**14EE703**
**EE 413**

**Hall Ticket Number:**

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**IV/IV B.Tech (Regular/Supplementary) DEGREE EXAMINATION**

**November, 2019** **Electrical & Electronics Engineering**
**Seventh Semester** **Utilization of Electrical Power**
**Time:** Three Hours **Maximum :** 60 Marks

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*Answer Question No.1 compulsorily.* (1X12 = 12 Marks)
*Answer ONE question from each unit.* (4X12=48 Marks)

**1.** Answer all questions (1X12=12 Marks)

a. What is meant by load equalization?
b. Define heating time constant.
c. List any two advantages of electric braking.
d. What is Tractive Effort?
e. What are the factors affecting the schedule speed of a train?
f. What is meant by Adhesive Weight?
g. What are the desirable properties the materials for heating element should have?
h. Write any two applications of Induction heating?
i. What is meant by electrolysis?
j. Define Illumination.
k. State inverse square law of Illumination.
l. Define glare.

**UNIT – I**

| | | |
|---|---|---|
| 2.a | Discuss the various factors that govern the choice of a motor for a given service. | 6M |
| 2.b | Discuss the terms ‘continuous’, ‘intermittent’ and ‘variable’ loads with examples. | 6M |
| | **(OR)** | |
| 3.a | Derive an expression for the temperature rise of an electric motor. | 6M |
| 3.b | Explain regenerative braking for induction motors. | 6M |
| | **UNIT – II** | |
| 4.a | Draw the speed-time curve of a main line service and explain how it works. | 6M |
| 4.b | A train has a scheduled speed of 40 km/hr between two stops, which are 4 km apart. Determine the crest speed over the run, if the duration of stops is 60 sec and acceleration and retardation both are 2 km/hr/sec each. Assume simplified trapezoidal speed-time curve. | 6M |
| | **(OR)** | |
| 5.a | Explain the mechanics of train movement with neat sketch. | 6M |
| 5.b | Derive an expression for specific energy output on level track using a simplified speed-time curve. | 6M |
| | **UNIT – III** | |
| 6.a | What are the different types of Electric heating? Write advantages of electric heating. | 6M |
| 6.b | With a neat sketch explain the working principle of core type induction furnace. | 6M |
| | **(OR)** | |
| 7.a | Explain the principle of dielectric heating and its applications. | 6M |
| 7.b | Describe with a neat sketch various methods of electric resistance welding. | 6M |
| | **UNIT – IV** | |
| 8.a | Discuss about sodium vapour lamp with neat diagram. | 6M |
| 8.b | What are polar curves? Explain Rousseau’s diagram and its importance in illumination engineering. | 6M |
| | **(OR)** | |
| 9.a | Explain the various factors to be taken into account for designing schemes for (i) Street lighting (ii) Flood lighting. | 6M |

9.b The illumination in a drawing office 30 m × 10 m is to have a value of 250 lux and is to be provided by a number of 300-W filament lamps. If the coefficient of utilization is 0.4 and the depreciation factor 0.9, determine the number of lamps required. The luminous efficiency of each lamp is 14 lm/W. 6M

**SCHEME OF EVALUATION**

**(14EE703)**

**Short answers.**

**a. What is meant by load equalization?**

**Ans)** Load equalisation is the process of smoothing the fluctuating load. The fluctuate load draws heavy current from the supply during the peak interval and also cause a large voltage drop in the system due to which the equipment may get damage.

**b. Define heating time constant.**

It is defined as the time taken by the motor in attaining the final steady value if the initial rate of rise of temperature were maintained through out the operation.

**c. List any two advantages of electric braking.**

Maintenance is easy.

No heat production

Capacity of the system can be incrased.

d. **What is Tractive Effort?**

The effective force, necessary to propel the train, at the wheels of locomotive is called the tractive effort.

**e. What are the factors affecting the schedule speed of a train?**

Acceleration and braking retardation , Maximum or crest speed, Duration of stop.

**f. What is meant by** Adhesive Weight?

The total weight to be carried on the driving wheels is known as Adhesive Weight.

**g. What are the desirable properties the materials for heating element should have?**

1. It should have high specific resistance so that a small length of wire (R = $\frac{pl}{a}$ , p = $\frac{Ra}{l}$) is sufficient to produce the required amount of heat.
2. It should have high melting point so that high temperature can be obtained.
3. It should have low temperature co-efficient since for accurate temperature control, the resistance should be nearly constant at all temperature and this is possible only if the resistance does not change with temperature.
4. It should not oxidize at higher temperatures otherwise its life is shortened and needs frequent replacement.

( writeany one)

**h. Write any two applications of Induction heating?**

1.surface Hardening 2.Deep hardening: 3.Tempering. 4.Smalting: 5.Soldering;

**i. What is meant by electrolysis?**

Splitting up of molecules of electrolyte into ions carrying electric charges and moving freely in the solution attracted towards electrodes which are dipped into electrolyte and connected to the d.c supply is known as electrolysis.

**j. Define Illumination.**

When the light falls upon any surface, the phenomenon is called the illumination. It is defined as the number of lumens, falling on the surface, per unit area.

**k. State inverse square law of Illumination.**

The amount which falls upon any square mm of such a surface will therefore diminishes as the radius increases, and will be inversely proportional to the square of the distance.

**l. Define glare.**

Glare maybe defined as brightness with in the field of vision of such a character as the cause annoyance discomfort interference with vision.

