SUMMER– 2019 Examinations

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	Attempt any FIVE :	20 Marks
a)	Define Electric drive. State the two advantages associated with electric drives.	
Ans:	**Electric Drive:** **(2 Marks)** It is a machine which gives mechanical power. e.g. drives employing electric motors are known as electric drives. **Following advantages of electric drive:** **(Any Four point Expected: 1/2 each point: 2 Marks)** 1. It is more economical. 2. It is more clean. 3. No air pollution. 4. It occupies less space. 5. It requires less maintenance. 6. Easy to start and control. 7. It can be remote controlled. 8. It is more flexible.	

	9. Its operating characteristics can be modified.
	10. No standby losses.
	11. High efficiency.
	12. No fuel storage and transportation cost.
	13. Less maintenance cost.
	14. It has long life.
	15. It is reliable source of drive.
b)	**State its eight applications of dielectric heating.**
Ans:	**Applications of Dielectric Heating:-** **(Any eight points are expected: 1/2 Mark each point, Total 4 Marks)** 1) In wood industry for manufacturing of ply wood. 2) In plastic Industry for making different containers. 3) For manufacturing process of raincoats & umbrellas. 4) In medical lines for sterilization of instruments & bandages. 5) For quick drying gum used for book binding purpose. 6) In cotton industry for drying & heating cotton cloths for different processes. 7) For Rubber vulcanizing, tyre and tube manufacturing process 8) Cooking of food without removing outer shell (e.g.-boiled egg) 9) In milk industry for pasteurizing of milk. 10) In Tobacco manufacturing industry for dehydration of tobacco. 11) In food processing industry, dielectric heating is used for Baking of cakes & biscuits in bakeries.
c)	**Compare resistance welding and arc welding on any four points.**
Ans:	**(Any Four Points From The Following Or Equivalent Points Are Expected 1 Mark To Each Point, Total 4 Marks)**

Sr.No	Parameters	Resistance Welding	Arc Welding
1	Type of welding	Plastic/Pressure/Non-fusion welding	Fusion/Non pressure welding
2	Principle of heat developed	Heat is developed due to I^2R losses where R is the contact resistance	Heat developed due to arc produced in between electrode and job
3	External filler material required	Not required during welding	Required during welding
4	External pressure required	Required	Not required
5	Type of supply used	Both AC,DC supply is used. But generally Ac Supply is used.	<u>Metal arc welding</u> – Both AC,DC supply is used. But generally Ac Supply is used.and for <u>Carbon arc welding</u> –only DC supply are used
6	Voltage &current required	Low voltage (2 to 20V AC) and high current (40 to 400A, in some cases 5 to 20KA) supply is required	<u>Metal Arc welding Voltage-</u> 70 to 100V AC and <u>Carbon arc welding voltage-</u> 50 to 60V DC, Current- 50-600-800A
7	Energy consumption	Low (3 to 4 KWH/Kg of deposited material)	High (5 to 10 KWH/Kg of deposited material.)
8	Temperature obtained	Temperature obtained is not very high (up to 1350^0C)	Temperature obtained is very high (up to 3500^0C to 6000^0C)
9	Power factor	Low	Poor
10	Type of electrode	Non-consumable	Coated electrodes are used

			electrodes are used.	for metal arc welding and bare electrodes are used for carbon arc welding.(Electrodes may be consumable or non-consumable)
	11	Application	It is suitable for mass production	It is suitable for heavy job, maintenance and repair work

| **d)**	**State any four requirements of an ideal traction system.**
Ans:	**(Any Four Points From The Following Or Equivalent Points Are Expected 1 Mark To Each Point, Total 4 Marks)** Ideal Traction system should processes following requirement:- 1. It should be Pollution free. 2. It should have low capital, Running and maintenance cost. 3. It should have quick starting time. 4. It should have high starting torque. 5. It should have high rate of acceleration & retardation. 6. Highest speeds are possible. 7. It should have easy speed control method. 8. Its braking system should be reliable and causes less wear. 9. It should have better riding quality (less vibration) 10. It should be free from unbalance forces i.e. coefficient of adhesion should be more. 11. It should have lower center of gravity.

12. The locomotive should be self-contained and able to run on any route

13. There should be no standby losses.

14. It should have high efficiency

15. Regenerative braking should be possible.

16. The wear caused on the track should be minimum.

17. Equipment should be capable of overloads for short periods.

18. Capability of withstanding voltage fluctuations.

19. Parallel running usually more than one motor (2 or 4 motors) should be possible.

20. Traction system should be clean & long life.

21. There should be no interference to the communication lines running along the lines.
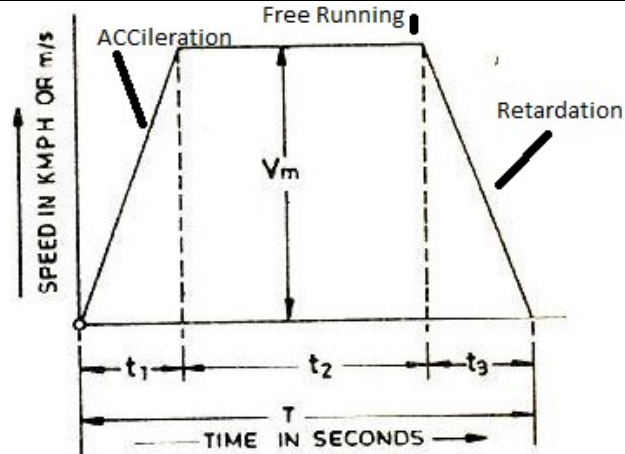
e)	**Draw simplified speed time curve. Show and list various time periods associated with it.**	
Ans:	**Typical speed time curve for main traction line :** (Total, 4 Mark)	
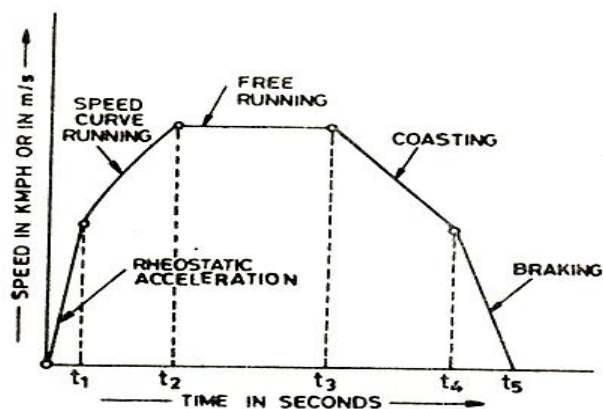
OR

Speed Time Curve list various time periods:-

There are five periods in the run of train as shown in speed time curve.

i) Constant acceleration period (o to A)

ii) Acceleration on speed –Time curve (A to B) For T_2 sec.

iii) Free Running or constant period (B to C) For T_3 sec.

iv) Coasting period (C to D) For T_4 sec.

v) Braking period (D to E) For T_5 sec.

