**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.

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**Q.1 a) Attempt any three of the following: ----------12 Marks**

**a) State the advantages of Electric heating. (Any eight advantages expected: 1/2 Mark each)**

**The following advantages of Electric heating**

1. It can be put into service immediately.
2. No standby losses.
3. High efficiency.
4. More economical than other conventional types of heating system.
5. Easy to operate and control.
6. No air pollution.
7. System is clean, as there is no waste produced.
8. No fuel transportation cost.
9. No space is required for storage of fuel and waste.
10. Noiseless operation.
11. Uniform heating is possible, heating at particular point is also possible (spot welding)
12. Dielectric material can be heated.
13. Electrical heating equipments are generally automatic, so it requires low attention and supervision.
14. Protection against overheating can be provided by suitable switch gear.

**b) What is drive? State the advantages and disadvantages of electrical Drive. (Meaning-: 1 Mark, Advantages any four: 1/2 each & Disadvantages any one points expected: 1 each point)**

**Drive:** It is a machine which gives mechanical power. e.g. drives employing electric motors are known as electric drives.

**Following advantages of electric drive:**

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. It is reliable source of drive.
14. Less maintenance cost.
15. It has long life.

**Following disadvantages of electric drive:**

1. It is used only where electricity is available.
2. On failure of supply (electricity) it cannot be used.

**c) List the factors governing selection of electric motor.**

- **Following Factors governing selection of electric drive (Motor):**

**(Any four points are expected-1 Mark each)**

**i) Nature of supply:** Whether supply available is AC, pure DC or rectified DC.

**ii) Nature of Drive (Motor):** Whether motor is used to drive individual machine or group of machines.

**iii) Nature of load:** Whether load required light or heavy starting torque or load having high inertia ,require starting torque for long duration. **OR** Whether load torque increases with speed

(T $\alpha$ N) or decreases with speed (T $\alpha$ 1/N ) **or** remains constant with speed (T = N) or increases with square of speed (T $\alpha$ $N^2$)

**iv) Electric Characteristics of drive:** Starting, running, speed control and braking characteristics of electric drive should be studied and it should be matched with load.

**v) 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.

**vi) Mechanical Considerations:** Types of enclosure, Types of bearing, Transmission of mechanical power, Noise and load equalization etc.

**vii) Cost:** Capital, running and maintenance cost should be less.

**d) State any four requirements of ideal traction system.**

**(Write Any Four points from requirements – 1 Mark to each point)**

**Ideal Traction system should processes following requirement:-**

i) It should have low capital, Running, maintenance cost.

ii) Quick starting time.

iii) It should have high rate of acceleration & retardation.

iv) Highest speeds are possible.

v) Easy speed control method.

vi) Braking system should be reliable.

vii) Absence of unbalance forces i.e coefficient of adhesion should be more.

viii) Centre of gravity should be lower.

ix) Better riding quality (less vibration)

x) Traction system should be clean & long life.

xi) It should be self contained.

xii) No standby losses.(it should possesses high efficiency)

xiii) Regenerative braking should be possible.

**Q.1 b) Attempt any one of the following: ----------06 Marks**

**i) Define the following term: 1) Utilization factor 2) Space to Height ratio 3) Lamp efficiency 4) Solid angle** **(Each Definition : 1.5 Mark)**

**1) Utilization factor:-**

It is defined as the ratio of total lumens reaching on the working plane to the total lumens given out by the lamp.

**2) Space-Height ratio:**

$$Space\ \ height\ ratio = \frac{Space\ \ between\ \ two\ \ lamps}{Height\ \ of\ \ lamps\ \ above\ \ working\ \ plane}$$

**3) Lamp Efficiency:-**

It is defined as the ratio of the total luminous flux emitting from the source to its electrical power input in watts.

**4) Solid angle:-**

The angle subtended at a point in space by an area is called solid angle.

**ii) List the objectives of Tariff and their types**

**Objectives of Tariff: (While calculating tariff following are some objectives)**

**(Any 3 objective expected: 1 Mark for each)**

i) All expenses like interest and depreciation (I &D) i.e recovery of cost of producing electrical energy at the generating station.

ii) Interest & Depreciation on capital investment made on T&D line.

iii) Recovery of cost of operation and maintenance of supply of electrical energy.

iv) T&D losses also considered while calculating tariff.

v) We should also think that electricity cannot be stored (not economically). It has to be consumed as soon as it is generated while calculating tariff.

vi)We should also think about investment required for future expansion.

vii) A reasonable profit should be added while calculating tariff.

**Types of Tariff:-** **(Any three types are expected: 1 Mark each)**

i) Flat-demand Tariff

ii) Simple-demand Tariff or Uniform Tariff

iii) Flat-rate Tariff

iv) Step-rate Tariff

v) Block-rate Tariff

vi) Two-part Tariff:

vii) Maximum demand Tariff

viii) Three-part Tariff

ix) Power factor Tariff :- a) KVA maximum demand Tariff

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

c) KW and KVAR Tariff

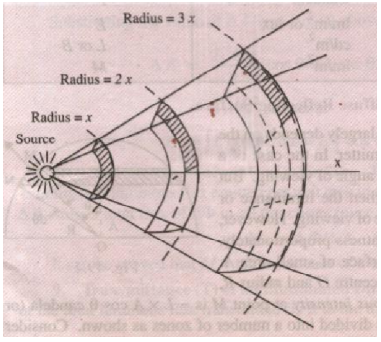
x) TOD (Time of Day) Tariff

**Q.2 Attempt any Four of the following: ----------16 Marks**

**a) State the laws of Illumination.**

**Laws of illumination: -** **(Figure 1 Mark & Statement 1 Mark for each law)**

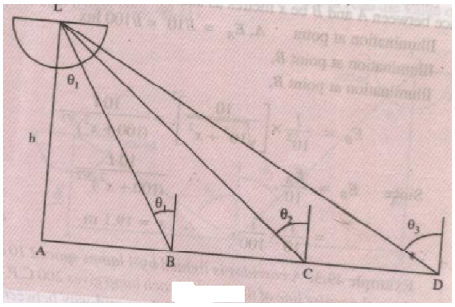
**a) Inverse Square Law :-**




**or Equivalent fig.**

Illumination is inversely proportional to the Square of distance between source and plain of the surface . $E \alpha \frac{1}{r^2}$

**b) Lambert's cosine law :-**




**or Equivalent fig.**

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.