## UNIT-1

2.a **Discuss the various factors that govern the choice of a motor for a given service.**

Those factors are as fallows.

1. Nature of the electric supply.

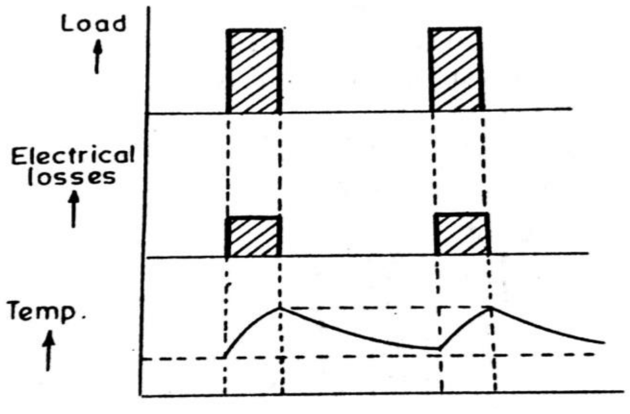
2. Type of drive.
3. Nature of load.
4. Electrical characteristics.
   (a) Operating or Running characteristics.
   (b) Starting characteristics.
   (c) Speed control.
   (d) Breaking characteristics.
5. Mechanical considerations.
   (a) Type of enclosures.
   (b) Type of bearings.
   (c) Type of transmission for drive.
   (d) Noise level.
   (e) Heating and cooling time constants.
6. Service capacity and rating.
   (a) Requirement for continuous, intermittent or variable load cycle.
   (b) Pull-out torque and overload capacity.
7. Appearance.
8. Cost.
   (a) Capital or initial cost.
   (b) Running cost.

(write any four factors each carry 2M)

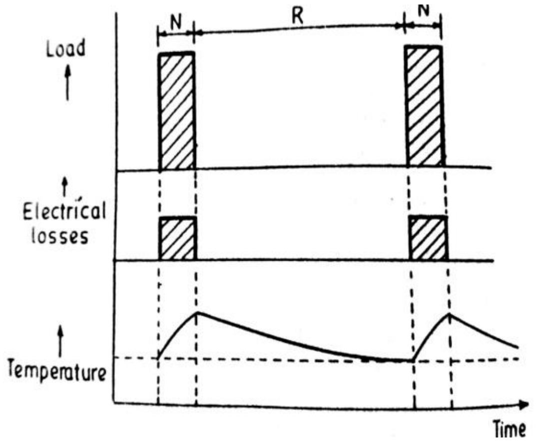
2.b **Discuss the terms 'continuous', 'intermittent' and 'variable' loads with examples.**

There are three different types of loads under which the motor is required to work, these are:

1. Continuous Loads
2. Intermittent Loads
3. Variable or Fluctuating Loads.
1. Continuous Loads: Drives likes pumps and fans etc. require a constant power as these keep on operating continuously and the choice of a suitable rating of motor is a simple affair.
   It is essential to calculate the exact amount of power needed by the drive so as to make the correct choice of the motor H.P. If the H.P of the motor is less than what is needed, the motor will overheat and subsequently burn out.
   On the other hand, if the H.P of the motor is more than what is demanded by the load, more will be operating at less than full load value, and hence lower efficiency and power factor.
2. Intermittent Loads: Intermittent Loads may be of two types:
   i) The motor may be loaded for a short time and then shut-off for a sufficiency long time allowing the motor to cool down. In such a case a motor with a suitable short time rating is adopted such as in mixies etc.




   ii) The motor may be loaded for some time and then shut-off for some times. Before the motor can cool down completely the load cycle repeats. In such a case a suitable continuous or short time rated motor is chosen which when operating on the particular load cycle, will not exceed the specified temperature limits.




3. Variable or Fluctuating Loads: In case of Variable or Fluctuating Loads the most accurate method of selection of a suitable rating of motor is to draw the heating and cooling curves for a number of motors. The smallest motor, which does not exceed the permitted temperature rise when operating on the particular load cycle, is then chosen for the purpose.

   However, an approximate and a simple method of selection of a suitable rating of motor is to assume that heating is proportional to square of the current and hence square of the load. The suitable continuous rating of the motor would be the r.m.s. value of the load curve. The procedure will be clear by the following examples.

(Continuous load-2M, intermittent-2M, variable-2M)

3.a **Derive an expression for the temperature rise of an electric motor.**

Ans) For finding the expression for temperature rise of an electrical machine after time t seconds from the instant of switching on. Let,

Power converted in to heat = W Joules/sec. or Watts
Mass of the Active parts of the machine = M kg
Specific heat of material = S Joules/Kg/°C
Surface Area of cooling =A $meters^2$
Co-efficient of cooling = α in watts per $meters^2$ of surface per °C of difference between surface and ambient cooling temperature.

(i) Heating Curve: Suppose a machine attains a temperature rise of θ °C above ambient temperature in °C after t seconds of switching on the machine and further rise of temperature by $d\theta$ in very small time $dt$.

Energy converted into heat = W. $dt$ Joules
Heat absorbed = $MSd\,\theta$ Joules
Heat dissipated = $A\,\theta\,\alpha$ dt Joules.