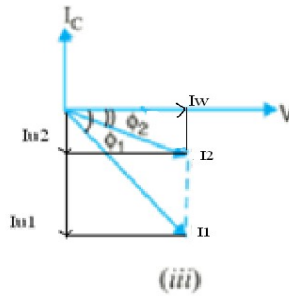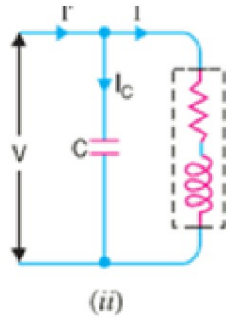|	
f)	**Describe the static capacitor method of power factor improvement.**
Ans:	**The static capacitor method of power factor improvement.** **(4 Marks)**

Before connecting capacitor   Phasor diagram
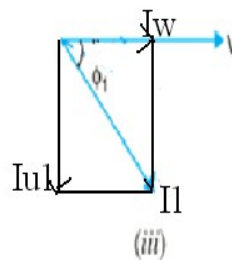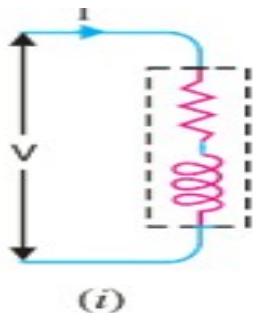
After connecting capacitor   phasor diagram

(ii)   (iii)

$\cos\phi_1$ = Initial Power factor

$\cos\phi_2$ = Improved Power factor

Calculation from current vector diagram:

$$I_C = I\mu_1 - I\mu_2$$

$$\therefore I_C = [I_w \tan\phi_1] - [I_w \tan\phi 2]$$

Now, $I_C = \dfrac{V}{X_C}$ $\therefore X_C = \dfrac{V}{I_C}$ $\therefore X_C = \dfrac{1}{2 \times \pi \times f \times c}$

$$\therefore C = \dfrac{1}{2 \times \pi \times f \times X_C}$$

Magnitude of new current:

$$I_2 = \sqrt{(I_w)^2 + (I\mu_2)^2}$$

Calculation from power triangle: Where ,
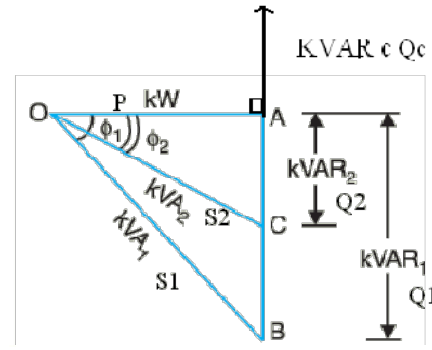
P = Active power KW

Q_1, Q_2 = Lagging reactive power before & after improving power factor

Q_C = Leading Reactive power drawn by Capacitor

S_1, S_2 = KVA Maximum demand before and after improving power factor

$\cos\phi_1$ = Initial Power factor

$\cos\phi_2$ = Improved Power factor

$Q_C = Q_1 - Q_2$

$Q_C = [\,P \tan \phi_1\,] - [\,P \tan \phi_2\,]$ KVAr rating of capacitor

Observation:

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

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

➢ **Connection diagram to connect capacitor to improve power factor (Delta connection)**
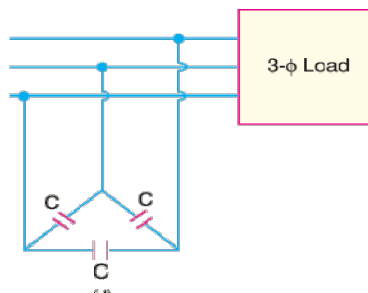
                                                    or equivalent figure

$$(Cph) = \frac{KVAR}{3\,\omega\,V^2}\,\text{Farad}$$

$$\omega = 2\pi\,f$$

> **3-ph Star connected Capacitor Bank:**
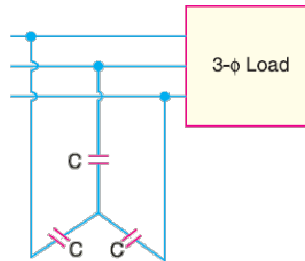
or equivalent figure

$$(Cph)_\lambda = \frac{KVAR}{\omega\, V^2} \, Farad$$

$$\omega = 2\pi f$$

OR Student may write this way

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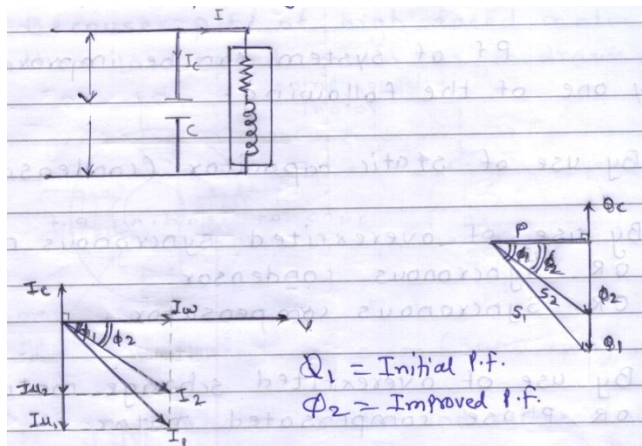
Observation:

> 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.

6. Less space is required. Therefore can be installed near load.

7. Greater reliability.

8. KVAr (leading) rating can be adjusted easily as per load condition.

➢ **Disadvantages of Static Capacitance: (Expected any one)**

1. It has short life as compared to synchronous condenser.

2. Capacitors get easily damaged if the voltage exceeds than its rated value. Once the capacitors are damaged its repair is uneconomical.

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.

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.

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.

g)	State any four factors governing selection of a motor for particular application.

Ans:	**(Any Four Points From The Following Or Equivalent Points Are Expected 1 Mark To Each Point, Total 4 Marks)**
	
	Following Factors governing / or are considered while selecting electric (Motor) for particular application:
	1. **Nature of supply:**
	Whether supply available is
	   ➢ AC,
	   ➢ Pure DC
	   ➢ Or Rectified DC
	
	2. **Nature of Drive (Motor):**
	Whether motor is used to drive (run)
	   ➢ Individual machine
	   ➢ OR group of machines.
	
	3. **Nature of load:**
	   Whether load required light or heavy starting torque
	   ➢ OR load having high inertia, requirehigh starting torque for long duration.
	   ➢ OR Whether load torque increases with speed (T α N)
	   ➢ OR decreases with speed (T α $1/N$)
	   ➢ OR remains constant with speed (T = N)
	   ➢ OR increases with square of speed (T α N²)
	
	4. **Electric Characteristics of drive:**
	   ➢ Starting,
	   ➢ Running,
	   ➢ Speed control
	   ➢ and braking characteristics
	of electric drive should be studied and it should be matched with load requirements(i.e. machine).
	
	5. **Size and rating of motor:**
	   ➢ Whether motor is short time running

➢ OR continuously running

➢ 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

➢ and load equalization

7.   **Cost:**
➢ Capital,
➢ Running
➢ and maintenance cost should be less.

Q.2	Attempt any TWO :	16 Marks
a) i)	(i) Give any four ideal requirements of elevators.	
Ans:	**Ideal requirements of elevator**:	

(Any Four requirements are Expected: 1 Mark each, Total :4 Marks)

1. There must be all safety features.

2. Compactable acceleration and retardation to avoid jerk.

3. It should have sufficient Speed (feet/min.) proportional to height of building.

4. There should adequate lighting and provision of fan.

5. There should better interior design of the car.

6. It should have minimum breaking period.

7. There should be wide-frontage for fast traffic.

8. It should have sufficient capacity to handle the weight (Average weight 68 Kg per person).

9. Sufficient space should be available for car (2 Sq,ft. per person).

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	10. There must be provision of back-up, when electric supply get's failure like D.G. sets.
a) ii)	**(ii) State the factors to be considered for selection of shape and size of elevators.**

Ans:	**(Any four points are Expected 1 Marks to each, Total 4 Marks)**
	
	The size and shape of elevator car depends on following factors:
	
	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.
	
	iii) Type of building
	
	iv) Application of elevator

b) i)	**(i) Compare AC & DC system of track electrification on any four points.**
Ans:	**(Any Four point expected: 1 Mark each, Total 4 Marks)**

S.No	Points	AC track Electrification	DC track electrification
1.	Supply given to O/H condition	1-ph, 25KV, AC 50 Hz	600/750V-Tromways 1500/3000V urban/ suburban
2.	Type of drive used	1-ph, AC series motor	DC series motor for tramways. DC compound motor
3.	Weight of traction motor	1.5 times more than d.c. series motor.	1.5 times less than a.c series motor
4.	Starting torque	Less starting torque than d.c series motor	High starting torque
5.	Accl^n and retardation	Less than d.c series	High

		motor	
6.	Overload capacity	Less than d.c series motor	High
7.	Method of speed control	Simple and smooth	Limited, except chopper method
8.	Maintenance cost of traction motor	More	Less
9.	Starting Efficiency	More	Less
10.	Ridding quality	Less, better than d.c.	Smooth (Better)
11.	Insulation cost	High	Low
12.	Cross section of conductor	Less	More
13.	Design of supporting structure	light	Heavy
14.	Distance between two substation	More	Less
15.	No. of substation required for same track distance.	Less	More
16.	Size (capacity) of traction substation	More	Less
17.	Capital & maintenance cost of substation	Less	More
18.	Cost track electrification for same track distance	Less	More
19.	Applications	Main line services	Urban and suburban area

b) ii)	**A electric train has a schedule speed of 25 km/hr between stations 800 m apart. The duration of stop is 20 seconds, the maximum speed is 20% higher than average running speed and the braking retardation is 3 km/hr/sec. Determine rate of acceleration required to operate the train.**

