <p>It is defined as the ratio of initial illumination to the ultimate maintained illumination on the working plane. OR</p> $\text{Depreciation factor} = \frac{1}{\text{Maintenance Factor}}$ <p>4) Luminous Efficiency:-</p> <p>It is ratio of energy radiated by the source in the form of light to the total energy radiated by the source.</p>
iv)	State four requirements of Tariff.
Ans:	<p>Following are the requirements of Tariff:</p> <p>(Any Four points expected: 1 Mark each: Total: 4 Marks)</p> <ul style="list-style-type: none">i) It should be easy to understand to consumer.ii) Easy to calculate.iii) Tariff should be attractive; It should not be too high or too low. It should be reasonable.iv) Tariff should be economical as compare to other types of energy sources.v) Tariff must be fair, so that different types of consumers are satisfied with rate of electrical energy charges.vi) Tariff should be framed into two parts i.e. fixed charges + running charges.vii) While calculating tariff it should cover all expenses and reasonable profit,



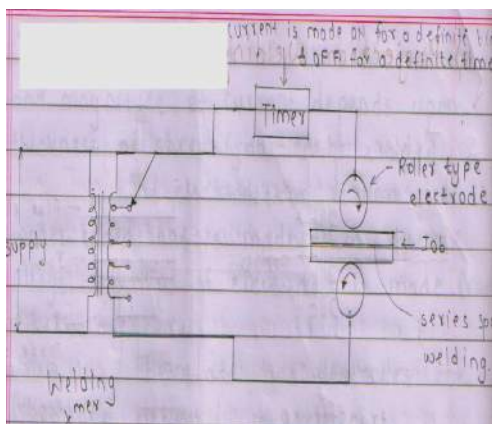
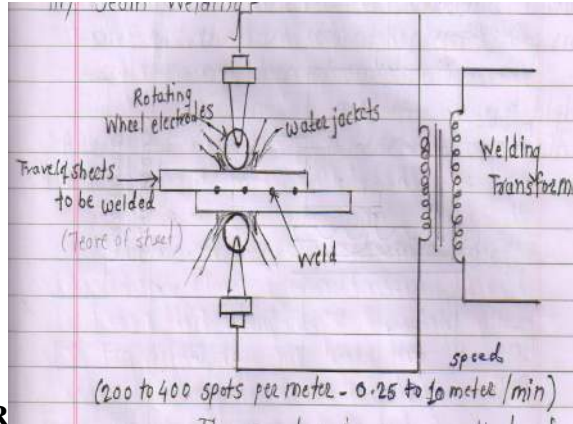
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Q. 4 b)	Attempt any ONE of the following :	06 Marks
a)	Describe with neat sketch, construction and working of seam welding machine.	
Ans:	Sketch of Seam welding:	(1 Mark)
	<div></div> <div style="text-align: center;">OR</div> <div></div>	
	Construction:	(2.5 Mark)
	<ul style="list-style-type: none">➤ Transformer used for seam welding is designed for low voltage and high current secondary.➤ Transformer is oil cooled➤ There are two electrodes in this type beam or roller type electrodes are used.	
	Working:	(2.5 Mark)
	<ul style="list-style-type: none">➤ Job is kept in between two electrodes under pressure. This pressure is kept constant throughout.➤ In this type intermittent current is used, it means current is ON for definite time and OFF for another time interval with the help of timer.➤ If current is continuously passes then heat produced may cause burning of job.➤ Heat is produced due to I^2R losses where 'R' is the contact resistance.➤ This heat is utilized to obtain welding temperature (to become a plastic state)➤ When welding temperature is reached supply is cut down and external pressure is applied simultaneously across the job to complete weld.	