$E_B = E_A \cos^3 \phi_1$ , $E_C = E_A \cos^3 \phi_2$, $E_D = E_A \cos^3 \phi_3$ *and so on.*

**b) Give the classification of Electric heating. (Any four classification expected: 1 Mark each)**

- **The classification of various electric heating methods:**

**1) Power frequency electric heating:**

**i) Resistance heating:**

a) Direct resistance heating

b) Indirect resistance heating

**ii) Arc Heating:**

a) Direct arc heating (furnace)

b) Indirect arc heating

**2) High frequency electric heating:**

**iii) Induction Heating:**

a) Direct core type induction heating (furnace)

b) Vertical core type induction heating or Ajax Wyatt induction heating

c) Indirect core type induction heating

d) Core loss induction heating

**iv) Eddy Current heating furnace**

**v) Dielectric heating**

**c) List the types and essential features of Elevator machines.**

**(Write Any Four points From Types- 2 Mark and for Any Four points From Features – 2 Mark)**

**Types of Elevator Machine:-**

**i) Drum Type :-**

a) Winding Drum
b) Traction Drum
c) Over mounted and under mounted

**ii) Traction Elevator:-**

**OR Student may write following Answer**

**Types of Elevator Machine:-**

i) According to Service :-
   a) Passenger Elevators
   b) Foregut (goods) Elevators
   c) Combination of Elevators
ii) According to Speed of Elevator :-
   d) Low speed Elevator
   e) Medium speed Elevator
   f) High speed Elevator
iii) According to capacity of Elevator :-
   g) Light duty Elevator
   h) Medium duty Elevator
   i) Heavy duty Elevator
   j) Extra Heavy duty Elevator
iv) According to Electric Current :-
   k) Alternating Current Elevator
   l) Direct Current Elevator
v) According to power unit (elevator machine):-
   m) Drum Elevator
   n) Traction Elevator
vi) According to location of power unit :-
   o) Over mounted Elevator
   p) Under mounted Elevator
vii) According to motor drive :-
   q) Gearless drive Elevator
   r) Geared drive Elevator
viii) According to Rope Drive :-
   s) Half wrapped Elevator

t) Full wrapped Elevator

ix) According to control System :-
u) Semi-Magnetic Type
v) Variable voltage type

x) According to basic principle of control :-
w) Variable Voltage control
x) Rheostatic control

xi) According to method of operating control :-
y) Semi-Magnetic Type
z) Full Magnetic Type

xii) According to method of operating elevator :-
a) Manual operation
b) Push button
c) Signal
d) Dual

xiii) According to velocity ratio between motor & car of the elevator:-
e) Direct Drive
f) 2:1 reduction ratio
g) Multi-reduction

xiv) According to method of balancing load :-
h) Counter Balanced type
i) Compensated type

**Features of elevator Machines :- (Write Any Four points From Features)**

i) There must be all safety features.
ii) Sufficient space should be available for car (2 Sqft per person).
iii) There should adequate lighting and provision of fan.
iv) There should be better interior design of the car.
v) Compactable acceleration and retardation to avoid jerk.
vi) Sufficient Speed (feet/minute).
vii) It should have minimum breaking period.
viii) There should be wide-frontage for fast traffic.
ix) It should have sufficient capacity to handle the weight (Average weight 68 Kg per person).
x) There must be provision of back-up, when electric supply get's failure like D.G. sets.

**d) Compare Rheostatic and Regenerative braking.**

**(Write Any Four points – 1 Mark to each point)**

| 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 |

**e) State the factors affecting specific energy consumption.**

- **Factors Affecting Specific Energy Consumption: (Any four factor expected: 1 Mark each)**

**i) Distance between stop:** Greater the distance between two stop less will be the SEC

**ii) Train Resistance:** Lesser the value of train resistance lower will be the SEC.

**iii) Gradient:** Specific energy consumption will be less for level track then up gradient track and for down gradient SEC will be less.

**iv) Variation in track Level:** SEC will more when there is variation in cross and longitudinal level of track than plain level track.

**v) Coasting period:** More the coasting period less will be the SEC.

**vi) Efficiency of equipments:** Greater the efficiency of equipments ($\eta$ of traction motor & $\eta$ of transmission gear) etc. less will be the specific energy consumption.

**d) State the importance and need of energy conservation.**

**The importance of energy conservation: (2 Mark)**

85% of Primary Energy Sources comes from fossil fuel and non-renewable energy sources. In last 200 years we have consumed 60% of all resources. Fossil fuels like coal, oil takes

number of years to form through natural cycle. Because of rise in population, industrialization, change in life style, there is steep rise in energy demand. To meet these demands we have consumed maximum fossil fuel. Hence these fuels are on the verge of depleting soon. Up-till now more than 60% of all sources have been consumed.

Rate of consumption of energy sources is more than that of formation. If rate consumption of energy increase similarly then no sources will be left over for next generation.

**Hence energy conservation is needed as it,** **(2 Mark)**

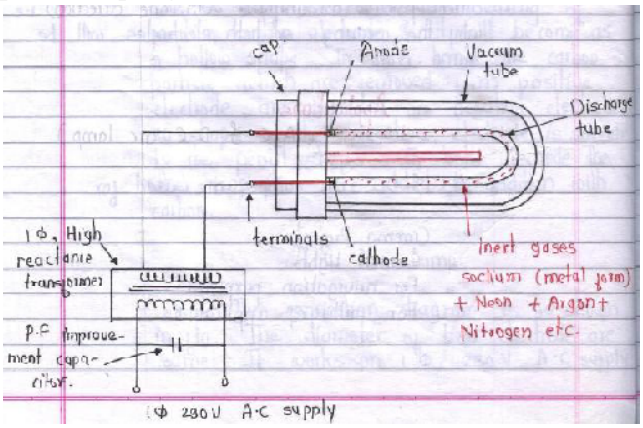
1) Reduces energy demand.
2) Reduces rise in energy cost.
3) Provides economical solution to energy shortages.
4) Increases financial capital.
5) Increases environmental value.

**Q.3 Attempt any Four of the following: ----------16 Marks**

**a) Explain construction and working with neat sketch of sodium vapour lamp.**

**(1 Mark for fig. & 1Mark for construction& 2 Marks for working)**

**Sodium Vapour Lamp Figure:-**




**or equivalent figure**

**Construction:-**

Above figure shows constructional details of sodium vapour lamp. It consists of 'U' shaped tube and at the ends of the tube two electrodes are sealed. This tube is filled with sodium and small quantity of neon gas. Since there is great effect of the change of surrounding temperature

on the light output given by the lamp, hence the inner tube is enclosed in an outer double walled glass tube. Before sealing the lamp vaccum is created between the two glass tube ( inner & outer).

