রনি পারভেজের 'EEE Job Preparation' সিরিজের প্রথম বই

RONY PARVEJ'S
EEE Job Solution

Volume-I: Job Exams arranged by BUET (1st Edition)

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Part-10: Supplement

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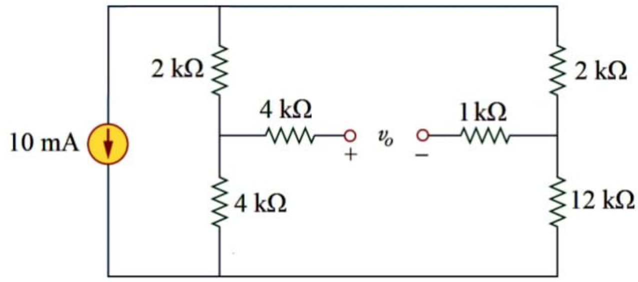
Supplement Questions & Solutions

1	Find V_0 in the following circuit: 	BTCL-17

Solution:

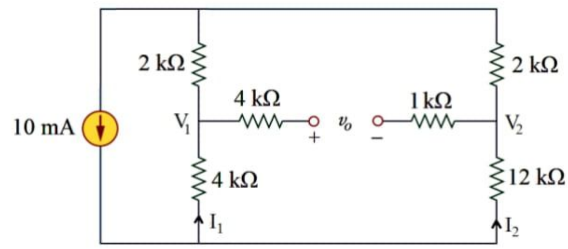
$$I_1 = \frac{(12+2)}{(4+2)+(12+2)} \times 10 = 7\ mA$$

$$I_2 = \frac{(4+2)}{(4+2)+(12+2)} \times 10 = 3\ mA$$

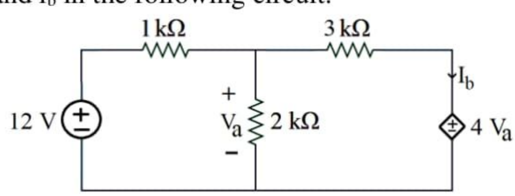
$$V_1 = -\ 4 \times 7 = -\ 28\ A$$

$$V_2 = -\ 12 \times 3 = -\ 36\ A$$

$$v_0 = V_1 - V_2 = (-28) - (-36) = +8\ V$$



Ans.

2	Find the value of V_a and i_b in the following circuit. 	DPDC-16

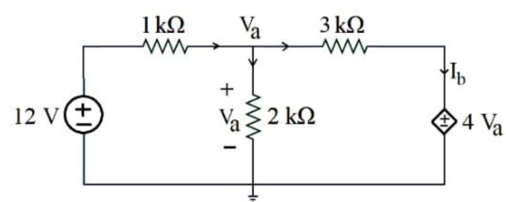
Solution:

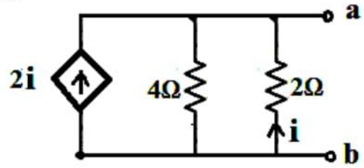
At V_a node,
Incoming Current = Outgoing Current

$$\frac{12 - V_a}{1} = \frac{V_a}{2} + \frac{V_a - 4V_a}{3}$$

$$\Rightarrow \quad V_a = 24\ V$$ **Ans.**

$$\therefore\ I_b = \frac{V_a - 4V_a}{3} = \frac{-3V_a}{3} = -24\ mA$$ ***Ans.***



3	What is the value of voltage across a-b terminal in the following circuit? 	BUET M.Sc.-14

Solution:

Current through 4 Ω resistor = 2i + i = 3i

Voltage across 4 Ω resistor = Voltage across 2 Ω resistor as they are in parallel

$$\Rightarrow \quad 4 \times 3i = 2 \times (-i)$$
$$\Rightarrow \quad 12i + 2i = 0$$
$$\Rightarrow \quad i = 0 \text{ A}$$