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b)	What are the different tariffs used by electricity supply authority? Describe any two of them in brief.
Ans:	<p>Types of Tariff:- (Any three types are expected: 1 Mark each; Total 3 Marks)</p> <ul style="list-style-type: none">i) Flat-demand Tariffii) Simple-demand Tariff or Uniform Tariffiii) Flat-rate Tariffiv) Step-rate Tariffv) Block-rate Tariffvi) Two-part Tariff:vii) Maximum demand Tariffviii) Three-part Tariffix) Power factor Tariff :-<ul style="list-style-type: none">a) KVA maximum demand Tariffb) Sliding Scale Tariff or Average P.F. Tariffc) KW and KVAR Tariffx) TOD (Time of Day) Tariff <p>Explanation: (Any Two Explanation Expected: 3 Marks)</p> <p>1) Flat Demand Tariff:</p> <ul style="list-style-type: none">➤ It is used where energy consumption is fixed per day i.e. where load is fixed and is used for fixed hours.➤ e.g. Street lighting, Road Signal system and advertising board.➤ In this type <u>no energy meter</u> is connected, so meter reading, billing, accounting, Stationary, bill distribution and collection etc. expenses are eliminated and also save time for billing.➤ Calculation: <p style="margin-left: 40px;">Energy consumed per day = Load (KW) X No. of working hrs. (H)</p> <p style="margin-left: 40px;">Energy consumed per Month =</p> <p style="margin-left: 40px;">Total energy consumed in one year × 12 Month Load</p> <p style="margin-left: 40px;">Energy consumed in one year = Energy consumed per day × 365 days</p> <p>2) Simple or uniform demand tariff:-</p>



- In this type of tariff cost of energy charges is calculated on the basis of actual energy consumed. Energy meter is connected in consumer premises.

➤ **Calculation:**

Energy Bill = (Current reading – Previous reading)

Energy Bill = (Total energy consumed (KWH) × Tariff (Rs) / unit

3) Flat Rate Tariff:-

- In this type of tariff there are two energy meter in one premises.
- One energy meter is for lighting circuit load and another meter is for power circuit load.
- Tariff rate for lighting and power load are different.
- Tariff rate for lighting is higher than tariff for power load.

Disadvantages:

1. Two energy meters are required.
2. Meter reading & Billing cost increases

➤ **Calculation:**

Energy Bill for lighting circuit = (Current reading – Previous reading) × Tariff (Rs) / unit for lighting circuit

Energy Bill for Power circuit = (Current reading – Previous reading) × Tariff (Rs) / unit for Power circuit

4) Step rate Tariff:-

- In this tariff there are steps for unit's consumption and cost/unit is less for more consumption of unit.
- The main disadvantage of this tariff is that the consumer unnecessarily wastes the power to enter the next stage.
- For example 1) Step- I- Rs.2/KWH :- If consumption not to exceed 50 unit
2) Step-II – Rs. 1.75/KWh:- If consumption not to exceed 200 unit.
3) Step-II- Rs. 1.50/KWh:- If consumption exceeds above 200 units.

5) Block Rate Tariff:-

- In case of block rate tariff there are blocks of units consumed and each block tariff rate/unit (KWH) is different.



- If generation is less than utilization than tariff rate/unit in each block goes on increasing and vice versa.
- E.g.

S.No	Block of units consumed from..... To	If, Generation is less than utilisation-Tariff (Rs)	If, Generation is more than utilisation-Tariff (Rs)
1	0 to 100 unit	3	8.55
2	101 to 300 unit	5	8.30
3	301 to 500 unit	7.15	7.15
4	501 to 1000 unit	8.30	5
5	Above 1000 unit	8.55	3

6) Two Part Tariff:-

- In this type of tariff energy bill is split into two parts.
- Only one energy meter is used to measure no. of units consumed it recovers a fixed charge which depends on load (KW).
- This type of tariff system is used for residential and commercial consumers.(up to 20 KW)
- This type of tariff is not used for industrial consumers.

$$\text{ENERGY BILL} = \text{FIXED CHARGE} + \text{RUNNING CHARGE}$$

➤ Advantages:

1. It recovers fixed charges which depends on load (KW), so it automatically recovers capital investment of Supply Company

➤ Disadvantages:

1. The consumer has to pay fix charges per month whether he has to consume or not consume the electrical energy.

➤ Application:

1. This type of tariff system is used for residential and commercial consumers.(up to 20 KW)
2. This type of tariff is not used for industrial consumers.

