CMR
INSTITUTE OF
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Internal Assesment Test - II

Sub:	Utilization of Electrical Power							Code:	15EE742
Date:	15/10/2018	Duration:	90 mins	Max Marks:	50	Sem:	7	Branch:	EEE
Answer Any FIVE FULL Questions									

		Marks	OBE CO	OBE RBT
1	Explian the construction and working of Flurosent Lamp with neat circuit diagram.	[10]	CO2	L3
2	It is desired to illuminate a drawing hall with an average illumination of 250 lux. The area of the hall is 30mX20m. The lamps are fitted at 5m height. Find out the number and size of incandesent lamps required for an effiency of 12 lumens/watt. Utilization fator = 0.4 and maintenance factor =0.85	[10]	CO2	L4
3	Estimate the number and wattage of lamps which would be required to illuminate a workshop space 60mX15m by means of lamps mounted 5 meters above the working plane. The average illumination required is 100lux. Co-efficient of Utilization =0.42,Manitenance factor =0.8, Luminous efficiency =16lumens/watt; space height ratio = unity	[10]	CO2	L4
4	Explian the construction and working of Neon Lamp with neat circuit diagram.	[10]	CO2	L3
5	Assuming trapezoidal speed – time curve of a train derive the equation for the distance covered between two stops and hence obtain the equation for maximum speed.	[10]	CO3	L3
6	With neat sketch briefly explain the various types of system in track electrification.	[10]	CO3	L3
7a	Compare the various aspects of AC and DC Electric traction System.	[5]	CO3	L2
7b	With circuit diagram explain the series parallel speed control of DC series traction motor.	[5]	CO3	L2
8	Sub urban trains run with an average speed of 36kmph between two stations 1.8km apart. Values of acceleration and retardation are 1.8km/h/s and 3.6 km/h/s. Calculate the maximum speed of the train assuming trapezoidal speed –time curve.	[10]	CO3	L3

Answer Key

1.

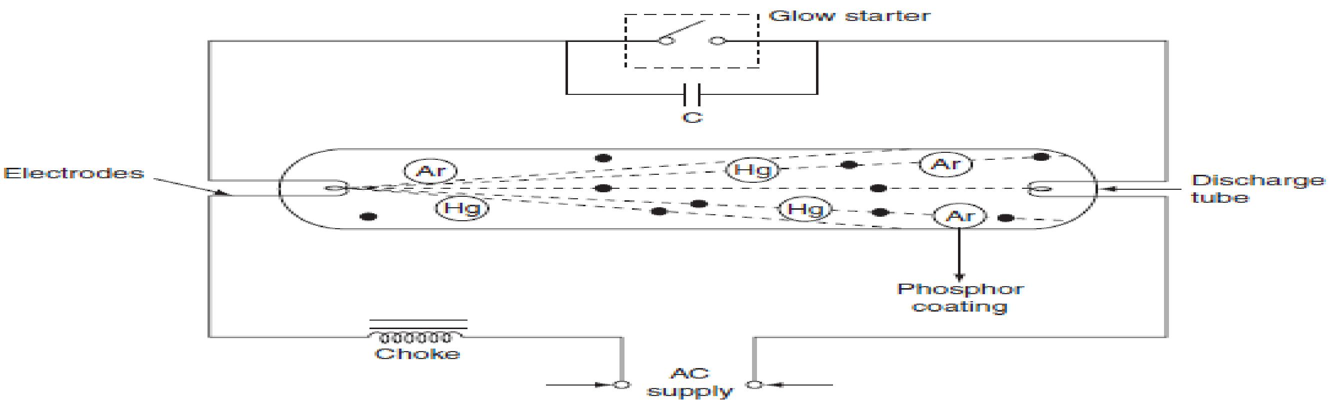
Fluorescent lamp is a hot cathode low-pressure mercury vapor lamp; the construction and working of the fluorescent lamp are explained as follows.

Construction

It consists of a long horizontal tube, due to low pressure maintained inside of the bulb; it is made in the form of a long tube.