Since energy converted into heat = Heat absorbed + Heat dissipated

$W\,dt = M.S.d\theta + A.\theta.\alpha\,dt$ …………. (1)

Or

$$(W - A.\alpha.\ \theta)dt = MSd\theta$$
$$\frac{dt}{MS} = \frac{d\theta}{W - A\alpha\theta}$$

Or

$$\frac{dt}{MS/A\alpha} = \frac{d\theta}{W/A\alpha - \theta} \ldots\ldots(2)$$

When final temperature is reached, there is no absorption of heat. Whatever heat is generated, has to be dissipated.

$$W\,dt = A\,\theta_m\,\alpha\,dt$$

Or steady state temperature, $\theta_m = \frac{W}{A\,\alpha}$ ………(3)

Substituting Eq. (3) in Eq. (2), we get

$$\frac{A\,\alpha}{MS}.t = \int \frac{d\theta}{(\theta_m - \theta)}$$

Integrating both sides, we get, (3M)

$\frac{A\,\alpha}{MS}.t = -\log_e(\theta_m - \theta) = K_1$ ...... (4)

Where $K_1$ is a constant of integration.

Substituting, $t = 0,\ \theta = \theta_1$, ambient temperature from initial conditions, we get,

$$0 = -\log_e(\theta_m - \theta_1) + K_1$$
$$K_1 = \log_e(\theta_m - \theta_1)$$

Substituting, $K_1 = \log_e(\theta_m - \theta_1)\,r$ in Eq. (4), we get,

$$\frac{A\,\alpha}{MS}.t = \log_e(\theta_m - \theta) + \log_e(\theta_m - \theta_1)$$
$$= \log_e\left[\frac{(\theta_m - \theta_1)}{(\theta_m - \theta)}\right]$$
$$e^{\frac{A\,\alpha}{MS}t} = \frac{(\theta_m - \theta_1)}{(\theta_m - \theta)}$$

Or

$$\theta_m - \theta = (\theta_m - \theta_1)e^{-\frac{A\,\alpha}{MS}t}$$
$$\theta = \theta_m - (\theta_m + \theta_1)e^{-\frac{A\,\alpha}{MS}t}$$

$= \theta_m - (\theta_m - \theta_1)e^{-t/\lambda}$ ......... (5)

Where $\lambda = \frac{MS}{A\alpha}$ and is known as heating time constant.

3.b **Explain regenerative braking for induction motors**.

In this of braking the motor is not disconnected from the supply but remains connected to the supply system, This method is superior as compared to the other two methods of electric braking namely plugging and rheostatic braking because in case of rheostatic braking namely plugging and rheostatic braking because in case of rheostatic braking stored energy of the rotating parts of the motor and its driven machine is wasted whilst in plugging extra energy is drawn during the braking period and wasted whereas in regenerative braking no energy is wasted and rather it is supplied back to the system.

Regenerative braking with induction motors occours inherently as soon as the load drives the motor at above synchronous speed . the motor then acting as an induction generator and feed backs to power supply line. The machine however is not self starting as a generator and requires to be connected in the system which supplies the excitation and determines the frequency at which the induction generator operates. Torque speed characterstics of an induction machine is shown and hence from it , is clear that without any external resistance in rotor circuit there is only a slight variation of speed with torque where as with external resistance inserted in the rotor circuit the speed increases for particular braking torque. This it is cl

Clear that with no extra resistance in the rotor circuit the speed during braking remains almost constant and independent of the gradient and weight of the train. This is great advantage with induction motor when used for traction. But if increased speeds are necessary with light loads ,these can be obtained by inserting external resistance in the rotor circuit.

(Regenerative braking-3M, for induction motor-3M)

4.a **Draw the speed-time curve of a main line service and explain how it works.**

**SPEED –TIME CURVE FOR MAIN LINE SERVICE:**

In the service, the distance between two stations is more than 10 Kms.

Speed – time curve mainly consists of

(i) Initial acceleration 1.5M

(ii) Constant speed run or free run 1.5M

(iii) Costing 1.5M

(iv) Retardation 1.5M

Typical speed time curve for main line service is shown.

**(i)Acceleration:**

With electric trains using d.c series motors the period of acceleration consists of two parts namely:

(a) constant acceleration or acceleration while notching up

(b) decreasing acceleration.

**(a)Constant Acceleration:**

The acceleration of the electric train is maintained constant during starting period which is achieved by supplying approximately constant current. The voltage across the motor is gradually increased by cutting out the starting resistance with the help of starter by moving the starter handle period ($0 - t_1$) and acceleration is known as rheostatic acceleration. The typical value of acceleration varies between 0.6 – 0.8 Kmphps.

**(b)Decreasing Acceleration:**

During speed curve running ($t_1$ to $t_2$) the voltage acting across the motor remains constant and current starts decreasing with increase in speed according to the characteristics of the motor and finally the current taken by the motor becomes constant. During this period though the train accelerates but acceleration decreases with the increase in speed and finally becomes zero at the speed at which the tractive effort developed by the motor becomes exactly equal to the resistance to the motion of train.