Ans:	Given:- Schedule speed of 25 km/hr, Distance between stations 800 m
	          Stop time 20 Sec.
	          Maximum speed is 20% higher than average running speed, Braking retardation is 3 km/hr/sec

$$Scheduled \ speed = \frac{3600D}{T_{sch}}$$

$$T_{sch} = \frac{3600 \times 0.8}{25}$$

$$= 115.20 \sec$$

$$Actualtime \ of \ run = T = T_{sch} - T_{stop}$$

$$= 115.20 - 20$$

$$= 95.20 \sec.$$ --**(1/2 Mark)**

$$A \text{var} age \ speed = \frac{3600D}{T}$$

$$= \frac{3600 \times 0.8}{95.2}$$ --- **(1 /2 Mark)**

$$= 30.2521 \ km/hr.$$

Maximum Speed = $1.2 \times$ Average speed

$$= 1.2 \times 30.2521$$

$$= 36.3025 \ km/hr.$$ --- **(1/2 Mark)**

$$\frac{1}{\alpha} + \frac{1}{\beta} = \frac{7200D}{V^2 \max} = \left[\frac{V_{\max}}{V_{ac}} - 1 \right]$$ --- **(1 Mark)**

$$= \frac{7200D}{(36.3025)^2} = [1.2 - 1] = \frac{5760}{1317.87}$$ -----------------------------------**(1/2 Mark)**

$$\frac{1}{\alpha} + \frac{1}{\beta} = 0.8741$$

$$\frac{1}{\alpha} = 0.8741 - \frac{1}{\beta}$$ -- **(1/2 Mark)**

$$= 0.8741 - \frac{1}{3}$$

$$\frac{1}{\alpha} = 0.5407$$

$$\alpha = 1.8495 \ kmphs$$ --- **(1/2 Mark)**

c)	A 3ph, 440 V, 50 Hz, 40 kW load has a pl. 0.85 lagging. Calculate kVAR rating of capacitor required to improve P.F. to 0.95 lagging. What will value of capacitor per phase, if (i) capacitors connected in star? (ii) Capacitors connected in delta?

Ans:	**Given Data**
	
	Volt : 440 V, f= 50 Hz
	P= 40 Kw $\cos\phi_1$ =0.85 $\cos\phi_2$ =0.95
	$\therefore Cos\,\varphi_1 = 0.85$
	
	$\tan\phi_1$ = 0.6197 ---------------------------- --- **(1/2 Mark)**
	$\cos\phi_2$ =0.95
	$\tan\phi_2$ = 0.3286 ------------------- --- **(1/2 Mark)**
	
	Q_1 = P $\tan\phi_1$
	  = 40 x 0.6197
	  = 24.788 KVAR --- **(1/2 Mark)**
	Q_2= P $\tan\phi_2$
	  = 40 x 0.3286
	  = 13.144 KVAR - --- **(1/2 Mark)**
	
	i) KVAR Rating of the capacitor Bank
	    Q_C = Q_1- Q_2
	    = P $\tan\phi_1$ - P $\tan\phi_2$ ------------------(1 Mark)
	    = 24.788 – 13.144
	  Q_C = 11.644 KVAR --- **(1 Mark)**
	$\therefore$**Capacitor when connected in Star :-**
	
	$C\ per\ phase = \dfrac{Q_C \times 10^3}{\omega V^2}$ or $Q_C = 2\,\pi\,F_C\,V^2$ - ---------------------------- **(1 Mark)**
	
	$C\ per\ phase = \dfrac{11.644 \times 10^3}{2\pi \times 50 \times (440)^2}$
	
	$C\ per\ phase = 1.914 \times 10^{-4}$ F - --- **(1 Mark)**
	$\therefore$**Capacitor when connected in delta :-**

	$C\ per\ phase = \dfrac{Q_C \times 10^3}{3\omega V^2}$ - -- **(1 Mark)** $C\ per\ phase = \dfrac{11.644 \times 10^3}{3 \times 2\pi \times 50 \times (440)^2}$ $C\ per\ phase = 6.38 \times 10^{-5}\ \ F$ - --- **(1 Mark)**
Q.3	**Attempt any FOUR :** **16 Marks**
a)	**State types of track electrification system.**
Ans:	**(Any Four TYPES Of Track Electrification From The Following Are Expected 1 Mark To Each TYPE Of Track Electrification, Total 4 Marks)** **Following are the different track electrification system** **D.C. Supply system:-** 1. Direct current track electrification: ➢ 600V, 750V DC for tramways ➢ 1500V, 3000V DC for Train (Urban and sub-urban services) **A.C. Supply system:-** 2. 1-Ph, 25KV,standard frequency AC supply system: ➢ 1-Ph, 25 KV, 50 Hz 3. 1-Phase, low frequency AC Supply system: ➢ 1-Ph, 15/16 KV, 16.2/3 Hz or 25 Hz 4. 3-Ph, Low frequency AC supply system; ➢ 3-Ph, 3.3/3.7 KV, 16 2/3 Hz or 25 Hz **Composite system:-** 5. 1-Ph AC (1-ph, 25KV) – DC Supply System 6. Kando System (1-Ph AC – 3-Ph AC)
b)	**State any one application of each of following :**

	(i) Direct resistance heating (ii) Indirect induction heating (iii) Direct arc heating (iv) Dielectric heating
Ans:	**(Any Two Application Are Expected Of Each Heating Type 1/2 Mark Each Application, Total 4 Marks)**

(i) Direct resistance heating:-   **(Any Two Application Are Expected)**

1. This type of heating used for industrial purpose

2. Salt bath heating: This utilized for the purpose of carbonizing, tempering, quenching and hardening of steel tools

3. Heating of water in boiler

(ii) Indirect induction heating: **(Any Two Application Are Expected)**

1. For heating as well as melting

2. Production of carbon free ferrous alloys.

3. For vacuum melting.

4. For melting non-ferrous metals for e.g. copper, aluminum, nickel etc.

5. For duplexing steel products.

6. Heating of non-conducting material is also possible if crucible is made from conducting material.

(iii) Direct arc heating:-   **(Any Two Application Are Expected)**

1. Used for continuous and large production of high quality steel.
2. For Ferro-alloy manufacturing

(iv) Dielectric heating:-   **(Any Two Application Are Expected)**

1. In food processing industry, dielectric heating is used for Baking of cakes & biscuits in bakeries.

2. Cooking of food without removing outer shell (e.g.-boiled egg) and pasteurizing of milk.

3. For Rubber vulcanizing.

4. In Tobacco manufacturing industry for dehydration of tobacco.

5. In wood industry for manufacturing of ply wood.

6. In plastic Industry for making different containers.

7. In cotton industry for drying & heating cotton cloths for different processes.

8. In tailoring industry for producing threads.

9. For manufacturing process of raincoats & umbrellas.

10. In medical lines for sterilization of instruments & bandages.

11. For heating of bones & tissues of body required for certain treatment to reduces paints & diseases.

12. For removal of moisture from oil.

13. For quick drying gum used for book binding purpose.

14. In foundry for heating of sand, core, which are used in molding processes.

c)	**State one applications of (i) Seam welding (ii) Butt welding (iii) Carbon arc welding (iv) Metal arc welding**
Ans:	**(i) Applications of Seam welding:-** **(Any one application expected: 1 Mark)**

It gives leak-proof joints.