7) Maximum Demand Tariff/KVA MD Tariff:-

- It is similar to two part tariff except that maximum demand (KVA) is actually measured by installing maximum demand (in KVA)
- M.D. Meter is installed in the premises of consumer, in addition to energy meter.



- Industrial consumer is trying to improve power factor to reduce maximum demand charges.

- This type of tariff is applicable to industrial consumer/H.T. consumer.

Maximum Demand Tariff =

$$\text{M.D. (KVA)} \times \text{Rs 'X'} + \{\text{Number of units (KWH) Actual consumer}\} \times \text{Rs 'Y'}$$

8) Three part Tariff:-

- Fixed charges per month depend on connected load.
- Semi-fixed charges depend on KVA maximum demand.
- Running charges depend on actual energy consume.
- This type tariff is used for HT consumer.

$$\text{ENERGY BILL} = \text{FIXED CHARGE} + \text{SEMI-FIXED CHARGE} + \text{RUNNING CHARGE}$$

9) Power Factor Tariff:-

- The tariff in which P.f. of industrial consumer is taken into consideration.
- Power factor tariff is used for industrial consumer /H.T. consumer.
- If the P.F. of consumer is less than P.F. declare by Supply Company (say below 0.92 Lag.) then penalty will be charged in energy bill.
- If The P.F. of consumer is more than P.F. declare by Supply Company (say above 0.96 lag.) then discount will be given in energy bill.

There are three types :

a) KVA maximum demand Tariff:

- It is similar to two part tariff except that maximum demand (KVA) is actually measured by installing maximum demand (in KVA) meter.
- M.D. Meter is installed in the premises of consumer, in addition to energy meter.(Now a days there is only one meter which measures all parameters)
- Industrial consumer is trying to improve power factor to reduce maximum demand charges. Since $KVA \propto I \propto 1/pf$
- This type of tariff is applicable to industrial consumer/H.T. consumer.

b) Sliding Scale Tariff or Average P.F. Tariff:



- In this case an average power factor say in the range of 0.92 lag to 0.96 lag is taken as a reference by electric supply company
- If power factor of industry falls below (say 0.92 lag) this reference power factor then penalty will be charged or suitable additional charges will be added in the energy bill.
- On the other hand, if the P.f. of consumer is above (Say 0.96 Lag) this reference P.f. then there is discount as suitable amount reduced from the energy bill.
- So consumer is trying to improve P.f. to get discount in energy bill. So overall P.f. of power system increases.
- As usual consumer has to pay actual energy consumption charges

c) KW and KVAR Tariff:

- In this type both active (KW) & reactive power (KVAR) supplied are charged separately and actual energy consumption charges,
- A consumer having low power factor draw more reactive power and shall have to pay more charges and vice-versa.
- So consumer is trying to improve power factor to reduce KVAR charges in energy bill, so power factor of power system increases.

Energy Bill = {Rs 'A'(KW) Charges} + {Rs 'B'(KW) Charges} + {Rs 'C'(KWH) Charges}

10) Time of Day (TOD) Tariff or OFF-load Tariff:-

- TOD energy meter is installed in the HT consumer premises.
- This meter is specially designed to measure energy consumption w.r.t. time.
- This type of tariff is such that energy consumption charges/unit are less at during OFF-load period
- There is a higher tariff rate energy consumption charge during peak-load period.
- This type of tariff is introduced to encourage industrial consumers to run their maximum load during OFF-load period.
- Due to this load factor of generating station increases. Such type of tariff is used for HT Consumer.
- e.g.