The tube consists of two spiral tungsten electrode coated with electron emissive material and are placed at the two edges of long tube. The tube contains small quantity of argon gas and certain amount of mercury, at a pressure of 2.5 mm of mercury. The construction of fluorescent lamp is shown in Fig. 7.12. Normally, low-pressure mercury vapor lamps suffer from low efficiency and they produce an objectionable colored light. Such drawback is overcome by coating the inside of the tube with fluorescent powders. They are in the form of solids, which are usually knows as phosphors.

A glow starter switch contains small quantity of argon gas, having a small cathode glow lamp with bimetallic strip is connected in series with the electrodes, which puts the electrodes directly across the supply at the time of starting. A choke is connected in series that acts as ballast when the lamp is running, and it provides a voltage impulse for starting. A capacitor of 4μF is connected across the starter in order to improve the power factor.



Working

At the time of starting, when both the lamp and the glow starters are cold, the mercury is in the form of globules. When supply is switched on, the glow starter terminals are open circuited and full supply voltage appeared across these terminals, due to low resistance of electrodes and choke coil. The small quantity of argon gas gets ionized, which establishes an arc with a starting glow. This glow warms up the bimetallic strip thus glow starts gets short circuited. Hence, the two electrodes come in series and are connected across the supply voltage. Now, the two electrodes get heated and start emitting electrons due to the flow of current through them. These electrons collide with the argon atoms present in the long tube discharge that takes place through the argon gas. So, in the beginning, the lamp starts conduction with argon gas as the temperature increases, the mercury changes into vapor form and takes over the conduction of current.

In the mean time, the starter potential reaches to zero and the bimetallic strip gets cooling down. As a result, the starter terminals will open. This results breaking of the series circuit. A very high voltage around 1,000 V is induced, because of the sudden opening of starter terminals in the series circuit. But in the long tube, electrons are already present; this induced voltage is quite sufficient to break down the long gap. Thus, more number of electrons collide with argon and mercury vapor atoms. The excited atom of mercury gives UV radiation, which will not fall in the visible region. Meanwhile, these UV rays are made to strike phosphor material; it causes the re-emission of light of different wavelengths producing illumination. The phenomenon of the emission is called as *luminescence.*

Advantages of fluorescent lamp

The fluorescent lamp has the following advantages:

- High efficiency.
- The life of the lamp is three times of the ordinary filament lamp.
- The quality of the light obtained is much superior.
- Less chances of glare.
- These lamps can be mounted on low ceiling, where other light sources would be unsatisfactory.

--[10 Marks]

2.

Solution. *Given* : $E = 250$ lux ; $A = 30 \times 20 = 600\ m^2$; $UF = 0.4$; $MF = 0.85$

Gross lumens required $= \dfrac{E \times A}{UF \times MF} = \dfrac{250 \times 600}{0.4 \times 0.85} = 441176$

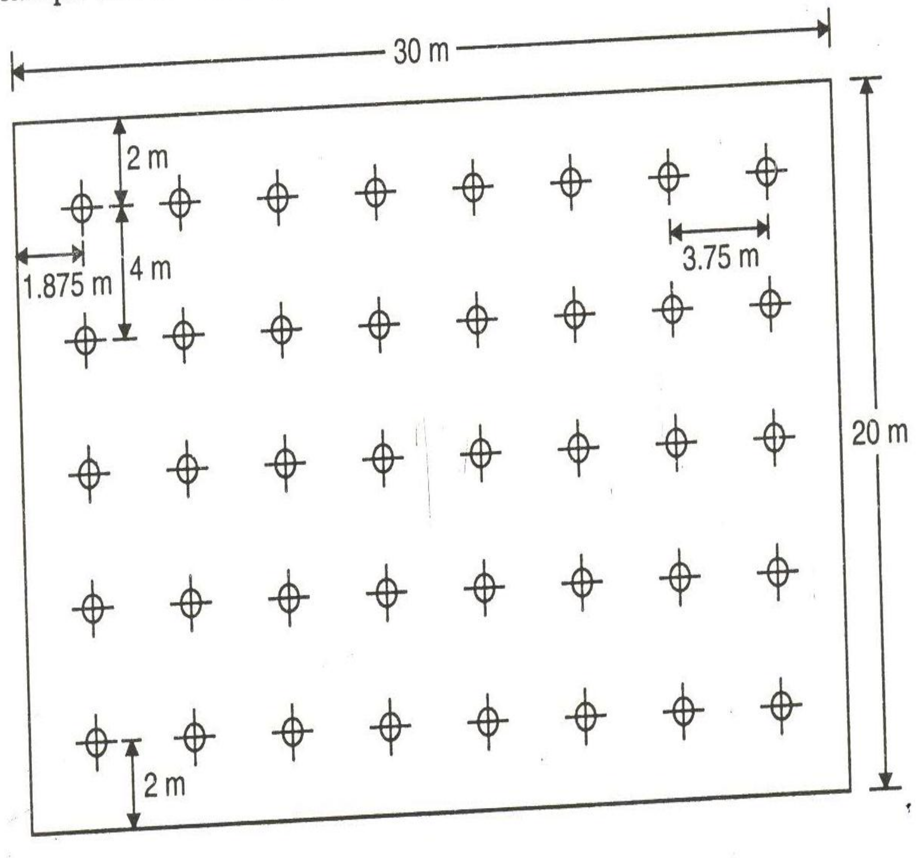
$\therefore$ Total wattage required $= \dfrac{441176}{12} = 36765$ W