1. Hence used for welding of various types of containers,

2. Pressure tank,

3. Tank of transformer,

4. Gas line,

5. Air craft tank,

6. Condenser,

7. Evaporator and

8. Refrigerator etc.

(ii) Application Butt Welding: (**Any one application expected: 1 Mark**)

1) For welding rod, wire, pipe etc

2) Butt welding is a resistance welding process for joining thick metal plates or bars at end

(iii) Application of Carbon arc welding: **(1 Mark)**

1. For welding non ferrous metals

(iv) Application of Metal arc welding: **(1 Mark)**

1. For welding Ferrous Metals, Can be used for vertical & overhead welding.

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d) | **Define : (i) Luminous Intensity (ii) Lumen (iii) Candle power (iv) MI-ICP**

Ans: | **i) Luminous intensity:-**   **(1 Mark)**

Luminous intensity = $Illumination = \dfrac{Luminous Flux}{Area}$

OR $I = \dfrac{\phi}{w}$ (*Where* $\phi = luminous\ flux$, $w = Solid\ Angle$)

OR

The luminous intensity in any particular direction is the luminous flux emitted by source per unit solid angle is called the luminous intensity of the source.

(ii) Lumen: **(1 Mark)**

It is defined as the luminous flux emitted by a source of one candle power per unit solid angle in all directions   **OR**

It is unit of luminous flux. One lumen is defined as luminous flux emitted per unit solid angle from a point source of candle power.

iii) Candle power: **(1 Mark)**

The candle power is the radiation capacity of the light source in the given direction. The candle power is always given in lumens output per unit solid angle of the given light source. $C.P = \dfrac{Lummens}{w}$, (*Where* $w = Solid\ Angle$)

	iv) MHCP (Mean Horizontal candle Power (MHCP) : **(1 Mark)**
	MHCP is defined as the mean of the candle power of source in all directions in horizontal plane.
e)	**State advantages of time off day tariff. (any four)**
Ans:	**Advantages of time off day tariff:** **(Any four point expected: 1 Mark each, Total 4 Mark)**
	1. Major industrial consumers are trying to run their maximum load during OFF load period , to get rebate in their energy bill .
	2. Major industrial consumers are trying to run their industry at reduced load during PEAK load period to avoid additional charges charged in energy bill.
	3. Due to above two reasons, it increases overall load factor as well as diversity factor of power system.
	4. As load factor and diversity factor of power system increases so overall cost per unit reduces.
	5. Also due to this there will be maximum utilization of power plant & infrastructure.
	6. Due to TOD tariff major industrial consumers are trying to run their maximum load during off load period
	So, TOD tariff helps to avoid the wastage of surplus energy generated during OFF load period.
	In this way it helps to conserve energy.
f)	**Define : (i) Average speed (ii) Schedule speed Also, state the four factors affecting the schedule speed.**
Ans:	**(i) Average Speed: -** **(2 Marks)**
	It is defined as distance covered between two stops divided by actual time of run is known as average speed. **OR**
	$$V_{av} = \frac{3600\,D}{T} \text{ Km/hr}$$
	Where T = is actual time of run in sec **OR**

$$Average\ Speed = \frac{Dis\tan ce\ between\ stops\ or\ stations}{Actual\ time\ of\ run}$$

(ii) Schedule Speed: -   (**1 Marks**)

It is defined as distance covered between two stops divided by schedule time is known as schedule speed. **OR**

$$Schedule\ Speed = \frac{Dis\tan ce\ between\ stops\ or\ stations}{(Actual\ time\ of\ run) + (Stop\ time)}$$ Km/hr

$$Schedule\ Speed = \frac{Dis\tan ce\ between\ stops\ or\ stations}{Schedule\ time}$$

The following factors affect the schedule speed:-

(Two factors affecting schedule speed are expected 1/2 Mark each , Total 1 Marks)

1. By acceleration
2. By retardation
3. By both acceleration and retardation
4. By maximum speed
5. By stop time
6. By coasting period

Q.4	**Attempt any FOUR :**	**16 Marks**
a)	**Draw fig. of rheostatic braking in case of D.C. series motor and D.C. shunt motor.**	

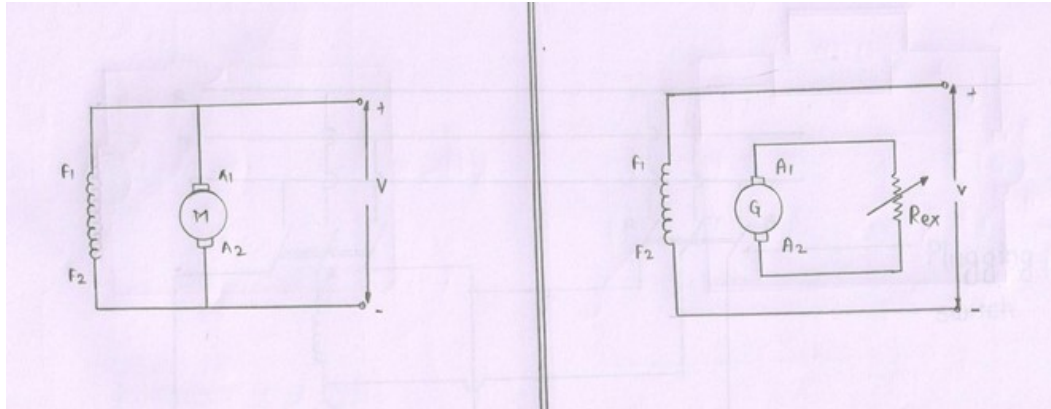Ans: | __Rheostaic braking or dynamic braking of DC series Motor:__   (**Figure : 2 Mark**)
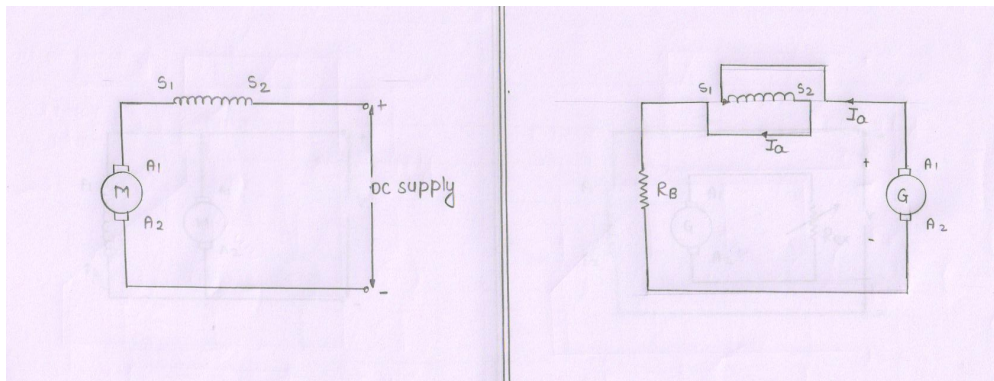
Under normal condition   **Under Dynamic breaking condition**

	Rheostaic braking or dynamic braking of DC shunt Motor: **(Figure : 2 Mark)** Under normal condition Under Dynamic breaking condition
b)	**State four advantages of Ajax Wyatt vertical core induction furnace.**
Ans:	**Advantages of Ajax Wyatt vertical core induction furnace:** **(Any Four Points Are Expected : 1 Mark each, Total 4 Marks)** 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. So no extra care is required to start the furnace 2) Magnetic coupling between primary & secondary winding is better because both windings are on central limb of magnetic core. So there will be less leakage flux, Hence leakage reactance is less, so power factor is better than horizontal crucible direct core type induction furnace. 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/cm2 OR 5Amp/mm2.. 4) But in this type of induction furnace there are no chances of interruption in secondary circuit even if current density exceeds 500A/cm2 OR 5Amp/mm2 Because tendency of weight of charge keep them in contact due to narrow 'V' shape. 5) So we can increase current density above 500A/cm2 OR 5Amp/mm2 to obtain more heat in less time.