S.No	Block	Rate / KWH Rs	Remark
1	9.00 am to 12.00 noon	Rs. 6.00 per unit	Peak load period
2	12.00 noon to 6.00 pm	Rs. 5.00 per unit	OFF load Period
3	6.00 pm to 10.00 pm	Rs. 6.00 per unit	Peak load period
4	10.00 pm to 9.00 am	Rs. 5.00 per unit	OFF load period

Q.5 Attempt any FOUR of the following : **16 Marks**

- a) A 400 V, 50 Hz, 3-phase line delivers 200 KW at 0.7 p.f. lagging. It is desired to improve



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	the line power factors to unity by using shunt capacitors. Calculate value of capacitance of each unit if they are connected in delta.
Ans:	<p>Volt : line volts $V = 400V$, $f = 50 \text{ Hz}$ $P = 200\text{kW}$ $\cos\phi_1 = 0.7$ $\cos\phi_2 = 1$</p> <p>$\therefore \cos\phi_1 = 0.7 \quad \therefore \phi_1 = 45.5729^\circ$</p> <p>$\therefore \tan\phi_1 = \tan 45.5729^\circ$</p> <p>$\tan\phi_1 = 1.020$ ----- (1/2 Mark)</p> <p>$\tan\phi_2 = 0$ ----- (1/2 Mark)</p> <p>$Q_1 = P \tan\phi_1$</p> <p>$= 200 \times 1.020$</p> <p>$= 204 \text{ KVAR}$</p> <p>$Q_2 = P \tan\phi_2$</p> <p>$= 200 \times 0$</p> <p>$= 0 \text{ KVAR}$</p> <p>$Q_C = Q_1 - Q_2$</p> <p>$= P \tan\phi_1 - P \tan\phi_2$ ----- (1 Mark)</p> <p>$= 204 - 0$</p> <p>$= 204 \text{ KVAR}$ ----- (1/2 Mark)</p> <p>\therefore Capacitor when connected in Delta:-</p> <p>$C \text{ per phase} = \frac{Q_C}{3\omega V^2}$ ----- (1 Mark)</p> <p>$C \text{ per phase} = \frac{204 \times 10^3}{3 \times 2\pi \times 50 \times 400^2}$</p> <p>$C \text{ per phase} = \frac{204 \times 10^3}{3 \times 50.265 \times 10^6}$</p> <p>$C \text{ per phase} = 1.3528 \times 10^{-3} \text{ F}$ ----- (1/2 Mark)</p>
b)	"Precautions are taken for ill effects due to negative resistance characteristics of an electric arc in electric arc welding." Justify the statement.
Ans:	<p>Effect of characteristics: (2 Mark)</p> <p>➤ Characteristics of Arc: Arc is conducting and it has negative temperature coefficient of resistance. i.e. its resistance decreases as temperature increases.</p> <p>➤ Effect of characteristics: This decreasing resistance will increase current further</p>



	<p>due to this arc blow increases i.e. arc does not remain steady. It goes on increasing and increasing. Due to this job may burn.</p> <p>Precautions:- (2 Mark)</p> <ul style="list-style-type: none">➤ In case of D.C Welding Stability of Arc: To stabilize arc D.C differential compound generator is used. It has dropping voltage characteristics, i.e., as load increases voltage suddenly decreases. Due to this characteristics arc remains steady.➤ In case of A.C Welding Stability of Arc: To stabilize the arc in case of metal arc welding series reactor is used.
c)	<p>Draw a labeled block diagram of A.C. electric locomotive.</p>
Ans:	<p>Block diagram of A.C. electric locomotive (4 Marks)</p> <p style="text-align: center;">equivalent figure</p> <p style="text-align: right;">or</p>
d)	<p>Describe any four points that proves the suitability of D.C. series motor in traction system.</p>