**Working:-**

Before the lamp starts working, the sodium is usually in the solid form deposited on the sides of the inner tube wall. When the voltage is applied to the lamp it warms up and starts vaporizing slowly and radiates out yellow colour light and after about 20 minutes, the lamp starts giving it's full output.

**b) State the causes of failure of heating element.**

**(Any Four Point Expected 1 Mark Each Point)**

**Following of the different causes of failure of heating element:**

**i) Formation of hot spot:**

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:**

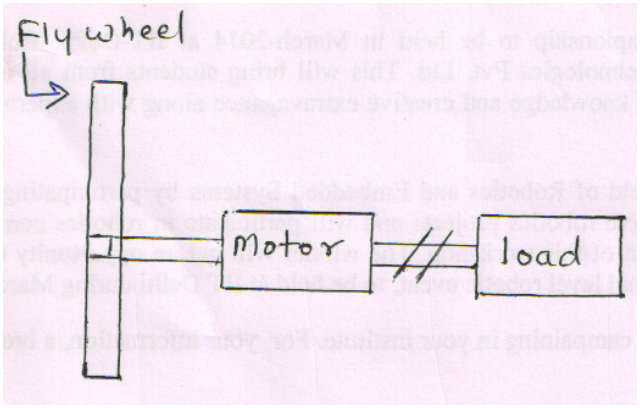
If heating element is directly exposed to chemical fumes then there is possibility of rusting of heating element which causes failure of heating element.

**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.

**c) With neat diagram. Explain the process at load equalization.**

**Diagram of Load Equalization:** **(Figure: 1 Mark & Explanation: 3 Mark)**




**or equivalent fig.**

**Explanation of load equalization:**

There are many types of loads which are fluctuating in nature for such type of loads, load equalization is necessary to draw the constant power from supply.

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 this is sudden heavy load on motor. In this way load demand on supply remains practically constant.

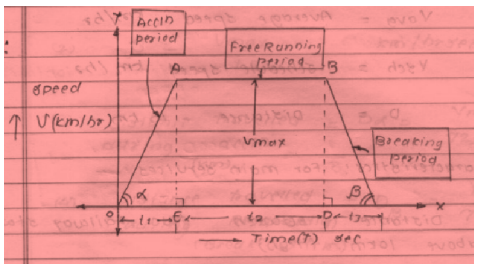
**d) An electric train has an average speed of 42 kmph on a level track between the stops 1400 mtr apart. It is accelerated at 1.7 kmphps and it is braked at 3.3 kmphps. Draw speed time curve and estimate specific energy consumption. Assume tractive resistance as 50 N/tone and allow 10% for rotational inertia.**

**Given Data:-**

D = 1400 M, average speed ($V_{av}$) = 42KM / Hr,

Acceleration ($\alpha$) = 1.7 Km/Hr/sec; Retardation ($\beta$) = 3.3 Km/Hr/sec.

**Speed time curve: -**




**or Equivalent fig.** **(1/2 Mark)**

➢ $V_{av} = \dfrac{3600\ D}{Actual\ Time\ of\ run}$

$\therefore$ $Actual\ Time\ of\ run = \dfrac{3600\ D}{V_{av}}$ , $Actual\ Time\ of\ run = \dfrac{3600 \times 1.4}{42}$

$\therefore$ $Actual\ Time\ of\ run = \dfrac{5040}{42}$

$\therefore$ $Actual\ Time\ of\ run = 120\ x10^3$ sec. ---------- **(1/2 Mark)**

➢ Maximum Speed =

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

But, $K = \dfrac{\alpha + \beta}{2(\alpha \times \beta)}$

$K = \dfrac{1.7 + 3.3}{2(1.7 \times 3.3)}$

$K = 0.4456$---------- ( **1/2 Mark)**

Now, $V_{max} = \dfrac{T - \sqrt{T^2 - 4K3600D}}{2K}$

$V_{max} = \dfrac{120 - \sqrt{120^2 - 4 \times 0.4456 \times 3600 \times 1.4}}{2 \times 0.4456}$

$V_{max} = 52.066$ kmph ----------Answer---------- **( 1/2 Mark)**

➢ Period during Acceleration ($t_1$) =

$\alpha = \dfrac{V_{max}}{t_1}$ $\therefore t_1 = \dfrac{52.066}{1.7}$

$t_1 = 30.6275$sec----------Answer---------- **( 1/2 Mark)**

➢ Breaking period ( $t_3$) =

$$\beta = \frac{V_{max}}{t_3} \qquad t_3 = \frac{V_{max}}{\beta}$$

$$t_3 = \frac{52.066}{3.3}$$

$t_3 = 15.7775$ sec----------Answer-------- **( 1/2 Mark)**

**The distance travelled during braking:**

$$= \frac{1}{2} \times V_m \times \frac{t_3}{3600}$$

$$= \frac{1}{2} \times 52.066 \times \frac{15.777}{3600}$$

$$= 0.11408\ km$$

$$D_1 = D - 0.11408$$

$$D_1 = 1.4 - 0.11408$$

$$D_1 = 1.28592\ \text{km}$$

Tractive resistance r = 50 N/ton, $= \frac{W_e}{W} = 1.1$

**The energy consumption at the axle of the train per ton-km:**

$$= \frac{0.01072\, V_m^2}{D} \times \frac{W_e}{W} + 0.2778 r \frac{D_1}{D}$$

$$= \frac{0.01072 \times (52.066)^2}{1.4} \times 1.1 + 0.2778 \times 50 \frac{1.285}{1.4}$$

$$= 20.757 + 12.737$$

$= 35.57\ W - hr$ ---------- **(1/2 Mark)**

**e) State any three drawbacks of low p.f. and state methods to improve it.**

**(Any Two Drawbacks Expected 1 Mark Each & Method 2 Mark)**

**Drawbacks of Low power Factor: -**

**1) Cross section of conductor increases: -** (C/s of conductor $\alpha\ I\ \alpha 1/(pf)$ OR As power factor reduces current increases, cross section of conductor increases. Hence its cost increases.

2) **Design of supporting structure: -** As power factor reduces, cross section of conductor increases, so its weight increases. To handle this weight design of supporting structure becomes heavier, so its cost increases.

3) **Cross section of terminals increases: -** As power factor reduces, current increases, Hence cross section of switch gear, bus bar, contacts, and terminals increases. So its cost increases.

4) **Copper losses increases: -** (copper losses $\alpha\ I^2\ \alpha\ 1/pf$ ) OR As power factor reduces current increases. So copper losses increases. As a effect efficiency reduces.

5) **Voltage drop increases: -** (*Voltage drop* $\alpha\ I\ \alpha 1/pf$ ) OR As P.f reduces current increases. Therefore voltage drop increases, so regulation becomes poor.