$\therefore \quad V_{ab} = 2 \times (-i) = 2 \times 0 = 0 \text{ V}$ **Ans.**

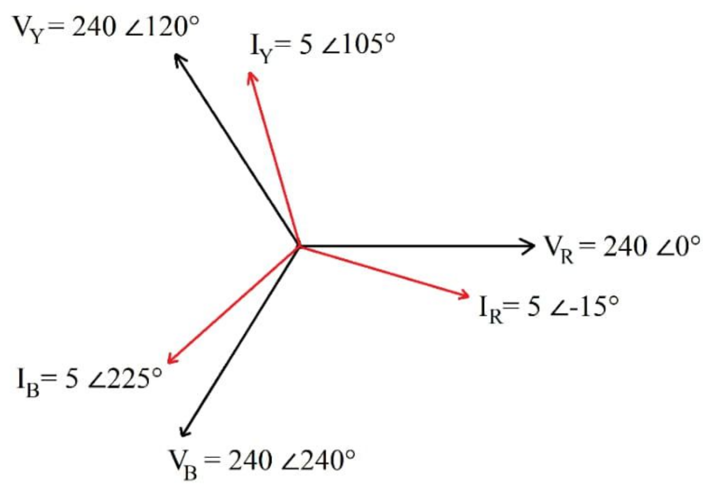
4	Find out the transient voltage at t = 2 sec. $V_{rms} = V\,(1 - e^{-t/RC})$	BUET M.Sc.-11

Solution:

$$V_{rms} = V\,(1 - e^{-2/RC})$$

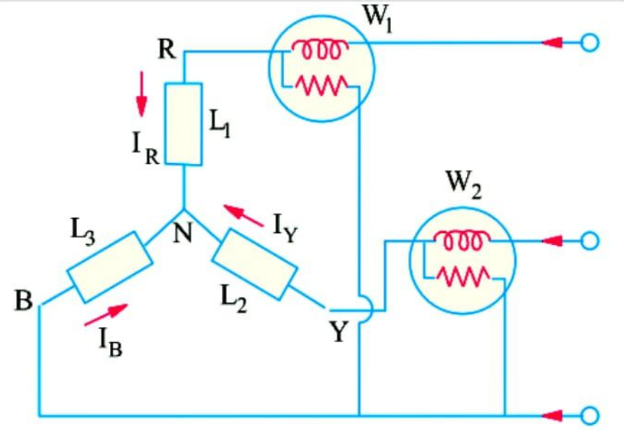
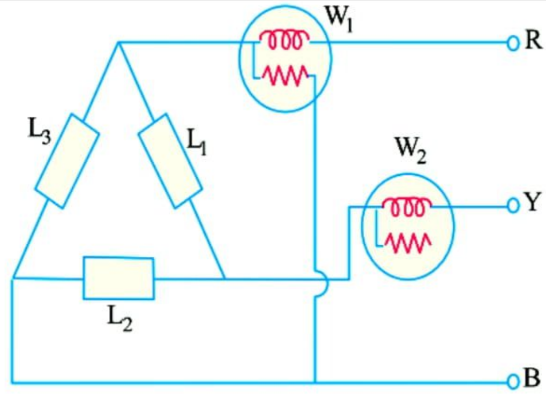
5	In a balanced 3-wire Y connected system, a 3-phase load has phase voltage of 240 V, a line current of 5A at lagging power factor 0.966 . Draw the phasor diagram.	PGCB-11

Solution:



6	Draw the connection diagram for two wattmeter method of measuring 3 Phase power of an unbalanced system.	DESCO-16

Solution:

For Y-Connected load	For Δ-Connected load
	

7	Draw the connection diagram of fluorescent lamp and incandescent lamp.	PGCL-11

Solution:

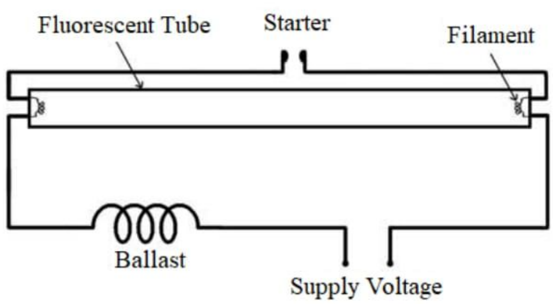


Figure: connection diagram of fluorescent lamp

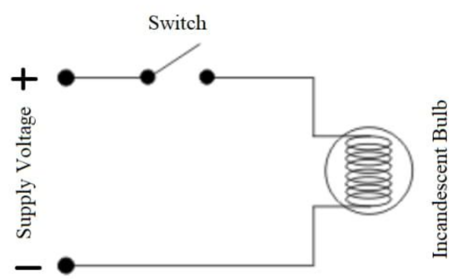


Figure: connection diagram of incandescent lamp

8	Find the average power dissipated per cubic meter in a non-conducting dielectric medium with relative permittivity of 4 and a loss tangent of 0.001, if $E = 1$ kV m^{-1} rms and the frequency is 10 MHz. *[Example 4.6, Electromagnetics With Application By Kraus]*	BUET M.Sc.-19

Solution:

Given,

- Current Density, $J = \sigma' E$
- Electric Field, $E = 1$ kV m^{-1} $= 10^3$ V m^{-1}
- Equivalent Conductance, $\sigma' = \omega\,\varepsilon\,\tan\delta$
- Frequency, $f = 10$ MHz $= 10^7$ Hz
- Angular Frequency, $\omega = 2\pi f = 2\pi \times 10^7$ rad/sec
- Relative Permittivity, $\varepsilon_r = 4$
- Vacuum Permittivity, $\varepsilon_0 = 8.854 \times 10^{-12}$ Fm^{-1}
- Permittivity, $\varepsilon = \varepsilon_r \varepsilon_0 = 4 \times 8.854 \times 10^{-12}$ Fm^{-1}
- Loss Tangent, $\tan\delta = 0.001$

Average power dissipated per cubic meter,

$$P = JE$$
$$= \sigma' E^2$$
$$= E^2 \sigma'$$
$$= E^2\,\omega\,\varepsilon\,\tan\delta$$
$$= (10^3)^2 \times (2\pi \times 10^7) \times (4 \times 8.854 \times 10^{-12}) \times 0.001$$
$$= 2.22\ W/m^3$$ ***Ans.***

Rony Parvej Special Note:

$$P = \frac{Power}{Volume} = \frac{Current \times Voltage}{Area \times Length} = \left(\frac{Current}{Area}\right) \times \left(\frac{Voltage}{Length}\right)$$

$$= Current\ Density \times Electric\ Field = JE$$

Rony Parvej Special Note:

depth of penetration, δ = (90° – θ)

tan δ = cos θ

or, Loss tangent = Power factor

9	A load received 10,000 VA at 0.707 p.f. Find: (a) Average power taken by the load (b) Total reactive power.	BPDB-10

Solution:

(a) P = S cos θ = 10,000 × 0.707 = 7070 W **Ans.**

(b) Q = S sin θ = S $\sqrt{1-\cos^2\theta}$ = 10,000 × $\sqrt{1-0.707^2}$ = 7070 VAR **Ans.**

10	The power supply to an inductive load is 240 V rms which draws average power of 10 kW at 0.85 lagging power factor? Find resistance and reactance of the circuit?	BTCL-17

Solution:

$$|I| = \frac{P}{V\cos\theta} = \frac{10{,}000}{240 \times 0.85} = 49\ A$$

$$Z = \frac{|V|}{|I|}\angle(\cos^{-1} p.f.) = \frac{240}{49}\angle(\cos^{-1} 0.85) = 4.898\ \angle 31.79° = 4.163 + j2.58 = R + j\,X$$