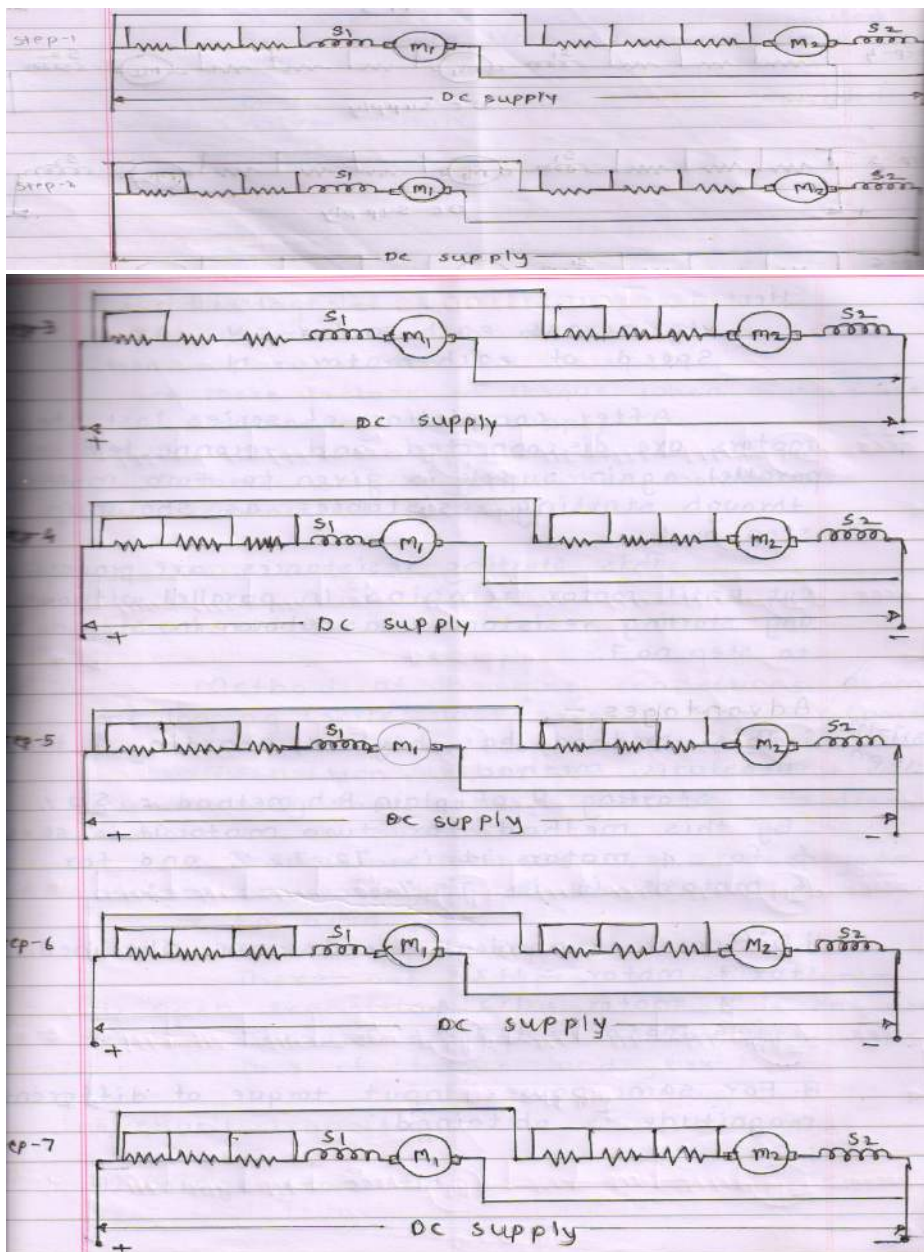


Ans:	<p style="text-align: right;">(Any Four Point Expected 1 Mark Each Point, Total: 4 Marks)</p> <p>DC series Motor is suitable for traction purpose because of following points:</p> <ol style="list-style-type: none">1) DC series motor has High torque at low speeds, low torque at high speeds, this is the basic requirement of traction unit.2) DC Series motor robust in construction and capable to withstand against continuous vibration.3) DC series motor weight is 1.5 times less than 1-Ph AC series motor for same H.P.4) DC Series motor has high starting torque.5) DC Series motor has high rate of acceleration and retardation.6) DC Series motor variable speed motor.7) DC Series motor speed-torque characteristics are such that as torque increases speed decreases. (Due to this characteristics motor is protected against overload)8) DC Series motor maintenance cost is less.9) When DC series motor are running in parallel the all motors share almost equal load.10) Torque obtained by DC series motor is smooth and uniform, so it improves riding quality.
e)	<p>Describe with neat sketch series-parallel control of traction motor</p>
Ans:	<p>With neat sketches series control of traction motor: (2 Mark)</p> <p style="text-align: center;">or equivalent figure</p>