6) **Handling Capacity of equipment reduces:** Handling capacity (KW) of each equipment reduces as power factor reduces.

7) **High KVA rating of equipment required:-** $KVA\ \alpha\ I\ \alpha\ 1/pf$ , OR As power factor decreases KVA rating of all equipments increases, so that its cost increases.

8) **Cost/unit increases: -** From all above disadvantages it is seen that cost of generation, transmission & distribution increases. Also its performance efficiency & regulation reduces, So that cost/unit increases.

**Methods of improving power factor:-**

1) By use of static capacitor (Condenser)
2) By use of over excited synchronous motor (Synchronous condenser)
3) By use of over excited Schrage motor
4) By use of phase advancer.

**OR**

**Methods of improving power factor:-**

1) Use Dc supply for transmission & Distribution of AC supply:- As far as possible Dc drives are used instead of AC drives by some arrangement (using rectifier)

2) Use overexcited Synchronous motor and Schrage motor to get mechanical power instead of induction motor.
3) Use high speed I.M instead of low speed I.M because P.f. of high speed motor is more than low speed motor as it draws less $I_u$.
4) Air gap between Stator and rotor should be kept as minimum as possible. Due to this, leakage flux reduces. So motor will draw less Iu, So its P.f. gets improved.
5) All electrical equipments such as Alternator, transformer, motor has maximum Power factor. When fully loaded, so select the rating of all electrical equipments such that it always operated at full load.
6) Switch I.M delta winding to Star winding, when load on motor reduces (50% of full load) to increase the power factor.
7) All equipments such has transformer, alternator, motor if needed to repair or maintenance, then it should be repaired properly to avoid low power factor. i.e it should be repaired from authorized companies servicing centre.

**Q.4 a) Attempt any three of the following: ----------12 Marks**

**i) Explain the principle of resistance welding.** **(4 Marks)**

**Working principle of resistance welding:**

In resistance welding, sufficiently heavy current at low voltage is passed directly through two metals in contact to be welded. Heat is produced due to $I^2R$ losses where 'R' is the contact resistance. The 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.

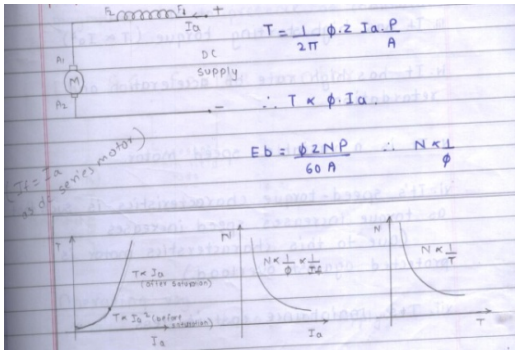
**ii) Compare AC & DC System Traction. (Write Any Eight points – 1/2 Mark to each point)**

| S.No | Points | AC System Traction | DC System Traction |
|---|---|---|---|
| 1 | Supply given to O/H condition | 1-ph, 25KV, AC 25 Hz | 600/750V-Tromways 1500/300V 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 then a.c series motor |
| 4 | Starting torque accl$^{n}$ and retardation | Less starting torque | High starting torque |
| 5 | Accl$^{n}$ and retardation | Less than d.c series motor | High |
| 6 | Overhead 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 | Regenerative braking | Easy | Difficult |
| 11 | Ridding quality | Less better than d.c | Smooth (Better) |
| 12 | Insulation cost | High | Low |
| 13 | Cross section of conductor | Less | More |
| 14 | Design of supporting structure | light | Heavy |
| 15 | Distance between two substation | More | Less |
| 16 | No.of substation required | Less | More |
| 17 | Size (capacity) of traction substation | More | Less |
| 18 | Capital & maintenance cost of substation | Less | More |
| 19 | Cost track electrification | Less | More |
| 20 | Electrolysis trouble | No | Yes, if ground is used as return path |
| 21 | Applications | Main line services | Urban and suburban area |

**iii) Explain suitability of DC series motor for traction.**

**(Any Four Point Expected 1 Mark Each Point)**

**Due to following characteristics and advantages of DC series motor it is suitable for traction duty: 1) Characteristics**




**or Equivalent fig.**

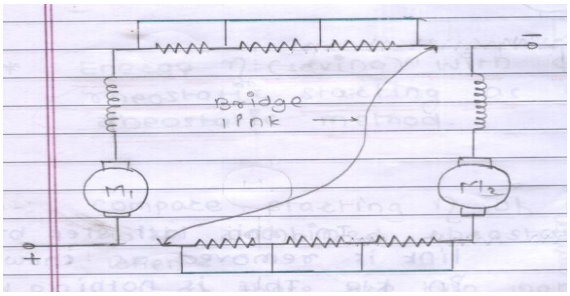
**Due to above characteristics shown on figure DC series Motor is suitable for traction purpose.**

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 increases. (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.

**iv) Sketch various steps required for Bridge Transition system** **(Each Step 1 Marks)**

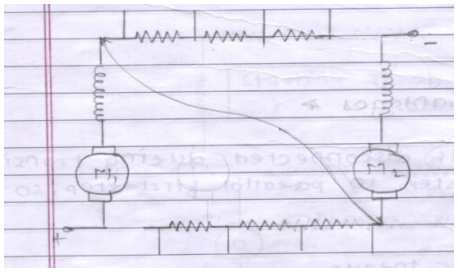
**In bridge transition, series last step to parallel first step, is carried out by following steps**

**Step i) -** Bridge link is connected between two motors as shown in figure**.**



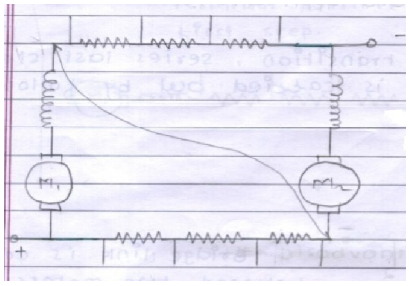

**or Equivalent fig.**

**Step ii) -** Bridge link is so rotated that two motors are put in series without starting resistance. Which are un-shorted at the same time



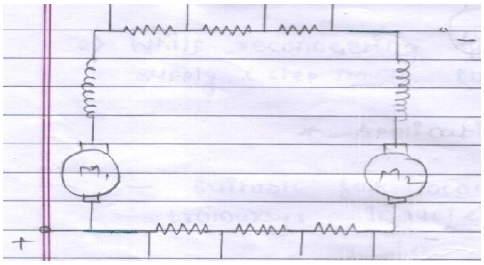
**or Equivalent fig**.