**(ii)Free Run or Constant Speed Run:**

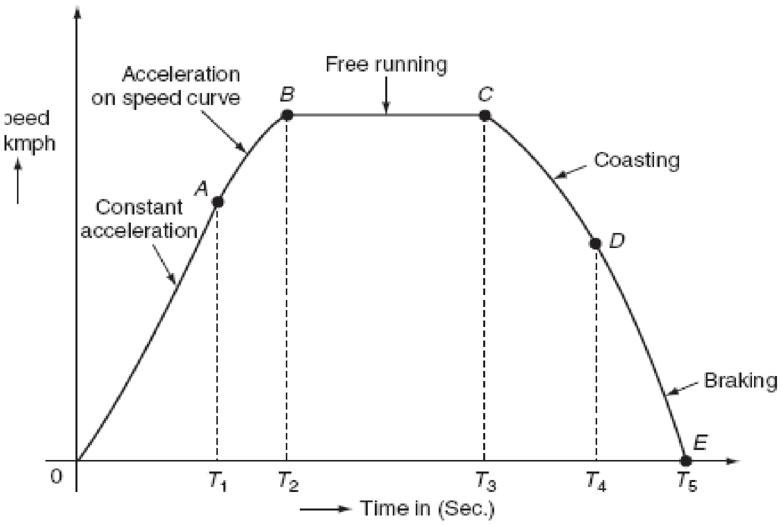
At the end of speed curve running i.e., at $t_2$ the train attains maximum speed. During this period the train runs with constant speed attained at $t_2$ and thus the power drawn from the supply is constant.

**(iii)Costing:**

At the end of free running period (i.e., at $t_3$) power supply is cut off and the train will start running due to its momentum. Due to the frictional resistance to the motion, the speed of that train starts decreasing or in other words there will be a retardation during this period and this retardation is known as coasting retardation.

**(iv)Retardation or Braking:**

At the end of coasting period (i.e., at $t_4$) the brakes are applied to bring the train to rest. During this period the speed decreases rapidly and finally reduces to zero.




4.b **A train has a scheduled speed of 40 km/hr between two stops, which are 4 km apart. Determine the crest speed over the run, if the duration of stops is 60 sec and acceleration and retardation both are 2 km/hr/sec each. Assume simplified trapezoidal speed-time curve.**

Ans

Acceleration $\alpha$ = 2 kmphps.
Retardation $\beta$ = 2 kmphps.
Distance of run $S$ = 4 km.
scheduled speed $V_s$ = 40 kmph.
scheduled time $T_s = \frac{S \times 3600}{V_s} = \frac{4 \times 3600}{40} = 360$ sec
Actual time for run $T = T_s$ − stop duration
$= 300 - 60 = 300$ sec.

$$V_m = \frac{T}{2k} - \sqrt{\frac{T^2}{4k^2} - \frac{3600S}{k}} \quad \text{where } k = \frac{1}{2\alpha} + \frac{1}{2\beta}.$$

$$k = \frac{1}{4} + \frac{1}{4} = 0.5$$

$$V_m = \frac{100}{2 \times 0.5} - \sqrt{\frac{300^2}{4 \times 0.5^2} - \frac{3600 \times 1.5}{0.3646}}.$$

(Formula – 2M, cal – 4M)



5.a **Explain the mechanics of train movement with neat sketch.**

The essential driving mechanism of an electric locomotive is shown in Fig. The electric locomotive consists of pinion and gear wheel meshed with the tractionmotor and the wheel of the locomotive. Here, the gear wheel transfers the tractiveeffort at the edge of the pinion to the driving wheel.

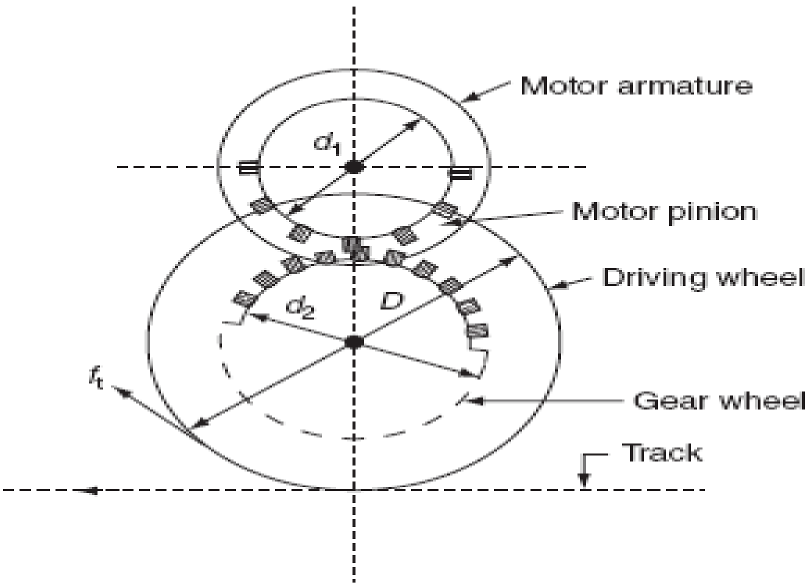



Fig- (3M)

**Fig.** Driving mechanism of electric locomotives

Let $T$ is the torque exerted by the motor in N-m, $F$p is tractive effort at the edge of the pinion in Newton,$F$t is the tractive effort at the wheel, $D$ is the diameter of the driving wheel, $d$1 and $d$2 are the diameter of pinion and gear wheel, respectively, and $\eta$ is the efficiency of the power transmission for the motor to the driving axle.