	6) Vertical crucible is always better than horizontal crucible for pouring and taking out the metal. Also space required is less.
	
	7) As heat is produced directly in the charge there is no heat transfer loss. So efficiency of furnace is more.
	
	8) As heat is directly produced in the charge time required for melting metal is less. So energy consumption is less.
	
	9) 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,
	    ➢ Through mixing of molten metal is possible.
	    ➢ Uniform heating is possible
	
	10) Accurate temperature control.
	
	11) Ideal working condition in a cool atmosphere with no dirt , noise and fuel.

c)	Compare between resistance welding and arc welding on any four points.
Ans:	**(Any Four Points From The Following Or Equivalent Points Are Expected 1 Mark To Each Point, Total 4 Marks)**

Sr.No	Parameters	Resistance Welding	Arc Welding
1	Type of welding	Plastic/Pressure/Non-fusion welding	Fusion/Non pressure welding
2	Principle of heat developed	Heat is developed due to I^2R losses where R is the contact resistance	Heat developed due to arc produced in between electrode and job
3	External filler material required	Not required during welding	Required during welding
4	External pressure required	Required	Not required
5	Type of supply used	Both AC,DC supply is	<u>Metal arc welding</u> – Both

|			
		used. But generally Ac Supply is used.	AC,DC supply is used. But generally Ac Supply is used. And for <u>Carbon arc welding</u> –only DC supply are used
6	Voltage &current required	Low voltage (2 to 20V AC) and high current (40 to 400A, in some cases 5 to 20KA) supply is required	<u>Metal Arc welding Voltage-</u> 70 to 100V AC and <u>Carbon arc welding voltage-</u> 50 to 60V DC, Current- 50-600-800A
7	Energy consumption	Low (3 to 4 KWH/Kg of deposited material)	High (5 to 10 KWH/Kg of deposited material.)
8	Temperature obtained	Temperature obtained is not very high (up to 1350^0C)	Temperature obtained is very high (up to 3500^0C to 6000^0C)
9	Power factor	Low	Poor
10	Type of electrode	Non-consumable electrodes are used.	Coated electrodes are used for metal arc welding and bare electrodes are used for carbon arc welding.(Electrodes may be consumable or non-consumable)
11	Application	It is suitable for mass production	It is suitable for heavy job, maintenance and repair work

d)	State direct and indirect lighting scheme with one application.
Ans:	**1. Direct lighting:** **(Figure Not compulsory)**
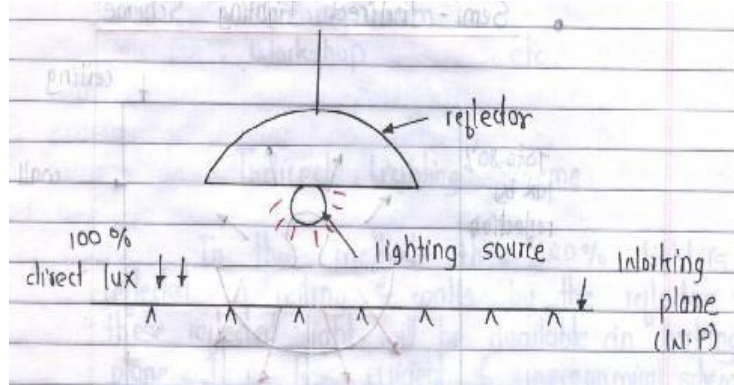
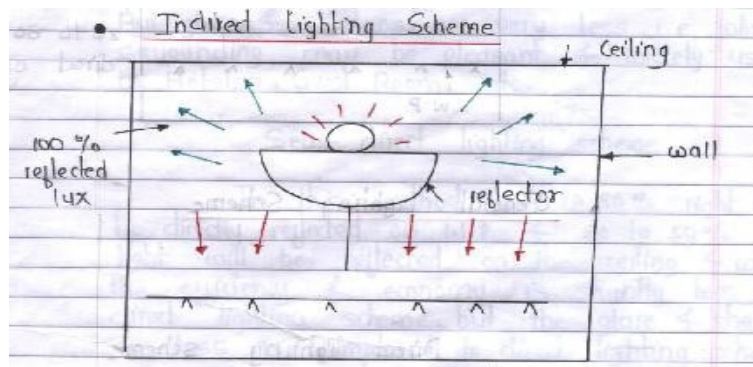**Explanation:**   **(1 Marks)**

As is clear from the name, in this system almost 90 to 95 % light falls directly on the object or the surface. The light is made to fall upon the surface with the help of deep reflectors.

Application of Direct lighting scheme: **(1 Marks)**

1. This type of lighting scheme is most used in industries and commercial lighting. Although this scheme is most efficient but it is liable to cause glare and shadows.

2. Indirect lighting: **(Figure Not compulsory)**

	Explanation: **(1 Marks)** In this system, the light does not fall directly on the surface but more than 90 % of light is directed upwards by using diffusing reflectors. Here the ceiling acts as a source of light and this light is uniformly distributed over the surface and glare is reduced to minimum. **Application of Indirect lighting scheme:** **(Anyone expected: 1 Marks)** 1. It provides shadow less illumination which is useful for drawing offices and composing rooms. 2. It is also used for decoration purposes in cinema halls, hotels etc.
e)	**D.C. series motor is used for traction purpose. Justify your answer with any four characteristics.**
Ans:	**(Characteristics 1 Mark, For justification points 3 Marks, Total 4 Marks)** Due to following characteristics and advantages, DC series motor is suitable for traction duty: 1) Characteristics: **(1 Mark)** Characteristics of DC series motor Advantages/ **Justification points:-** **(Any six points are expected 1/2 Mark each, Total 3 Marks)** 1. DC Series motor has high starting torque. 2. DC Series motor has high rate of acceleration and retardation. 3. DC series motor has speed- Torque characteristics is such that it produces high torque at low speeds, low torque at high speed.
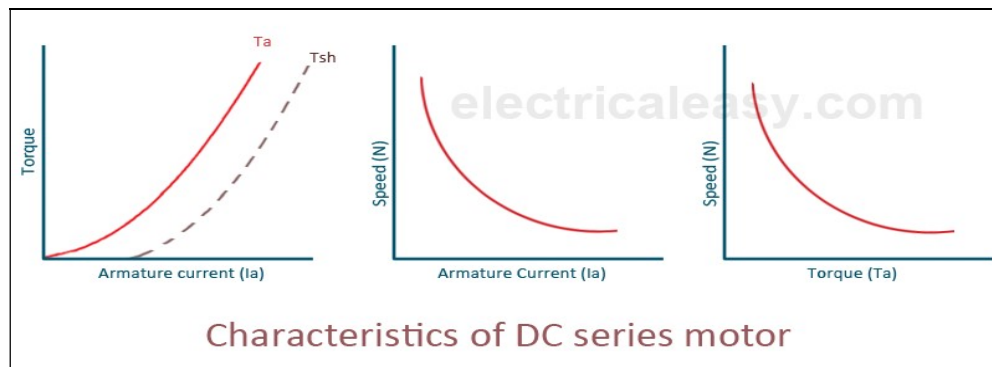
4. DC Series motor is variable speed motor. Due to these characteristics motor is protected against overload i.e. self –reliving property against over load