**Step iii) –** The portion of external resistance are connected in each motor circuit as shown in fig.



**or Equivalent fig.**

**Step iv) –** In this last step bridge link is removed as shown in fig. This is the parallel first step.



**or Equivalent fig.**

**Q.4 b) Attempt any One of the following: ----------06 Marks**

**i) State and explain the factors to be considered while designing lighting scheme.**

**(Any six points are expected-1 Mark each)**

**Design considerations for interior illumination:**

1. Visit to corresponding site and make the proper survey of every room and its interior applications. Measure the dimensions of every room (length, width, height). Make the proper plan layout with proper isometric view.
2. Find out application and working plane of every room.
3. As per the illumination standard decide proper lux level on that particular working plane.
4. As per quality of civil work and surrounding conditions and colour of walls and ceiling decide waste light factor, utilization factor, depreciation factor etc.
5. Find out total lumens required on working plane.

$$\text{Total lumens required on working plane} = \frac{AIW}{CD}$$

6. Decide the type and wattage of lamp which is to be used for that particular application
7. Assume the proper illumination efficiency of those specific lamps which are to be used on that working plane
8. Find out total no. of lamps and tubes for that particular working plane and after that find out total no. of lamps & tubes or any other lamps for interior application of commercial installation. By assuming proper space to height ratio make the proper illumination scheme. This procedure is repeated for every working plane in every room.
9. Find out total no. of lamps or tubes for that particular working plane

$$Number\ of\ Lamps\ \ required = \frac{Total\ \ Lumens\ \ \text{Re}quired}{Wattage\ of\ \ each\ \ lamp\ \ \%\eta\ of\ each\ \ lamp}$$

10. Find out total power consumption of all interior applications for calculated lamps and tubes.
11. Find out the rated current for all applications.

If 1Ph, 230V supply is provided, $P = VI\cos\phi$

If 3ph, 400V supply is provided, $P = \sqrt{3}\ VI\cos\phi$

12. Determine size of wire or cable required for whole residential or commercial installation.

The size of wire is decided by the starting current, which is 1.5 times rated current, for momentary overload S.C. future expansion and starting surge.

**OR Student may write this way**

i) **Comfortable: -** The energy illumination scheme should be comfortable to everybody.

ii) **Pleasant surrounding**: By the electrical lighting or the electrical illumination scheme the surrounding area of that location should be pleasant.

iii) **Long Life: -** The life of the designed illumination should be larger.

iv) **Economy: -** The cost of the designed illumination scheme should be low.

v) **Less maintenance: -** For any type of illumination scheme the maintenance & repairing should be less.

vi) **Appearance: -** The appearance of illumination scheme should be good.

vii) **Less glares: -** The glare is fatigue to the human eyes. The illumination scheme is designed is such a way that there should be less glare to everyone i.e. Only electrical & mechanical accidents will be less.

viii) **Less Flickers: -** This flicker should be always less for any type of illumination scheme.

ix) **To avoid hard Shadows: -** The whole illumination scheme is designing for minimum shadows. At the time of flood light the hard shadows are avoided.

x) **Sufficient lux Level: -** The lux level is decided by the type of application, type of location.

xi) **Cleanliness: -** The illumination scheme should be free from any type of ash, smoke or any other air pollution it should be clean.

xii) **Simple Control: -** The illumination scheme designed by the electrical lighting is very simple. The control, multicolour light intensity control is also possible in electrical illumination.

**OR Student also may be write this way**

1) Level of illumination or degree of illumination.
2) Glare
3) Shadows
4) Colour rendering

5) Lamps fittings

6) Maintenance

**1) Level of illumination or degree of illumination**:

It depends on nature of work to be carry out. The degree of level of illumination also depends on following factors.

i) The size of object & its distance from observer.

ii) If object is moving higher level of illumination is required than stationary object.

iii) If the objects are required to be seen for long duration of time, higher level of illumination is necessary & for stair cases, corridors less illumination is required.

**2) Glare**:

The glare causes unnecessary eye fatigue so it must be avoided, it can be prevented by using diffusing glass screen, suitable reflectors & proper mounting height. Reflected glare from the polished surfaces within the line of vision should be avoided.

**3) Shadows**:

The formation of long and hard shadows must be avoided. The long and hard shadows cause accident. Such shadows can be avoided by

i) Using proper mounting height of the lamps. ii) Using more number of lamps & providing indirect lighting.iii) Employing wide surface sources of light.

Complete absence of shadows is again not recommended as soft shadows are required to identify three dimensional objects.

**4) color rendering**:

This refers to the ability of the light source to reproduce the original colour of the objects when the object is illuminated by that source.

**5) Lamp fittings**:

The lamp fittings serve the following functions in good illumination scheme.

i) To diffuse the light ii) To cut off the light at certain angle to avoid glare iii) To give mechanical protection to light source. iv) To increase the aesthetical requirement of the premises. V) To control the level of light (control gear)