Now, the torque developed by the motor $T = F_p \times \frac{d_1}{2}$ N-m.

$$\therefore F_p = \frac{2T}{d_1} \text{ N.} \quad \textbf{(10.9)}$$

The tractive effort at the edge of the pinion transferred to the wheel of locomotive is:

$$F_t = F_p \times \frac{d_2}{D} \text{ N.} \quad \textbf{(10.10)}$$

From Equations (10.9) and (10.10) $F_t = \eta \times \frac{2T}{d_1} \times \frac{d_2}{D}$

$$= \eta \cdot T \cdot \frac{2}{D}\left(\frac{d_2}{d_1}\right)$$

$$= \eta T \cdot \frac{2}{D} \cdot r,$$

where '$r$'= $\left(\frac{d_2}{d_1}\right)$ is known as gear ratio.

$$\therefore F_t = 2\eta r \frac{T}{D} \text{ N.} \qquad \textbf{(10.11)}$$

(3M)

5.b **Derive an expression for specific energy output on level track using a simplified speed-time curve.**

11.10. DETERMINATION OF SPECIFIC ENERGY OUTPUT USING SIMPLIFIED SPEED-TIME CURVE

Let the track have a gradient of G percent through out its run.

Energy output to accelerate the train from rest to a speed $V_m$

$$= \frac{1}{2}\frac{F_t V_m}{3,600} \times \frac{t_1}{3,600} \text{ kWh} = \frac{1}{2}\frac{F_t V_m}{3,600} \times \frac{V_m}{3,600\,\alpha} \text{ kWh} \qquad \text{since } t_1 = \frac{V_m}{\alpha}$$

$$= \frac{1}{2}\frac{V_m^2}{(3,600)^2\alpha}[277.8\, W_e\alpha + 98.1\, WG + Wr] \text{ kWh} \quad ...(11.19)$$

since $F_t = 277.8\, W_e\, \alpha + 98.1\, WG + Wr$

Energy output to run the train at the speed $V_m$ against the gradient and resistance to motion

$$= \frac{F_t' V_m}{3,600} \times \frac{t_2}{3,600} \text{ kWh} = \frac{F_t' \times S'}{3,600} \text{ kWh} = Wr + 98.1\, WG] \times \frac{S'}{3,600} \text{ kWh} \quad ...(11.20)$$

since $\frac{V_m t_2}{3,600} = S'$, the distance travelled during free run

Total energy output for the run

$$= \frac{V_m^2}{2\alpha(3,600)^2}[277.8\, W_e\alpha + 98.1\, WG + Wr] + [Wr + 98.1\, WG] \times \frac{S'}{3,600} \text{ kWh}$$

$$= \frac{V_m^2 \times 1,000}{2\alpha \times (3,600)^2}[277.8\, W_e\alpha + 98.1\, WG + Wr] + [Wr + 98.1\, WG] \times \frac{S' \times 1,000}{3,600} \text{ Wh}$$

$$= \frac{V_m^2}{2\alpha} \times \frac{1,000}{(3,600)^2} \times 277.8\, W_e\alpha + \frac{V_m^2}{2\alpha} \times \frac{1,000}{(3,600)^2}[98.1\, WG + Wr] + \frac{1,000\, S'}{3,600}[Wr + 98.1\, WG]$$

$$= 0.01072\, V_m^2\, W_e + [98.1\, WG + Wr]\left[\frac{V_m^2}{2\alpha \times 3,600} + S'\right] \times \frac{1,000}{3,600}$$

$$= 0.01072\, V_m^2\, W_e + \frac{1,000}{3,600}[98.1\, WG + Wr][S'' + S']$$

where $\frac{V_m^2}{2\alpha \times 3,600} = S''$, distance travelled during accelerating perioc

$$= 0.01072\, V_m^2 W_e + 0.2778\,(98.1\, WG + Wr)\, S_1 \quad ...(11.21$$

re $S_1$ is the distance travelled during acceleration and free run in km

$$\text{pecific energy output} = \frac{\text{Energy output for the run in watt-hours}}{\text{Weight of train in tonnes} \times \text{distance of run in km}}$$

$$= \frac{0.01072\, V_m^2\, W_e + 0.2778(98.1\, WG + Wr)S_1}{W \times S}$$

$$= \frac{0.01072\, V_m^2}{S} \times \frac{W_e}{W} + 0.2778\frac{S_1}{S}(98.1\, G + r) \text{ watt-hours per tonne-k} \quad ...(11.$$

6.a **What are the different types of Electric heating? Write advantages of electric heating.**

Electric heating methods can be classified as:

**Electric heating** **(3M)**

**Power frequency heating** **high frequency heating**

**Arc heating** **Resistance heating** **Induction heating** **dielectric heating**

**Direct resistance heating** **Indirect resistance heating** **Infrared heating**

**<u>Advantages of electric heating over other systems of heating :</u>**

The main advantages of electric heating over other systems of heating (i.e coal, gas, or oil) heating are: **(3M)**

**1.Economical:** Electric heating is economical as electric furnaces are cheaper in initial cost as well as maintenance cost. It does not require any attention so there is a considerable saving in labour cost over other systems of heating. moreover, the electric energy is also cheap as it is produced on large scale.

**2. Cleanliness:** Since dust and ash are completely eliminated in electric heating system, so it is clean system and cleaning costs are rendered to a minimum.

**3. Absence of fuel gases:** Since no fuel gases are produced in this system, the atmosphere around is clean and pollution free.

**4. Ease of control:** Simple, accurate and reliable temperature of a furnace can be had with the help of manual or automatic devices. Desired temperature can be had in electric heating system which is not convenient in other heating systems.