Taking 8 lamps along the length giving a spacing of $\dfrac{30}{8}$ m *i.e.*, 3.75 m lengthwise and 5 lamps along width giving spacing of $\dfrac{20}{5}$ m *i.e.*, 4 m width wise.

$\therefore$ Total number of lamps $= 8 \times 5 =$ **40. (Ans.)**

Wattage of each lamp $= \dfrac{36765}{40} \approx$ **1000 W. (Ans.)**

These 40 lamps will be arranged as shown in Fig. 1.48.



---**[10 Marks]**

3

Solution. *Given* : $A = 60 \times 15 = 900\ m^2$; $E = 100$ lux ; $UF = 0.42$; $MF = 0.78$;

Luminous efficiency = 16 lm/W

$$\text{Gross lumens required} = \frac{E \times A}{UF \times MF} = \frac{100 \times 900}{0.42 \times 0.78} = 274725$$

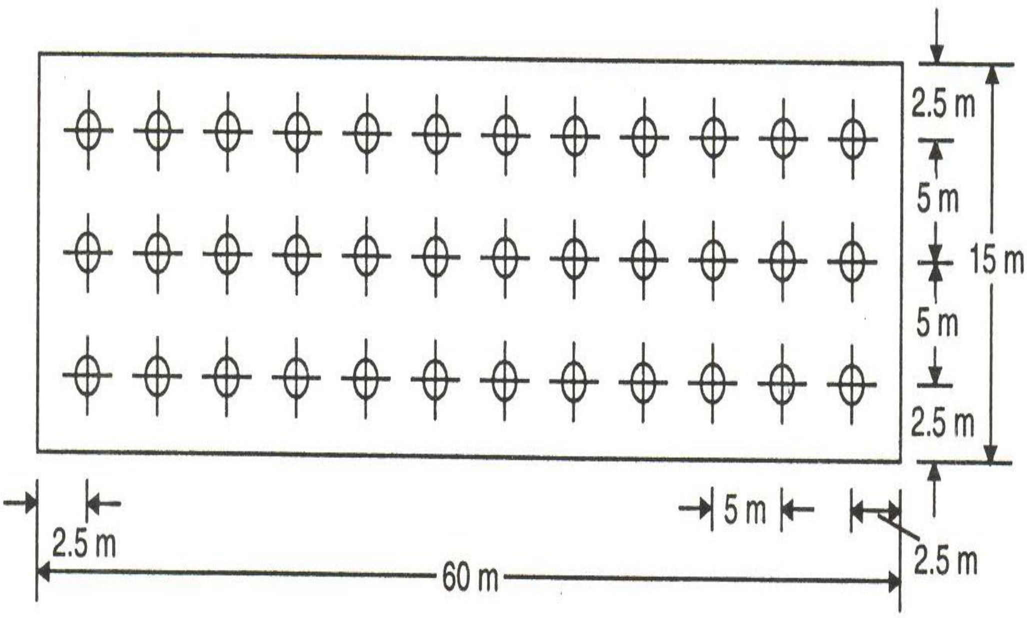
$$\text{Total wattage required} = \frac{274725}{16} = 17170\ W$$