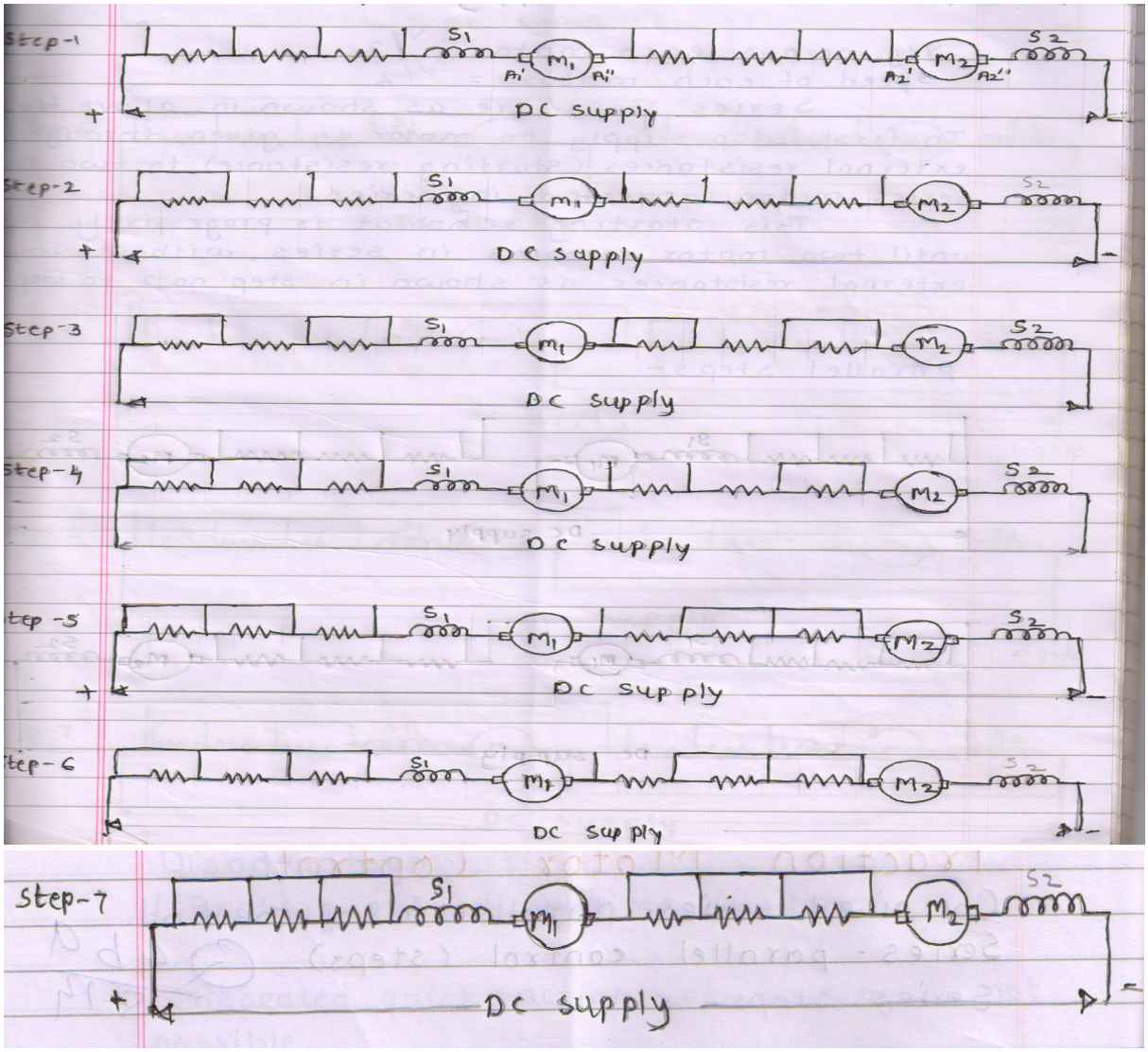
**6) Maintenance**:

Regular cleaning of lamps & light fittings is necessary to maintain their efficiency. The maintenance is necessary against dust, water leakage, dangerous gases which may cause corrosion of light fittings. Hence light fittings should be simple & easy from maintenance point of view.

**ii) Explain with neat sketches series parallel control of traction motor.**

**With neat sketches series control of traction motor:** **(3 Mark)**

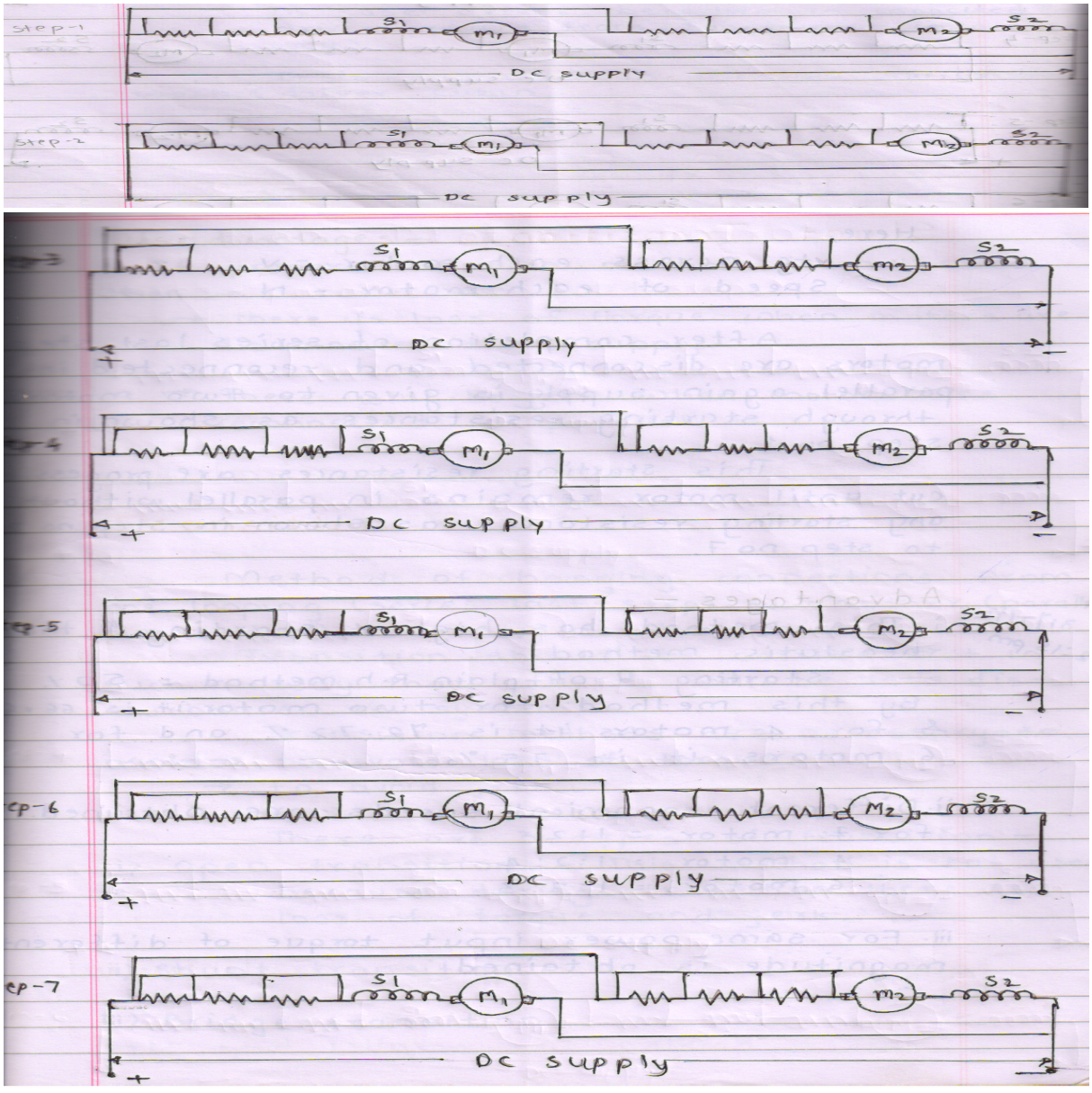
- Voltage across each motor = V/2 and speed of each motor = N/2
- Series steps are shown as below figure; In first step supply to motor is given through external resistances, (starting resistance) to two DC series motor connected in series.
- This starting rheostat is progressively cut until two motor remains in series, without any external resistances as shown in step no.2