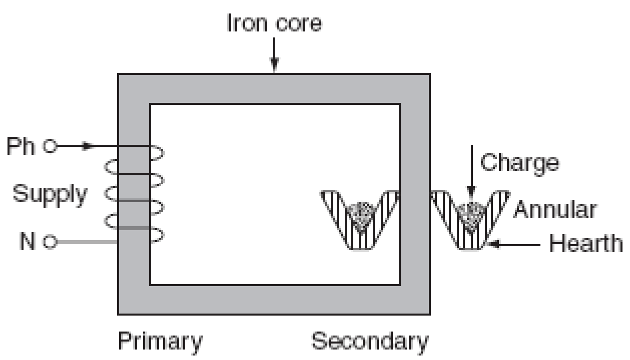
**5. Efficiency:** It has been practically found that 75 to 100% of heat produced by electric heating can be successfully utilized as the source can be brought directly to the point where heat is required there by reducing the losses.

## (write any four advantages)

6.b **With a neat sketch explain the working principle of core type induction furnace.**

The core type furnace is essentially a transformer in which the charge to be heated forms singleturn secondary circuit and is magnetically coupled to the primary by an iron core as shown in Fig.

**Fig.** **(2M)**



The furnace consists of a circular hearth in the form of a trough, which contains the charge to be melted in the form of an annular ring. This type of furnace has the following characteristics: ○ This metal ring is quite large in diameter and is magnetically interlinked with primary winding, which is energized from an AC source. The magnetic coupling between primary and secondary is very weak; it results in high leakage reactance and low pf. To overcome the increase in leakage reactance, the furnace should be operated at low frequency of the order of 10 Hz. ○ When there is no molten metal in the hearth, the secondary becomes open circuited thereby cutting of secondary current. Hence, to start the furnace, the molten metal has to be taken in the hearth to keep the secondary as short circuit.

○ Furnace is operating at normal frequency, which causes turbulence and severe stirring action in the molten metal to avoid this difficulty, it is also necessary to operate the furnace at low frequency.

○ In order to obtain low-frequency supply, separate motor-generator set (or) frequency changer is to be provided, which involves the extra cost.

○ The crucible used for the charge is of odd shape and inconvenient from the metallurgical viewpoint. ○ If current density exceeds about 500 A/cm2, it will produce high-electromagnetic forces in the molten metal and hence adjacent molecules repel each other, as they are in the same direction. The repulsion may cause the interruption of secondary circuit (formation of bubbles and voids); this effect is known as *pinch effect.*

The pinch effect is also dependent on frequency; at low frequency, this effect is negligible, and so it is necessary to operate the furnace at low frequency. (4M)

7.a **Explain the principle of dielectric heating and its applications.** (6M)

## Dielectric Heating:

When non-metallic metals i.e. insulators such as wood, plastic, china glass, ceramics e.t.c. are subjected to high alternating voltage their temperature will increase after some time. This increase in temperature is due to the conversion of dielectric loss to heat. The material to be heated is placed as slab between the metallic plates or electrodes connected to high frequency a.c. supply.

Dielectric loss is depend upon the frequency and high voltage therefore for obtaining adequate heating effect high voltage at about 20 Kv and frequency of about 10-30 MHz are usually employed. High frequency is obtained from valve oscillator.

The current drawn by the capacitor when connected to an a.c. supply voltage does not lead the supply voltage by exactly $90^0$ since it is not possible to get a pure capacitor and there is always some resistance due to which heat is always produced in the dielectric material placed in between the two plates of capacitor. The electric energy dissipated in the form of heat energy in dielectric material is known as dielectric loss. (3M)

**(i) synthetics:** The raw materials called plastic performs used for synthetics are required to be heated uniformly before putting them in hot moulds so that the whole mass becomes fluid at a time, otherwise if the raw material is put directly in the moulds usually heated by steam the outer surface of the perform will become hot and starts curing while inner surface does not reach the fluid temperature there by resulting in unequal hardening of plastic.

**(ii) Diathermy:** Dielectric heating is employed for heating tissues, and bones of body required for the treatment of certain types of pains and diseases.

**iii) Sterilization:** Dielectric heating is quite suitable for sterilization of bandages, absorbent cotton, instruments e.t.c.

**(iv) Baking of foundary cores:** Dielectric heating is more suitable foe baking foundary cores where thermo setting binders are employed as they set instantaneously when brought to polymerizing temperature.

**(v) Textile industry:** In textile industry, dielectric heating is employed for drying purpose.

**(vi) Food processing:** The dielectric heating for food processing is one of the most modern method and set fourth such processes which are outside.

**( write 3 applications)**

**7.b Describe with a neat sketch various methods of electric resistance welding. (6M)**

**Types of Resistance Welds:**

Depending upon the shape of the weld and the manner in which the weld is obtained, the resistance welding can be classified as:

(a) Spot Welding. (1.5M)

(b) Projection Welding. (1.5M)

(c) Seam Welding. (1.5M)

(d) Butt Welding. (1.5M)

**(a) Spot Welding:**

**Definition:**

Spot welding is a form of resistance welding in which the parts or pieces are joined in spots by heating relatively small sections of parts or pieces between suitable electrodes under pressure.

It is a method in which two electrodes are placed on both sides of the work. With the help of transformer the arrangements is such that current is passed from the electrode on one side directly through the work into the electrode on the other side and back to the transformer.

**(b)Projection Welding:**

It is a modified form of spot welding. In this type of welding, electrodes used are flat metal knows as plates known as platens. The two pieces of base metal are held together between the platens out of which one piece have projections or bumps which are obtained by passing through a machine when current is passed from a transformer to the pieces to be welded, metal gets heated up near the projection area and charges to plastic state.