5. It has high power to weight ratio.

6. DC series motor consumes less power than AC motors for same HP

7. DC Series motor maintenance cost is less.

8. DC series motor weight is 1.5 times less than 1-Ph AC series motor for same H.P.

9. Torque is unaffected by variation in supply voltage.

10. Torque obtained by DC series motor is smooth and uniform, so it improves riding quality.

11. DC Series motor robust in construction and capable to withstand against continuous vibration.

12. When DC series motor are running in parallel the all motors share almost equal load.

| f)	**Sketch the various steps required for bridge transition system.**
Ans:	**(Each Step 1 Mark, Total 4 Marks)** In bridge transition, series last step to parallel first step, is carried out by following steps Step1: Bridge link is connected between two motors as shown in figure (Series last step) Step2:Bridge link is so rotated that two motors are put in series without starting resistance. Which are un-shorted at the same time.
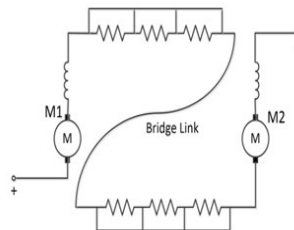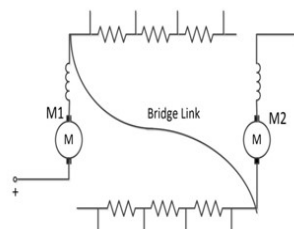
Step 3:The portions of external resistance are connected in each motor circuit as shown in fig
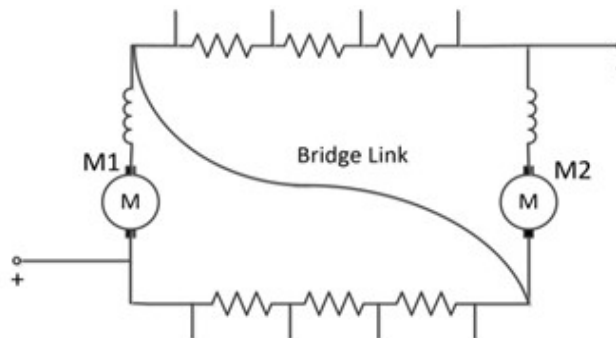
Step4: In this last step bridge link is removed as shown in fig. This is nothing but parallel first step.
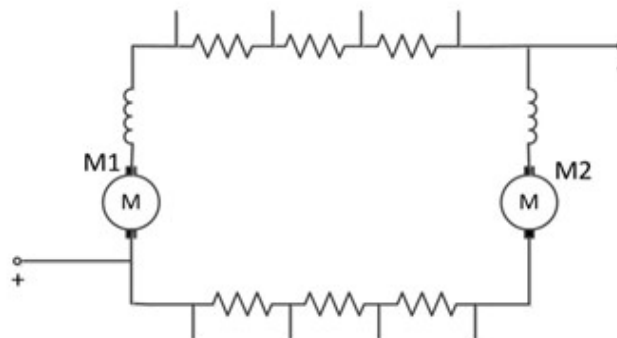
Q.5	**Attempt any FOUR :**	**16 Marks**
a)	**State the meaning of load equalization. How is it done ?**	
Ans:	**Meaning of load equalization:**	

<p style="text-align:center;color:red;">**(Meaning : 2 Mark, Figure: 1 Mark & explanation: 1 Mark)**</p>

There are many types of load which are fluctuating in nature e.g. wood cutting m/c, Rolling mill. Etc. For such type of loads, load equalization is necessary to draw the constant power from supply. Because,

When there is sudden load on motor, it will draw more current from supply at start to meet additional power demand. Due to this heavy current there is large voltage drop in supply system. This will affect electrical instrument, equipment, m/c, other consumer etc. which are connected across same supply line.

Also to withstand heavy current, size of input cable increases so cost of cable increases, Hence it is necessary to smooth out load fluctuations on motor.

<u>**The process of smoothing out load fluctuation is called load equalization**</u>.

|	**How load equalization is done?**
	Load equalization is done by means of **flywheel**. It is mounted on motor shaft. Flywheel stores kinetic energy when there is light or no load & it supplies kinetic energy when there is sudden heavy load on motor. In this way load demand on supply remains practically constant.
b)	**Draw figure of indirect arc furnace. State its two advantages and two disadvantages.**
Ans:	**(Figure: 2 Mark, advanatges:1 Mark & disadvantages: 1 Mark, Total 4 Marks)** **Figure of indirect arc furnace:** **(2 Marks)**
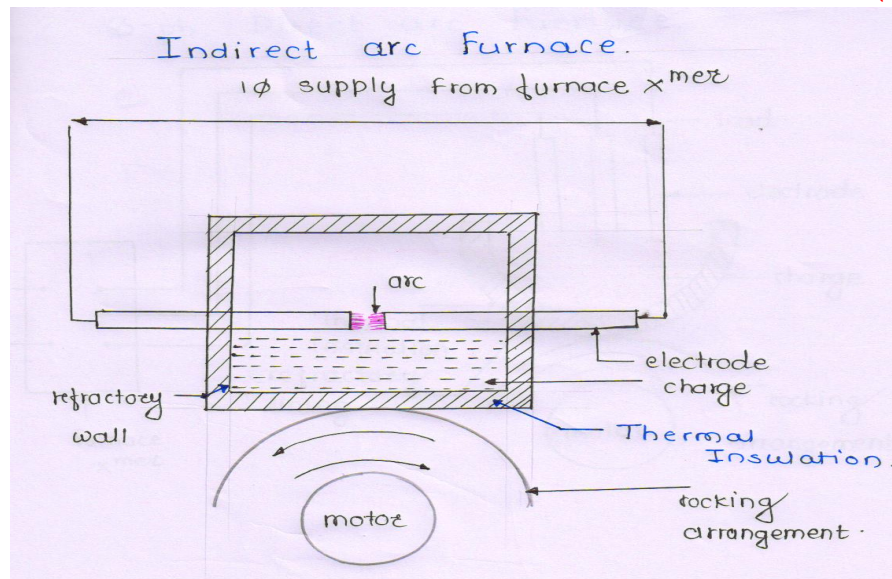
Advantages: (Any Two advantages expected: 1/2 each: total 1 Mark)

1. No carbon particles of electrodes are mixed with molten metal. So we will get more pure casting.

2. Rocking arrangement is compulsory in this type of furnace, due to this

   ➢ Uniform heating is possible.

   ➢ Through mixing of molten metal is possible

   ➢ Life of refractory wall increases.

Disadvantages: (Any Two disadvantages expected: 1/2 each: total 1 Mark)

1. This type of furnace is not build of large capacity, because there is limitation to use

	only two electrodes because of its shape
	2. Initial cost is more because rocking arrangement is compulsory required. (As there is no automatic stirring action taking place in charge just like bottom conducting direct arc furnace.
	3. Due to indirect heating temperature obtained is less.)
	4. Melting time required is more than direct arc furnace
	5. Capacity of furnace is less.
c)	**Give classification of electrical welding.**
Ans:	**(Total 4 Marks)**
	i) Resistance Welding:-
	1) Spot welding
	2) Seam welding
	3) Projection Welding
	4) Butt Welding- i) Simple butt welding
	ii) Flash butt welding
	ii) Arc welding:-
	1) Carbon Arc Welding: a) shielded welding b) unshielded welding
	2) Metal Arc Welding: a) shielded welding b) unshielded welding
d)	**State any four factors to be considered while selecting electrical welding system.**
Ans:	**(Any Four Factors From The Following Or Equivalent Points Are Expected 1Mark To Each Point , Total 4 Marks)**
	Following Factors are considered while selecting of electric welding system:-
	1) Type of Material:-
	Whether similar metal is to be welded or dis-similar metal is to be welded.
	2) Property of Material:-
	Whether ferrous or non-ferrous metal is to be welded.
	3) Thickness of job:-

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.

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.

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.

6)<u>Type of Supply Available</u>:-

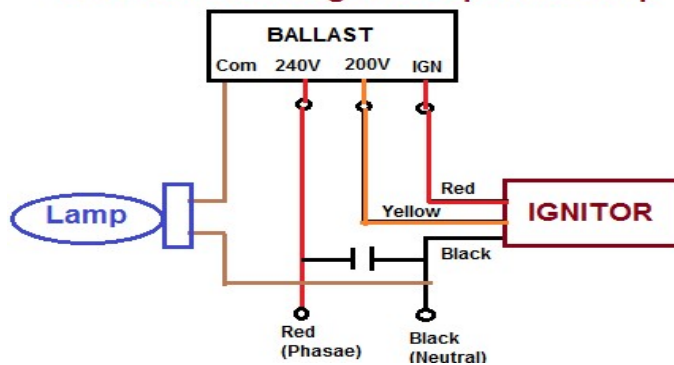Whether AC or DC or both supply are available.