**or equivalent figure**

**With neat sketches parallel control of traction motor:** **(3 Mark)**

- Voltage across each motor = V and speed of each motor = N
- After completion of series last step motors are disconnected and reconnected in parallel again supply is given to two motors through starting resistance as shown in step No.1
- This starting resistances are progressively cut until two motor remains in parallel without any starting resistances as shown in step no.2 to step No.7



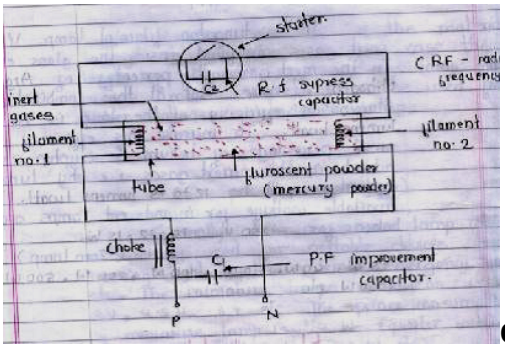

**or equivalent figure**

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

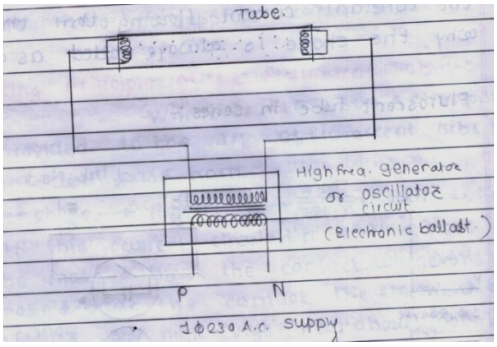
**a) Explain with neat sketch working of Fluorescent tube.**

**(Working- 2 Mark & Figure-2 Mark)**

**Figure of fluorescent lamp:-**




**OR**




**Construction:-**

Fluorescent tube consists of tube, choke, starter & power factor improvement capacitor.

**Operation:-**

When switch is ON current flows through the choke-filament no1- starter-filament no. 2- to neutral, At that time choke induces high voltage which is applied to two filaments and ionized gas, Due to this there will be high voltage ionization so that light will be emitted through the tube. Choke is acting as ballast starter is used for make and break the circuit. To operate the fluorescent lamp, need a ballast (choke) to limit the current & provide the necessary starting voltage and starter for starting the tube.

**b) List the factors deciding selection of electric welding system.**

**(Any four Factors are expected: 1 Mark each)**

**Following Factors are considered while selecting of electric welding system**

**i) Type of Material:-**

Similar metal is to be welded or dis-similar metal is to be welded.

**ii) Property of Material:-**

Weather ferrous or non-ferrous metal is to be welded.

**iii) 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.

**iv) Temperature required:-**

Weather 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.

**v) Pressure required:-**

If job is needed pressure at the time of welding in that case resistance welding is used. and if pressure is not required Arc welding is used.

**vi) Type of Supply Available:-**

Weather AC or DC or both supply are available .When both supply are available AC is used because it has more advantages than DC.

**vii) Type of Application:-**

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

**c) Which factors are to be considered to choose size and shape of elevator car? (4 Mark)**

**The size and shape of elevator car depends are following two 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.fit/ 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

**d) List out the types of enclosures of electric motor with their function.**

**Types of enclosures:-** **(Any Four Types expected : 1/2 Mark each)**

i) Open type enclosure.
ii) Screen protected enclosure.
iii) Drip proof.(moisture) enclosure.
iv) Flame (Fire) proof enclosure.
v) Totally enclosed type enclosure.
vi) Pipe ventilated totally enclosed type enclosure.

**Functions of enclosures as follows;-** **(2 Mark)**

i) It protects the operator against the contact with live and moving parts.
ii) It provides the protection to internal parts of motor against mechanical injury.
iii) It provides the protection against entry of moisture, dirt, dust particles inside the motor.
iv) It gives mechanical support.
v) Main purpose of enclosure is to fold the motor.

**e) Explain two advantages and disadvantages of 25 KV AC systems over DC system.**

**Advantages of 25 KV AC System :-** **(Any two advantages expected, 1 Mark for each)**

i) As system voltage is high (25KV) as compared to DC supply system (3000V) so current drawn by overhead conductor is less because. ( $I \alpha 1/V$ )
ii) Due to low current cross section of overhead conductor reduces. So its weight reduces.
iii) As weight of overhead conductor reduces design of supporting structure becomes lighter.
iv) Due to low current copper losses in transmission line reduces, so transmission efficiency increases.
v) Due to low current voltage drop in transmission line decreases. Due to this distance between two substation increases. So number of substation required is less than DC track electrification system for same track distance. eg.

| S.No. | Voltage level | Distance between 2 substation |
|---|---|---|
| 1 | 1-ph AC, 25KV | 50 to 80 KM |
| 2 | 3000V DC | 12 to 30 KM |
| 3 | 1500V DC | 5 to 12 KM |
| 4 | 750/600V DC | 2 to 5 KM |

vi) Due to low current size (capacity) of AC substation is more than DC substation. So number of substation required is less than DC track electrification system for same track distance.

| S.No. | Supply System | Size of Substation |
|---|---|---|
| 1 | 1-ph AC, 25KV | 10 to 15 MW |
| 2 | 3000V DC | 2 to 6 MW |

vii) Due to all above advantages cost of track electrification less as compared to DC track electrification system.

viii) Characteristics of 1-Ph AC series motor such as high starting torque, variable speed are suitable for traction purpose.

ix) Starting efficiency is high in case of AC supply system as voltage is reduced with the help of transformer.

**Disadvantages of 25KV AC System:** **(Any 2 disadvantages expected: 1 Mark each)**

**i)** As system voltage is high as compared to DC supply system so its insulation cost is more.

**ii)** Torque obtained by 1-Ph AC series motor is not uniform like DC series motor because of presence of frequency. So it affects riding quality.

**iii)** In this supply system 1-Ph series motor is used to obtain necessary torque. But AC series motor is less superior than DC series motor for traction purpose. Because AC series motor has less starting torque, acceleration and retardation than DC series motor. (because of power factor)

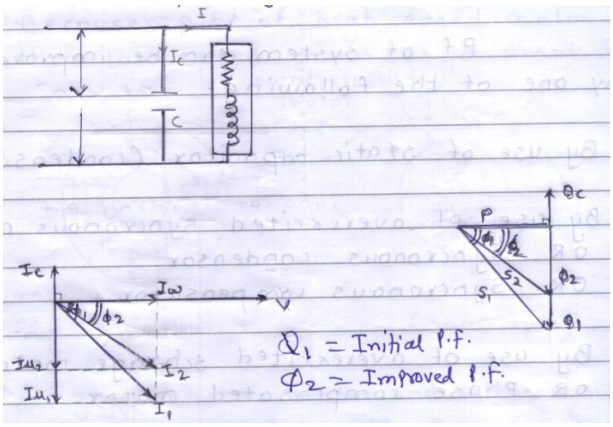
**iv)** Weight of 1-Ph AC Series motor is 1.5 times greater than weight of DC series motor for same HP, so it affects pay load capacity.