**(c) Seam Welding;**

Seam welding can be defined as a series of spot welds made progressively along a joint between the two overlapping pieces of sheet metal.

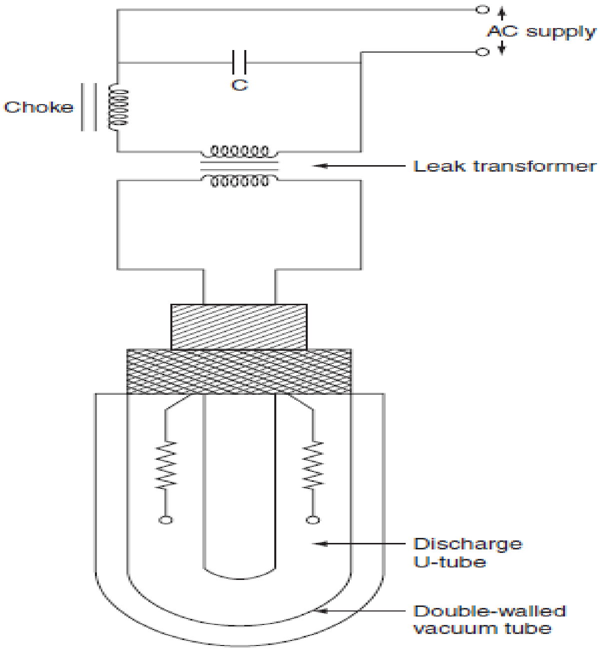
In this method, the work pieces to be welded are cleaned, overlapped suitably and is placed between two circular electrodes which clamp the work pieces together by electrode force. A current impulse is applied to the circular rollers to the material is contact with them. The heat generated makes the material plastic and pressure from the electrodes completes the weld. Due to the current impulse applied the power driven circular rollers are set in rotation and the work piece moves steadily forward.

**(d) Butt welding;**

In this method, the two pieces to be welded are gripped firmly one in each clamp and are correctly aligned so that when brought into contact one with other by sliding the movable clamp to the fixed one they fit together. Force is applied so that faces of two pieces touch together and remain under pressure.

8.a Discuss about sodium vapour lamp with neat diagram.

A sodium vapor lamp is a cold cathode and low-pressure lamp. A sodium vapor discharge lamp consists of a *U*-shaped tube enclosed in a double-walled vacuum flask, to keep the temperature of the tube within the working region. The inner *U*-tube consists of two oxide-coated electrodes, which are sealed with the ends. These electrodes are connected to a pin type base construction of sodium vapor lamp is shown in Fig.

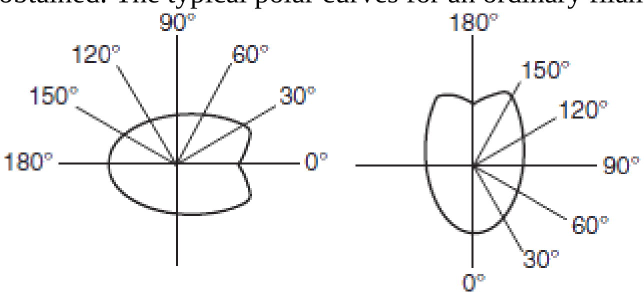



This sodium vapor lamp is low luminosity lamp, so that the length of the lamp should be more. In order to get the desired length, it is made in the form of a *U*-shaped tube. This long*U*tube consists of a small amount of neon gas and metallic sodium. At the time of start, the neon gas vaporizes and develops sufficient heat to vaporize metallic sodium in the *U*-shaped tube. Working Initially, the sodium is in the form of a solid, deposited on the walls of inner tube. When sufficient voltage is impressed across the electrodes, the discharge starts in the inert gas, i.e., neon; it operates as a low-pressure neon lamp with pink color. The temperature of the lamp increases gradually and the metallic sodium vaporizes and then ionizes thereby producing the monochromatic yellow light. This lamp takes 10–15 min to give its full light output. The yellowish output of the lamp makes the object appears gray. In order to start the lamp, 380 – 450 V of striking voltage required for 40- and 100-W lamps. These voltages can be obtained from a high reactance transformer or an auto transformer. The operating power factor of the lamp is very poor, so that a capacitor is placed to improve the power factor to above 0.8. More care should be taken while replacing the inner tube, if it is broken, then sodium comes in contact with the moisture; therefore, fire will result. The lamp must be operated horizontally or nearly so, to spread out the sodium well along the tube. The efficiency of sodium vapor lamp is lies between 40 and 50 lumens/W.

.(fig.-2M, working-4M)

8.b What are polar curves? Explain Rousseau's diagram and its importance in illumination engineering.

All over discussions so far were based on the assumption that luminous intensity or the candle power from a source is uniformly distributed over the surrounding surface. But none of the practical type of lamp gives light uniformly distributed in all directions because of its unsymmetrical shapes. It is often necessary to know the distribution of light in various directions to as certain how the candle power of light source varies in different directions. The luminous intensity in all directions can be represented by polar curves. If the luminous intensity is a horizontal plane passing through the lamp is plotted against angular position, a curve known as horizontal polar curve is obtained. If the luminous intensity in a vertical plane is plotted against the angular position, a curve known as vertical polar curve is obtained. The typical polar curves for an ordinary filament lamp are shown in the following fig.