For a space-height ratio of unity, only three lamps can be mounted along the width of th room. Similarly, 12 lamps can be arranged along the length of the room.

$$\text{Total number of lamps} = 12 \times 3 = 36$$

$$\text{Wattage of each lamp} = \frac{17170}{36} = 477\ W$$

We will take the nearest standard lamp of **500 W.** The arrangement of the lamps will be a shown in the Fig. 1.49.



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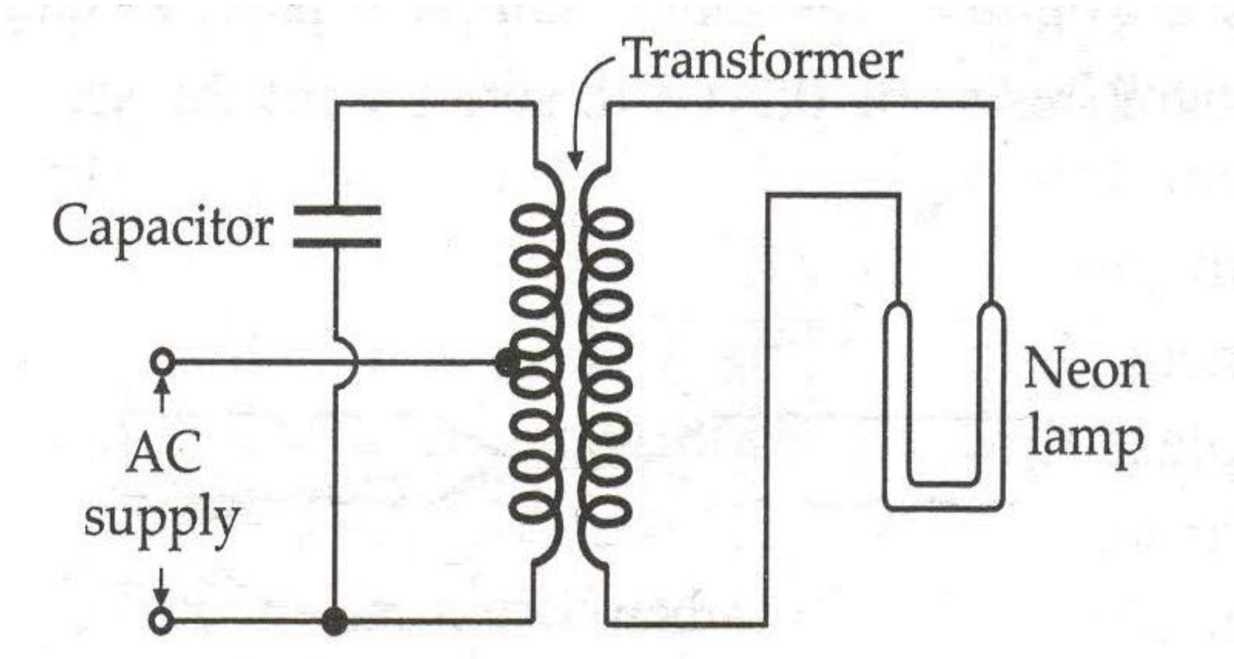
4

NEON DISCHARGE LAMP This is a cold cathode lamp, in which no filament is used to heat the electrode for starting. The discharge tube is filled with neon gas. A low voltage of 150 V on DC or 110 V on AC is impressed across the two electrodes; the discharge takes place through the neon gas that emits light or electromagnetic radiation reddish in color. The sizes of electrodes used are equal for both AC and DC supplies. On DC, neon glow appear nearer to the negative electrode; therefore, the negative electrode is made larger in size. Neon lamp electric circuit consists of a transformer with high leakage reactance in order to stabilize the arc. Capacitor is used to improve the power factor. Neon lamp efficiency is approximately 15–40 lumens/W. The power consumption of the neon lamp is 5 W. If the helium gas is used instead of neon, pinkish white light is obtained. These lamps are used as night lamps and as indicator lamps and used for the determination of the polarity of DC mains and for advertising purpose.