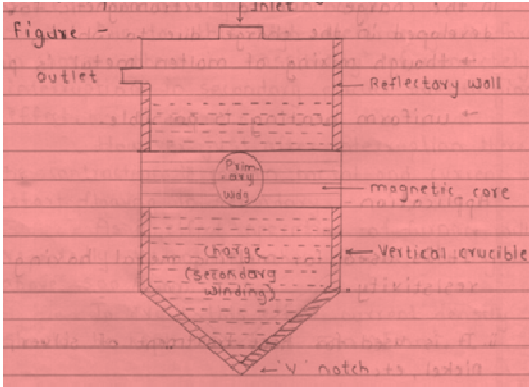
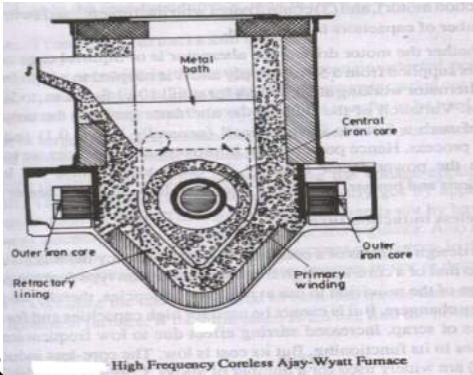
With neat sketches parallel control of traction motor:

(2 Mark)



or equivalent figure



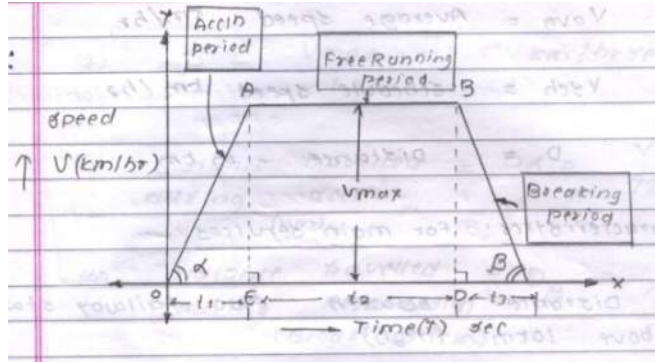
a)	Draw the neat sketch of Ajax Wyatt Furnace. Describe its operation. State its four advantages.
Ans:	<p>➤ Neat sketch of 'Ajax Wyatt' vertical core furnace: (1 Mark)</p> <div style="display: flex; justify-content: space-around; align-items: center;">OR</div> <p style="text-align: center;">or Equivalent fig.</p> <p>Operation of Ajax Wyatt' vertical core furnace: (3 Mark)</p> <p>It is based on principle of transformer. In this type of primary winding is as usual which is wound around one limb of magnetic core but secondary winding is actually charge which is to be melted is kept in crucible.</p> <p>When AC Supply is given to primary winding current flows through primary winding which creates alternating flux in magnetic core this flux links to the secondary winding i.e. charge through magnetic core. Hence according to faraday's law of electromagnetic induction emf will be induced in secondary winding that is in the charge.</p> <p>As charge forms a close circuit (secondary) heavy current flows through charge this current is responsible to produce heat in charge due to I^2R losses. This heat is utilized to melt the charge.</p> <p>Where, R = Resistance of charge & I secondary current</p> <p>Advantages Ajax Wyatt' furnace: (Any Four Point Expected : 1 Mark each, Total: 4 Mark)</p> <ol style="list-style-type: none">1) As furnace has narrow 'V' shape crucible at bottom. So small quantity of molten metal remains in narrow 'V' notch from previous operation, which will help to keep secondary short circuited.