(a) Horizontal polar curves (b) Vertical polar curves

The polar curves are used to determine the mean horizontal candle power ( m.h.c.p.) and mean spherical candle power (m.s.c.p.). these are also used to determine the actual illumination of a surface by employing the candle power in that particular direction as read from the vertical polar curve in the illumination calculations.

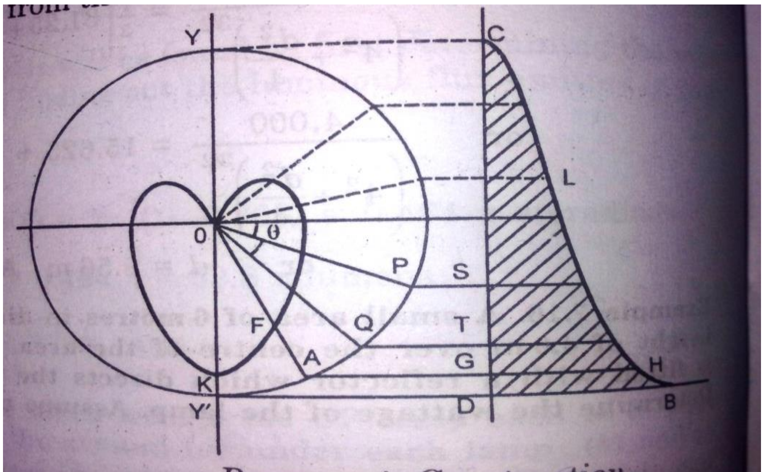
The mean horizontal candle power of a lamp can be determined from the horizontal polar curve taking the mean value of the candle power in a horizontal direction.

Mean spherical candle power can be determined from the vertical polar curve by Rousseau's construction.

**Rousseau's construction:** The construction is illustrated in the fallowing figure. A semi circle of any convenient radius is drawn with the pole of the polar diagram as centre. The line CD is drawn equal and parallel to the vertical diameter $YY^1$. Now from this line CD ordinate equal to corresponding radius on the polar curve are set up such as BD = OK, GH= Of and so on. The curve obtained by joining the ends of these ordinates is known as Rousseau's curve. The mean ordinate of this curve gives the m.s.c.p. of the lamp having polar curve given as in the fallowing figure.

The mean ordinate of the curve = $\frac{\textbf{Area CSTGDBHLC}}{\textbf{Length of CD}}$

The area under the curve can either be determined on the graph paper or found by Simpson's rule.



Rousseau's Construction

9.a **Explain the various factors to be taken into account for designing schemes for (i) Street lighting (ii) Flood lighting.**

Two general principles are usually employed in the design of street lighting installations ,namely

Diffusion and specular reflection principle

**Diffusion principle**: In this case the lamps fitted with suitable reflectors are used. The reflectors are so designed that they may direct the light downwards and spread as uniformly as possible over the road surface. in order to avoid glare the reflectors are made to have a cut-off between $30^0$ to $45^0$ so that the filament is not visible except from underneath it. The diffusion nature of the road surface causes the reflection of a certain proportion of the incident light in the direction of the observer. The illumination at any point on the road surface is calculated by applying point to point or inverse-square law method. Over certain properties of the road the surface is illuminated from two lamps and the resultant illumination is the sum of the illuminations due to each lamp.

**Specular Reflection principle**: in this case the reflectors are curved upwards so that the light is thrown on the road at a very large of incidence. It is observed that a motorist requires to see objects about 30 meters away. Thus in figure the observer is shown about 30 meters from the object. Much of the light from the lamps $L_3$ is not reflected towards the observer, whereas most of the light from the lamps $L_1$ and $L_2$ is reflected towards him. Thus the object will appear silhouetted against the bright road surface due to lamps at along distance. the requirements of a pedestarian, who requires to see objects in his immediate neighbourhood, is also fulfilled in this method as some light from the lamps falls directly downwards. The method of street lighting is only suitable for straight sections of load. This method is more economical also as compared to the diffusion method of lighting but it suffers from the dis advantages that it produces glare for the motorists.

**Flood lighting calculations:** The problem of flood-lighting calculations may be roughly separated into three

**First step:** Illumination level required: the illumination level required depends upon the type of building, the purpose of the flood lighting the amount of conflicting light in the vicinity.

**Second step:** Type of projector : two considerations enter into the choice of a projector .,viz, beam size and light output. The former determines the area covered by the beam and latter the illuminations provided. Beam angle of the projector is decided keeping in view the of projector from the surface.

**Third step:** Number of projectors: For any desired intensity over a definite surface the number of projectors required is obtained from the following relation

N=(A *E* depreciation factor*waste light factor)/(utilisation factor*wattage of lamp*luminous efficiency of lamp)

9.b **The illumination in a drawing office 30 m × 10 m is to have a value of 250 lux and is to be provided by a number of 300-W filament lamps. If the coefficient of utilization is 0.4 and the depreciation factor 0.9, determine the number of lamps required. The luminous efficiency of each lamp is 14 lm/W.**

Ans Area to be illuminated $A = 30 \times 10 = 300 m^2$.

Illumination required = 250 lumen.

Total lumen required $= \frac{A \times E}{D.F \times U.F}$

$= \frac{300 \times 250}{0.9 \times 0.4} = 208,333.33$.

Total wattage required $= \frac{208,333.33}{14} = 14,880.95$.

wattage of each lamp $= \frac{14,880.95}{300} = 49.6$.

No. of lamps required = 50.

(Formula - 2M, Calculation - 4M)



Signature of Staff

Signature of HOD