**v)** Maintenance cost of 1-Ph AC series motor is more than DC series motor.

**vi)** Its overload capacity is less than DC series motor.

**f) Explain briefly the static capacitor method of power factor improvement.**

**(1 Marks for any one figure, Vector diagram 1 Mark, Formula 1 Mark & advantages & disadvantages (Any Two) – 1 Mark)**




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

Calculation from current vector diagram: $I_w = I \times Cos\phi_1$

$$I_C = I\mu_1 - I\mu_2 \quad \therefore I_C = [I\mu_1 \tan\phi_1] - [I\mu_2 \tan\phi 2]$$

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

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

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

Calculation from power triangle = $Q_C = Q_1 - Q_2$

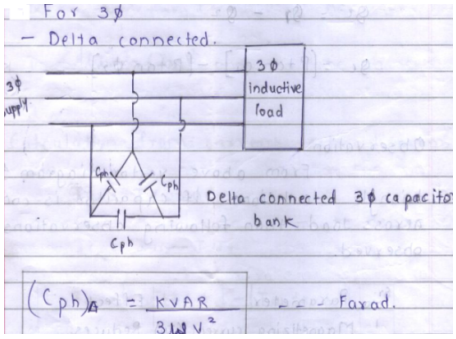
$$Q_C = [P \tan\phi_1] - [P \tan\phi_2] \text{ KVAr rating of capacitor}$$

**Observation:**

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

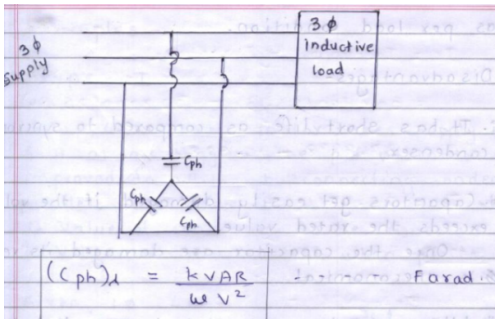
| S.No. | Parameter | Effect |
|---|---|---|
| 1 | Magnetizing current ( $I\mu$ ) | Reduces |
| 2 | Power factor | Improves |
| 5 | Total current | Reduces |
| 4 | Lagging reactive power (KVAr) | Reduces |

- **Connection diagram to connect capacitor to improve power factor (Delta connection)**




$\omega = 2\pi f$

- **3-ph Star connected Capacitor Bank:**




- **Advantages of Static Capacitor: (Expected any two)**
  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 two)**
  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.

**Q.6 Attempt any Four of the following: ----------16 Marks**

**a) State any eight advantages of coreless Induction furnace. (Any Eight: 1/2 Mark each)**

**Following are the advantages of coreless induction furnace:**

1. As there is no magnetic core weight & size of furnace reduces.
2. Low erection cost.
3. Crucible of any shape can be used.
4. Both conducting and non conducting charge can be heated.
5. Due to high frequency, high voltage supply, time required for heating is less.
6. Temperature of charge can be controlled accurately by controlling frequency.
7. Pouring arrangement is simple.
8. Intermittent operation of furnace is possible.
9. Furnace operation is free from smoke, dust, noise etc.

**b) State various applications of Dielectric Heating.**

**(3 Marks for first four points & 1/2 Mark to each next two point -total 4 Marks)**

**Application of Dielectric Heating:-**

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 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 process.

**c) Discuss Merits and Demerits of group Drive.**

**Following merits of group drive:** **(Any four merits expected: 1/2 each)**

1. **Initial cost :**

   A cost of single motor of large capacity is less tha n cost of number of small motor for same HP. For e.g cost of 10 HP motor is much less than that of the 10 motor of 1HP

2. **Diversification of load:**

   All the machine and tool may not work at a time. So we can select main motor of slightly small capacity (HP) then the total requirements of individual machines. For e.g. we can select 7.5 HP motor instead of 10 HP by considering diversity factor

Due to this there is reduction in initial cost of motor also electricity charges/HP are reduced.

3. **Overload capacity:**

   It has higher overload capacity. For e.g. 100% overload on individual machine would cause only 8 to 10% overload on main motor.

4. **Space required:** Less
5. **Maintenance cost:**

   Maintenance cost of single motor of large capacity is less than maintenance cost of number of small motors of total HP. For e.g. maintenance cost of 10 HP motor is much less than that of maintenance cost of 10 motor of 1 HP

6. **Efficiency and power factor:**

   If group drive is run at nearly equal to full load then efficiency and power factor of group drive will be higher.

**Following demerits of group drive:** **(Any four merits 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 machine operations are required to be shut down

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/Alternation:**

   Possibility of addition or alternative in existing system is limited.

7. **Efficiency and power factor:**

   If group drive is operated at reduced load then its efficiency and power factor will be less.

**d) How does the value of acceleration and retardation affect the specific energy consumption for a given run at a given schedule speed?** **(4 Mark)**

By increasing the value of acceleration and retardation the specific energy consumption for a given run at a given schedule speed decreases. Since coasting period increases.

**OR**

Retardation and acceleration values-- For given schedule speed, greater the value of acceleration and retardation, more will be the period of costing and therefore, less the period during which power is on. Hence distance will be small and therefore, specific energy consumption will accordingly be less.

**e) State and explain two types of Tariff's suitable for industrial consumers.**

**Types of Tariff:-** **(Any two types are expected: 1 Mark each)**

i) Maximum demand Tariff

ii) Power factor Tariff :- a) KVA maximum demand Tariff

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

c) KW and KVAR Tariff

iii) TOD (Time of Day) Tariff

**Suitable Tariff for Industrial Consumer:** **(Any two Explanation Expected: 1 Mark each)**

**i) 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.

**ii) 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. declared by Supply Company (say below 0.92 lag.) than penalty will be charged in energy bill.

- If The P.F. of consumer is more than P.F. declared by Supply Company (say above 0 .96 lag) than discount will be given in energy bill.

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

- TOD energy meter is installed in the HT consumer premises.
- If the P.F. of consumer is less than P.F. declared by Supply Company (say below 0 .92 lag) then penalty will be charged in energy bill.
- 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 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.