7) <u>Application</u>:-

In case of mass production, resistance welding is used & for repair work Arc welding is used.

e)	**Explain with neat diagram metal halide lamp.**
Ans:	**Diagram metal halide lamp:**

(Diagram: 2 Mark, Construction: 1 Mark & operation: 1 Mark, Total 4 Mark)

or equivalent figure

Construction is similar to mercury lamp.

➢ MH lamps consist of an arc tube (inner) enclosed by an outer tube.
➢ Vacuum is created between the inner & outer glass tube to prevent heat loss.

> The inner arc tube contains the electrodes and various metal halides, along with mercury and inert gases that make up the mix.

> MH lamp has three electrodes – two for maintaining the arc and a third internal starting electrode

> **OR** Pulse-start MH lamps do not have a starting electrode. An igniter in the pulse start system delivers a high voltage pulse (typically 3 to 5 kilovolts) directly across the lamp's operating electrodes to start the lamp

> IT require a ballast to give high voltage at staring to produce the arc

> The capacitor is used to improve the power factor.

Operation:

> When the lamp is turned on, a high voltage at starting is applied across two electrodes, to initiate an arc which discharges and vaporizes argon gas (starting gas), mercury vapor and chemical components called "metal halides"

> The energized metal atoms emit light.

f)	**State any four causes of failure of resistance heating element.**
Ans:	Following of the different causes of failure of resistance heating element:

<p align="center">(**Any Four causes expected: 1 Mark each, Total 4 Marks**)</p>

i) **Formation of hot spo**t:

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 at hot spot.

ii) **Due to oxidization:**

At high temperature material gets oxidized which may cause failure of heating element.

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.

iv) **Mechanical 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.

Q.6	**Attempt any FOUR :**	**16 Marks**
a)	**Derive expression of most economical P.F.**	
Ans:	<u>**Derivation:**</u>	**(4 Mark)**

Let,

P = Active power KW

S_1, S_2 = KVA Maximum demand before and after improving power factor

Q_1, Q_2 = Lagging reactive power before & after improving power factor

Q_C = Leading Reactive power drawn by Capacitor

$\cos\phi_1$ = Initial Power factor

$\cos\phi_2$ = Improved Power factor

Rs X = Tariff charges towards M.D. (KVA) /year

Rs Y = Expenditure towards KVAr to be neutralized per year (Expenditure towards P.F. improving apparatus)

1) <u>Before improving Power factor</u>:

$$Q_1 = P \tan\phi_1$$

$$\cos\phi_1 = \frac{P}{S_1}$$

$$S_1 = \frac{P}{\cos\phi_1}$$

$$\boxed{\therefore \text{KVA}_1 \ (S_1) = \ P \sec\phi_1}$$

2) <u>After improving Power factor</u>**:**

$$Q_2 = P \tan \phi_2$$

$$\cos \phi_2 = \frac{P}{S_2}$$

$$S_2 = \frac{P}{\cos \phi_2}$$

$$\boxed{\therefore KVA_2 \; (S_2) = P \sec \phi_2}$$

3) <u>Saving in KVA charges</u>**:**

$$= Rs \; X \; (S_1 - S_2)$$

$$= Rs \; X \; (P \sec \phi_1 - P \sec \phi_2)$$

$$= Rs \; X \cdot P \; (\sec \phi_1 - \sec \phi_2)$$

4) <u>Expenditure towards KVAr to be neutralized</u>**:**

$$= Rs \; Y \; (Q_1 - Q_2)$$

$$= Rs \; Y \; (P \tan \phi_1 - P \tan \phi_2)$$

$$= Rs \; YxP \; (\tan \phi_1 - \tan \phi_2)$$

5) Net Saving**:**

= Saving in KVA charges - Expenditure towards KVAr to be neutralized.

$$= [Rs \; X \cdot P \; (\sec \phi_1 - \sec \phi_2)] - [Rs \; Y \; (P \tan \phi_1 - P \tan \phi_2)]$$

Saving will be maximum when differentiate above equation with respect to ϕ_2 and equate to zero.

$$\frac{ds}{d\phi_2} = \frac{d}{d\phi_2} \Big[Rs \; X \; P \; (\sec \phi_1 - \sec \phi_2) \Big] - \Big[Rs \; Y \; P \; (\tan \phi_1 - \tan \phi_2) \Big]$$

$$= 0 - \text{X P} \sec\phi_2 \times \tan\phi_2 - 0 + \text{Y P} \sec^2\phi_2$$

$$0 = -\text{Rs X P} \sec\phi_2 . \tan\phi_2 - 0 + \text{Rs Y P} \sec^2\phi_2$$

$$\text{Rs X P} \sec\phi_2 . \tan\phi_2 = \text{Rs Y P} \sec^2\phi_2$$

$$\therefore \text{Rs X} \ \tan\phi_2 = \text{Rs Y} \ \sec\phi_2$$

$$\therefore \text{Rs X} \ \frac{\sin\phi_2}{\text{Cos}\phi_2} = \text{Rs Y} \ \frac{1}{\text{Cos}\phi_2}$$

$$\therefore \text{Rs X} \ \sin\phi_2 = \text{Rs Y} \quad \therefore \ \sin\phi_2 = \text{Rs} \frac{Y}{X}$$

6)

$$\therefore \ \sin^2\phi_2 + \ Cos^2\phi_2 = 1$$

$$Cos^2\phi_2 = 1 - \ \sin^2\phi_2$$

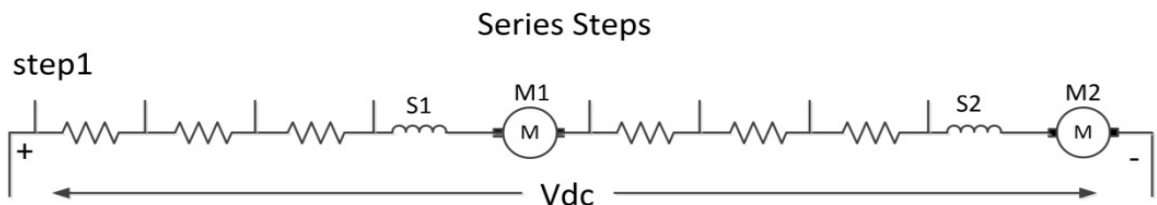> Most economical power factor $= Cos \ \phi_2 = \sqrt{1 - (Y/x)^2}$

Most economical power factor at which maximum saving will occurs

|		
b)	**Draw neat sketches of series parallel control of traction motors.**	
Ans:	**Series steps of traction motor:** **Step 1 –** • Two traction motors M1 and M2 are connected in series and started with all starting resistances in series. • The starting resistances are cut out one by one gradually from step 1 to step 7 and finally two motors are in series without any resistance. • In series connection the supply voltage V is divided in two motors. (Both motors get half or (V/2) volts). So speed is also half. (N/2)	