	<p>So no extra care is required to start the furnace</p> <p>2) Magnetic coupling between secondary & primary winding is better because both windings are on central limb of magnetic core</p> <p>So there is less leakage flux, Hence leakage reactance is less, so power factor is better than horizontal crucible direct core type induction furnace.</p> <p>3) Due to pinch effect in ordinary core type induction furnace there are chances of temporary interruption in secondary circuit when current density exceeds above 500A/mm^2</p> <ul style="list-style-type: none">➤ But in this type of induction furnace there are no chances of interruption in secondary circuit even if current density exceeds 500A/mm^2 because tendency of weight of charge keep them in contact due to narrow 'V' shape.➤ So we can increase current density above 500A/mm^2 to obtain more heat in less time. <p>4) Vertical crucible is always better than horizontal crucible for pouring and taking out the metal. Also space required is less.</p> <p>5) As heat is produced directly in the charge there is no heat transfer loss. So efficiency of furnace is more.</p> <p>6) As heat is directly produced in the charge time required for melting metal is less. So energy consumption is less.</p> <p>7) As current is directly induced in the charge there is automatic stirring action taking place in the charge due to electromagnetic forces developed in the charge due which,</p> <ul style="list-style-type: none">➤ Through mixing of molten metal is possible.➤ Uniform heating is possible <p>8) Temperature can be controlled easily.</p>
b)	<p>The distance between two stations is 2 km. It is desired to have scheduled speed of 40 km/hr. with duration of stop of 20 sec. Assuming trapezoidal speed - time curve calculate: (i) The maximum speed required when the acceleration is to be limited to 1.2 km/hr./sec. and braking retardation to be 3 km/hr./sec. and (ii) The distance covered during acceleration and retardation.</p>
Ans:	<p>Given Data :-</p> <p>D = 2 KM, Schedule speed (V_{sch}) = 40KM / Hr, Stop Time = 20 sec.</p> <p>Acceleration (α) = 1.2 Km/Hr/sec; Retardation (β) = 3 Km/Hr/sec.</p>



Trapezoidal speed time curve :-



or Equivalent fig.-(1 Mark)

➤ $V_{sch} = \frac{3600 D}{ScheduleTime}$ ----- (1 Mark)

∴ $ScheduleTime = \frac{3600 D}{V_{sch}}$

∴ $ScheduleTime = \frac{3600 \times 2}{40}$

∴ $ScheduleTime = \frac{7200}{40}$

∴ $ScheduleTime = 180 \text{ sec.}$ ----- (1/2 Mark)

➤ $ScheduleTime = ActualTime of Run + Stoptime$

∴ $ActualTime of Run = ScheduleTime - Stoptime$

∴ $ActualTime of Run = 180 - 20$

∴ $ActualTime of Run = 160 \text{ sec.}$ ----- (1/2 Mark)

➤ Maximum Speed =

$V_{max} = \frac{T - \sqrt{T^2 - 4K3600D}}{2K}$ ----- (1/2 Mark)

But, $K = \frac{\alpha + \beta}{2(\alpha \times \beta)}$ ----- (1/2 Mark)