---[10 Marks]

5.

1. Trapezoidal speed-time curves. Fig. 7.4 sh... speed-time curve OABC.

Let, D = Distance between stops (*metres*),

t = Actual time of run between stops (*seconds*),

α = Acceleration during starting period (m/s^2),

β = Retardation during braking (m/s^2),

V_m = Maximum (or crest) speed (m/s),

V_a = Average speed ($= D/t$), *m/s,

t_1 = Time of acceleration (*seconds*),

t_3 = Time of braking (*seconds*), and

t_2 = Time of free running $= t - (t_1 + t_3)$, in *seconds.*

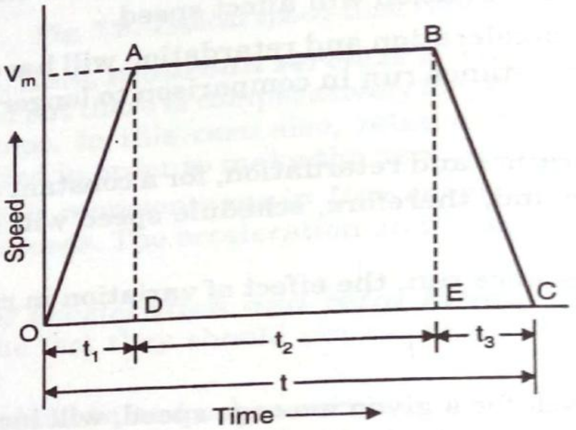


Fig. 7.4. Trapezoidal speed-time curve.

From Fig. 7.4, we have

$$\alpha = \frac{V_m}{t_1} \quad \text{or} \quad t_1 = \frac{V_m}{\alpha}$$

$$\beta = \frac{V_m}{t_3} \quad \text{or} \quad t_3 = \frac{V_m}{\beta}$$

Since the total distance D between the stops is given by the area of trapezium $OABC$, therefore,

$$D = \text{Area } OABC$$
$$= \text{Area } OAD + \text{Area } ABED + \text{Area } BCE$$
$$= \frac{1}{2} V_m t_1 + V_m t_2 + \frac{1}{2} V_m t_3$$
$$= \frac{1}{2} V_m t_1 + V_m [t - (t_1 + t_3)] + \frac{1}{2} V_m t_3$$
$$= V_m \left[\frac{t_1}{2} + t - t_1 - t_3 + \frac{t_3}{2}\right] = V_m \left[t - \frac{1}{2}(t_1 + t_3)\right]$$

or,
$$D = V_m \left[t - \frac{V_m}{2}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)\right] \qquad \{\text{From } (i), \text{ and } ...$$

Let,
$$K = \frac{1}{2}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right), \quad \text{or} = \frac{\alpha + \beta}{2\alpha\beta}$$

Substituting the value of K in the above eqn., we get

$$D = V_m(t - KV_m)$$

$$KV_m^2 - V_m t + D = 0$$

$$\therefore \quad V_m = \frac{t \pm \sqrt{t^2 - 4KD}}{2K} \quad \text{...}(iii)$$

The +ve sign will not be used, as it will give much higher value of V_m which will not be met with in practice. Therefore, we have

$$V_m = \frac{t - \sqrt{t^2 - 4KD}}{2K} \quad \text{...}(7.2)$$

From eqn. (*iii*), we get

$$KV_m^2 = V_m t - D$$

$$K = \frac{t}{V_m} - \frac{D}{V_m^{\ 2}} = \frac{D}{V_m^{\ 2}}\left(V_m \cdot \frac{t}{D} - 1\right)$$

Now,

$$V_a = \frac{D}{t}$$

$$\therefore \quad K = \frac{D}{V_m^2}\left(\frac{V_m}{V_a} - 1\right) \quad \text{...}(7.3)$$

---[10 Marks]

6. Systems of track electrification

- **(a) The DC System**
- **(b) The Single Phase AC System**
- **(c) The Three Phase AC System**
- **(d) The Composite System**
  - Single Phase - Three Phase System or Kando System
  - Single Phase - DC System

The DC system

- In this system, D.C. series motors used for getting the necessary motive power, D.C. compound motors are also used for tramways and trolley buses where regenerative braking can be utilized.
- The operating voltage is from 600 V to 750 V for tramway and suburban railways and from 1500 V to 3000 V for mainline service.
- The distribution system consists of one contact wire in case of tramways and two contact wires in case of trolley buses.
- The spacing of sub-stations depends upon the operating voltage and the traffic density of the route.