Voltage across each motor is Vdc/2 and speed is N/2 RPM
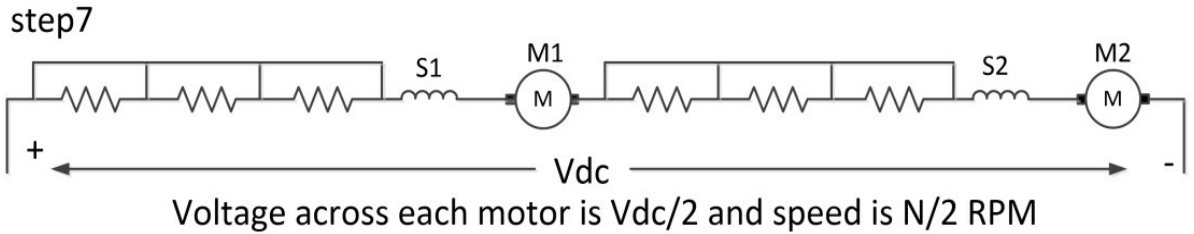
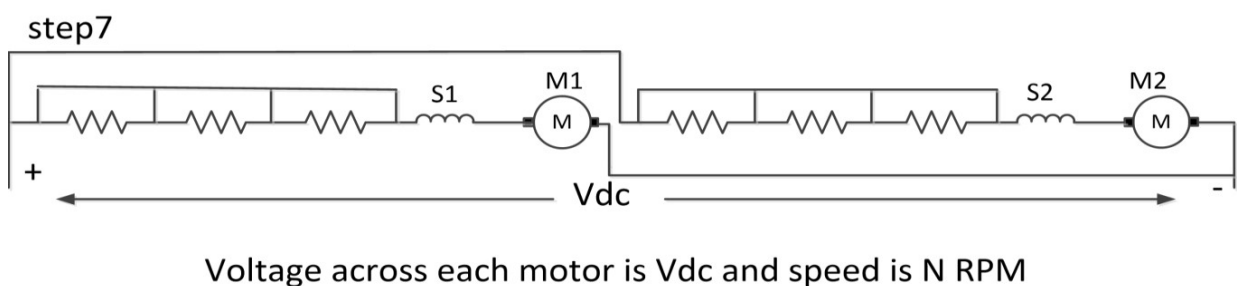## Parallel steps of traction motor:

Step 1 –

➢ After completion of series last step motors are now connected in parallel again with series resistance otherwise motor will draw very high current and may damage itself.
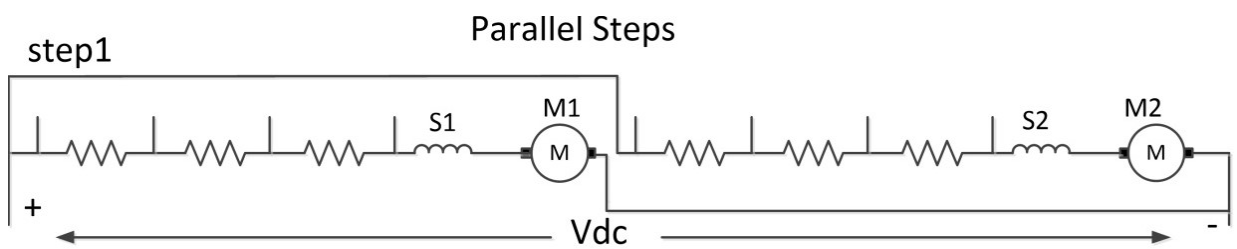
Step 2 to 7 –

➢ Both motors are now connected in complete parallel and starting resistances are cut out one by one 2 To 7

➢ In parallel connection, voltage across M1 and M2 will be full i.e. V (voltage is always same in parallel).

➢ Voltage across each motor = V and speed of each motor = N

➢ So, voltage is now increased from (V/2) to V.

➢ Hence, speed also increases from (N/2) to N and motor runs with full speed.

Voltage across each motor is Vdc and speed is N RPM

c)	**State types of mechanical power transmission system.**
Ans:	**Following types of mechanical power transmission system:-** **(4 Marks)**

i) Direct Transmission Drive: -

There are two types of direct transmission drive,

1) Fixed (rigid) Coupling.

2) Flexible Coupling.

ii) Indirect Transmission drive:-

1. **Belt Drive:-** The leather belt is most economical drive .It is used up to 300HP and slip is 4%

2. **Rope Drive: -** This type of drive is used when power to be transmitted is beyond the scope of belt drive. Slip is very small

3. **Chain Drive: -** It is more expensive than belt and rope drive. But it is more efficient and can be used for greater speed ratio. It is used where no slip is required.

4. **Gear Drive: -** With the help of this drive speed reduction is obtained. (Speed increase is also obtained.)

5. **Vertical Drive: -** In this type of drive motor is arranged vertically.

d)	**State the different methods of temperature control of resistance furnace/oven.**
Ans:	**Following Methods of temperature control of resistance furnace/oven.:** **(4 Marks)**

A) By varying voltage across heating element:

1. With the help of autotransformer.

2. With the help of tap-changing transformer.

3. By use of series impedance or reactance.

4. Bucking and boosting secondary voltage.

5. By use of separate M.G. Set (for large capacity resistance furnace/oven)

6. By series and parallel combination of resistances

B) <u>By varying the value of resistance of heating element:</u>

1. By varying number of heating element.

2. By varying value of resistance by different configuration in circuit

C) By use of thermostat:

---

e) | **A factory has a maximum demand of 250 kW with a load factor of 0.6. The following tariffs are offered: (i) 2 part tariff 70/kW of M.D./year + 4 paise/kWh (ii) A flat rate of 10 paise/kWh. Which tariff is economical ?**

Ans:

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

$= Load\ Factor \times M.D(KW) \times 8760$ ---------------------------- (1/2 Mark)

$= 0.6 \times 250 \times 8760$

$= 1314000\ Kwh$ --(1/2 Mark)

➢ **Case-I: Energy Bill :-**

$= (Tariff\ given\ Rs.\ 70\ of\ M.D.\ /\ year + Rs.\ 4\ paise\ /\ Kwh)$ ------ (1/2 Mark)

$= ((250 \times 70) + (1314000 \times 4/100))$

$= (Rs.\ 17500 + Rs.52560)$

= 70060 Rs. -- (1/2 Mark)

➢ **Case-II: Energy Bill :-**

$= (Tariff\ given\ flat\ rate\ of\ 10\ Paise\ /\ Kwh)$ ------------------------- (1/2 Mark)

$= (1314000 \times 10/100))$

= 131400 Rs. -- (1/2 Mark)

Remark:- ------------------------------- (1 Mark)

Two part tariff will be cheaper i.e. 70/kW of MD/year + 4 paisa/kWh because power consumption is less

OR

➢ According to energy bill Case-I is economical

➢ For industrial consumer Case-I is economical

f)	**State the two functions and types of enclosures provided to machine.**
Ans:	**(Function: 2 Marks & Types: 2 Marks, Total 4 Marks)**

Functions of enclosures as follows:-(Any Two point expected: 1 Mark each, Total : 2 Mark)

1. It protects the operator against the contact with live and moving parts.

2. It provides the protection to internal parts of motor against mechanical injury.

3. It provides the protection against entry of moisture, dirt and dust particles inside the motor.

4. It gives mechanical support.

5. It fold the machine

Types of enclosures and their function: -

(Any Two types expected: 2 Mark each, Total : 4 Mark)

i) Open type enclosure:-

It is used where motor is installed in clean atmosphere and in closed room.

ii) Screen Protected enclosure:- (Guarded enclosure:**)**

Here screen is provided for rotating parts for better protection. It is also used where motor is installed in clean atmosphere and in closed room.

iii) Drip (moisture) proof enclosure:- (Weather-protected type 1 enclosure, Weather-protected type 2 enclosure, Waterproof enclosure,**)**

This type of enclosure is used in very damp atmospheric condition such as water pumping station motor on ship sub-merssible motors, etc.

iv) Flame (Fire) proof enclosure:- (Splash-proof enclosure, Dust-ignition-proof enclosure**)**

It is used where motors are installed in explosive atmosphere like chemical plants, mines etc.

v) Totally enclosed type enclosure:-

It is used where there is dusty atmosphere such as saw mill, stone crushing plant, coal handling plant, cement manufacturing plant, cotton industry etc.

As it is totally enclosed it requires special cooling arrangement.

vi) Pipe ventilated totally enclosed type enclosure(Totally enclosed fan-cooled enclosure, Totally enclosed pipe-ventilated enclosure, Totally enclosed water-cooled enclosure,

Totally enclosed water–air-cooled enclosure, Totally enclosed air–air-cooled enclosure**)**

It is used where there is dusty atmosphere such as saw mill, stone crushing plant, coal handling plant, cement manufacturing plant, cotton industry etc.

As it is totally enclosed it requires pipe ventilation, clean and cold air is circulated through pipe forcefully for cooling of motors and hot air is taken out through pipe.

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