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	$K = \frac{1.2 + 3}{2(1.2 \times 3)}$ $K = 0.5833 \text{----- (1 /2Mark)}$ $V_{\max} = \frac{160 - \sqrt{160^2 - 4 \times 0.5833 \times 3600 \times 2}}{2 \times 0.5833}$ $V_{\max} = 56.7345 \text{ KM/Hr -----Answer----- (1/2 Mark)}$ <p>➤ Distance covered during Acceleration ($D\alpha$) =</p> $D\alpha = \frac{V_{\max}^2}{7200 \alpha} \text{----- (1 Mark)}$ $D\alpha = \frac{56.7345^2}{7200 \times 1.2}$ $D\alpha = 0.3725 \text{ Km -----Answer----- (1/2 Mark)}$ <p>Distance covered during Retardation ($D\beta$) =</p> $D\beta = \frac{V_{\max}^2}{7200 \beta} \text{----- (1 Mark)}$ $D\beta = \frac{56.7345^2}{7200 \times 3}$ $D\beta = 0.1490 \text{ Km -----Answer--- (1 /2 Mark)}$
c)	<p>A consumer draws 500 KW power steadily at 0.8 p.f. lagging for 3650 hours per annum. The tariff is Rs. 1300 per KVA of maximum demand plus Rs. 1.00 per kwh. The annual cost of phase advancing plant is Rs. 150 per KVAR. Find the annual saving if the power factor of load is improved.</p>
Ans:	<p>Given Data: - $P = 500 \text{ KW}$, $\cos \phi = 0.8 \text{ lag}$, working Hours = 3650/annum</p> <p>Tariff = (Rs.1300 / KVA of maximum demand / annum + Rs. 1.00 / Kwh)</p> <p>The annual cost of phase advancing plant = Rs.150 / KVAR</p> <p>Saving in max. demand charges:</p> $= \text{Rs. X.P.} \left(\frac{1}{\cos \phi_1} - \frac{1}{\cos \phi_2} \right) = \text{Rs. X.P.} (\sec \phi_1 - \sec \phi_2) \text{----- (4Marks)}$



$$= \text{Rs. } 1300 \times 500 \left(\frac{1}{0.8} - \frac{1}{0.9933} \right)$$

$$= \text{Rs. } 1300 \times 500 (1.25 - 1.006)$$

$$= \text{Rs. } 158128.80 \text{----- (3Marks)}$$

$$\text{Net Saving per year} = \text{saving} - \text{expenditure} \text{----- (1Marks)}$$

$$= 158128.80 - 150$$

$$= 157978.80 \text{ Rs.}$$

OR

$$\text{➤ } KVA = \frac{KW}{\cos \phi} \text{----- (1Mark)}$$

$$KVA = \frac{500}{0.8}$$

$$KVA = 625 \text{----- (1 Mark)}$$

➤ **No. of Units consume in One Year**

$$= M.D(KW) \times \text{No. of working hours in one year}$$

$$= 1 \times 500 \times 3650$$

$$= 1825000 \text{ Kwh} \text{----- (1 Mark)}$$

➤ **Annual Energy Bill :-**

$$= (\text{Rs. } 1300 / KVA \text{ of maximum demand / annum} + \text{Rs. } 1.0 / \text{Kwh})$$

$$= (\text{Rs. } 1300 \times 625 + \text{Rs. } 1 \times 1825000)$$

$$= (\text{Rs. } 812500 + \text{Rs. } 1825000)$$

$$= 2637500.00 \text{ Rs.} \text{-----Equation No. 1----- (1 Mark)}$$

Saving will be maximum only at most Economical Power factor hence: Most Economical Power factor is calculated.

$$\text{➤ Most Economical P.f.} = \sqrt{1 - \left(\frac{Y}{X} \right)^2} \text{----- (1Mark)}$$

$$= \sqrt{1 - \left(\frac{150}{1300} \right)^2}$$



	<p>= 0.99332 lagging ----- (1/2Mark)</p>
➤	<p>New Maximum Demand =</p> $KVA = \frac{KW}{New \cos \phi} \text{----- (1Mark)}$ $New KVA = \frac{500}{0.99332}$ $New KVA = 503.3620 \text{----- (1/2Mark)}$
➤	<p>Annual Energy Bill if the Power factor load is improved:-</p> <p>= (Rs.1300 / KVA of max imum demand / annum + Rs.1.0/ Kwh)</p> <p>= (Rs.1300 × 503.3620 + Rs.1 × 1825000)</p> <p>= (Rs.654370.60 + Rs.1825000)</p> <p>= 2479370 .60 Rs. ----- Equation No. -----2----- (1/2 Mark)</p>
➤	<p>Annual Saving = Equation 1 – Equation 2</p> <p>= 2637500 Rs. – 2479370.60 Rs.</p> <p>= 158129.40 Rs. Saving if the power factor of load is improved. (1/2 mark)</p>

-----**END**-----