The single phase AC system

- In single phase AC system ac series motors are used for getting necessary motive power.
- The voltage employed for distribution network is 15 to 25 kV at 25 Hz, which is stepped down on locomotive to a low voltage suitable for supplying to single ac series motor.
- The spacing of substation is 50 to 80 km.
- The change of supply frequency become necessary because of
  - ✓ Better performance.
  - ✓ Improves its commutation properties, power factor and efficiency.
  - ✓ Reduces the line reactance and hence the voltage drop.
- AC single phase system is invariably adopted for main line service.

The three phase AC system

- In this system 3-phase induction motor operating at 300 to 3600 V and low frequency are employed for getting the required motive power.
- The 3-phase induction motor
  - Simple
  - Robust in construction
  - High operating efficiency

- Automatic regenerative braking without required any additional equipment.

The kando system (single phase to three phase system)

- In this system single phase high voltage (25 kV) at normal supply frequency is usedto distribute power.
- The locomotive which carries a phase convertor which converts single phase AC to three-phase AC. The three-phase power is then fed to three-phase induction motors for getting necessary motive force.
- In this system only one contact wire of overhead system which is overcome the disadvantage of 3 phase ACsystem.

--[10 Marks]

7 a.

Factor	DC Traction	AC Traction
Motor	DC series motor.	AC series motor.
Performance	Good performance.	Not as good as that used for DC traction.
Starting torque	More.	Less.
Speed control	ThespeedcontrolofDCseriesMotoris limited.	Wide range of speed control is Possible.
Interference	DCsystem causeslessinterference with Communication lines.	It will produce more interference with Communication lines.
Overhead distribution	Heavier and more costly Comparatively.	Lighter and less costly.
Substations	The number of substations required for a given track distance on DC traction is More.	The number of substations required in AC traction is less.
Weight of cu	Weight of cu required per track km is more.	Weight of cu required per track km is less.
Application	Tramway, Trolley bus.	Main Line Service.

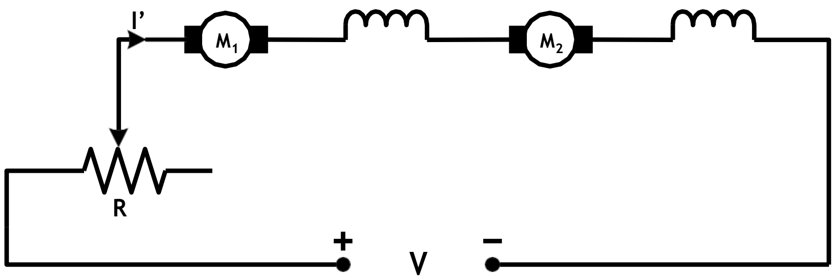
--[5 Marks]

7b.

(a) Series-Parallel Control

- The main disadvantage of wastage of electrical energy in rheostatic control is partly overcome in this method when there are two or more motors.
- In case of two motors, the motors are first connected in series with each other and starting and control resistance as illustrated in Figure 1(a).

Figure 1(a)



- The additional resistance is gradually cut-out by controller as the motor attain speeds and finally the control resistance is totally removed, then each motor has one half of the line voltage across it, as shown in Figure 7.19(b).

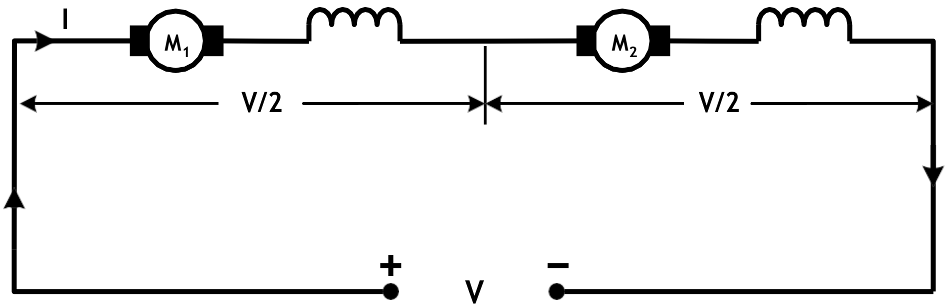


Figure 1(b)

- This is the first running position. In this position for any given value of armature current, each motor will run at half of its normal speed.
- In the next step the two motors are connected in parallel and in series with a variable resistance R, as shown in Figure1(c).

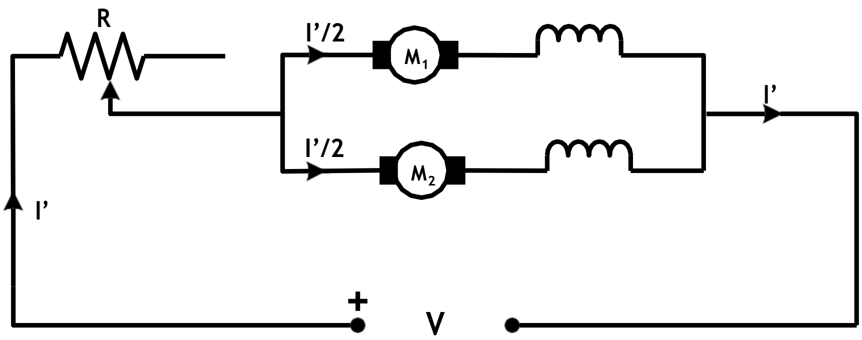


Figure 1(c)

- This resistance is gradually cut out as the motors attain the speed and finally when this resistance is totally removed from the circuit, as illustrated in Figure 1(d), the second position is obtained.

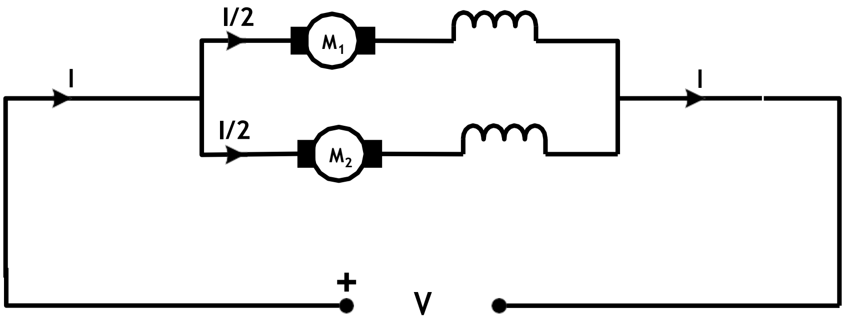


Figure 1(d)

---**[5 Marks]**

8.

Solution. *Given :* $V_a = 36\ \text{km/h} = \frac{36 \times 1000}{3600} = 10\ \text{m/s}$; $D = 1.8\ \text{km} = 1800\ \text{m}$;

$$\alpha = 1.8\ \text{km/h/s} = \frac{1.8 \times 1000}{3600} = 0.5\ \text{m/s}^2 ;\ \beta = 3.6\ \text{km/h/s} = \frac{3.6 \times 1000}{3600} = 1.0\ \text{m/s}^2.$$

Maximum speed of the train, V_m :

Time of run, $t = \frac{D}{V_a} = \frac{1800}{10} = 180\ \text{s}$

Also, $K = \frac{\alpha + \beta}{2\alpha\beta} = \frac{0.5 + 1.0}{2 \times 0.5 \times 1} = 1.5$

Using the relation : $V_m = \frac{t - \sqrt{t^2 - 4KD}}{2K}$ ...[Eqn. (7.2)]

$$= \frac{180 - \sqrt{(180)^2 - 4 \times 1.5 \times 1800}}{2 \times 1.5}$$

$$= 11.01\ \text{m/s} = \frac{11.01 \times 3600}{10000} = 39.64\ \text{km/h.}\quad \text{(Ans.)}$$

---**[10 Marks]**