∴ Resistance, R = 4.163 Ω **Ans.**

Reactance, X = 2.58 Ω **Ans.**

11	When connected to a 215-V (rms), 50-Hz power line, a load absorbs 4 kW at a lagging power factor of 0.8. Find the value of capacitance necessary to make it a resonance circuit. *[Similar to Example 11.15, Sadiku]*	BUET M.Sc.-17

Solution:

$$C = \frac{Q_C}{\omega V_{rms}^2} = \frac{P\,(\tan\theta_1 - \tan\theta_2)}{\omega V_{rms}^2} = \frac{[4000 \times \{\tan(\cos^{-1} 0.8) - \tan(\cos^{-1} 1)\}]}{(2 \times 3.1416 \times 50 \times 215^2)} = 206.58\ \mu F$$ **Ans.**

12	A small workshop has three types of load: Load-1: 20 kW at unity power factor Load-2: 10 kW at 0.7 lagging power factor Load-3: 5 kW at 0.8 lagging power factor Find the capacitor required to improve the power factor of the workshop to unity. Assume the supply voltage, V_{rms} = 400 V and frequency is 50 Hz.	EGCB-20

Solution:

$P_{total} = P_1 + P_2 + P_3 = 20 + 10 + 5 = 35$ kW

$Q_{total} = Q_1 + Q_2 + Q_3 = P_1 \tan\theta_1 + P_2 \tan\theta_2 + P_3 \tan\theta_3$

$= 20 \tan(\cos^{-1} 1) + 10 \tan(\cos^{-1} 0.7) + 5 \tan(\cos^{-1} .8) = 13.95$ kVAR

$$S_{total} = \sqrt{P_{total}^2 + Q_{total}^2} = \sqrt{35^2 + 13.95^2} = 37.68\ kVA$$

$$p.f._{\ total} = \frac{P_{total}}{S_{total}} = \frac{35}{37.68} = 0.929$$

$$C = \frac{Q_C}{\omega V_{rms}^2} = \frac{P\ (\tan\theta_1 - \tan\theta_2)}{\omega V_{rms}^2} = \frac{[35000 \times \{\tan(\cos^{-1} 0.929) - \tan(\cos^{-1} 1)\}]}{(2 \times 3.1416 \times 50 \times 400^2)} = 277.51\ \mu F$$ **Ans.**

13	Two induction motors and a synchronous motor is connected to a system as load with following characteristics: Induction Motor-1: 100 kW, 0.878 p.f; Induction Motor-2: 1500 kW, 0.85 p.f and Synchronous Motor: 200 kW, 0.80 p.f. Find the power factor of the system.	BCPCL-18

Solution:

$P_{system} = P_{IM-1} + P_{IM-2} + P_{SM} = 100 + 1500 + 200 = 1800$ kW

$Q_{system} = Q_{IM-1} + Q_{IM-2} + Q_{SM} = P_{IM-1} \tan\theta_{IM-1} + P_{IM-2} \tan\theta_{IM-2} + P_{SM} \tan\theta_{SM}$

$= 100 \tan(\cos^{-1} 0.878) + 1500 \tan(\cos^{-1} 0.85) - 200 \tan(\cos^{-1} 0.8)$

≈ 834.13 kVAR

$$S_{system} = \sqrt{P_{system}^2 + Q_{system}^2} = \sqrt{1800^2 + 834.13^2} = 1983.88\ kVA$$

$$p.f._{\ system} = \frac{P_{system}}{S_{system}} = \frac{1800}{1983.88} \approx 0.907 \text{ lagging}$$

14	An infinite bus is operating at 480 V. One load on the bus is an induction motor consuming 200 KW at 0.8 p.f. lagging and another load is a synchronous motor consuming 150 KW at 0.85 p.f. leading. What is the line power factor?	EGCB-12

Solution:

$P_{line} = P_{IM} + P_{SM} = 200 + 150 = 350$ kW

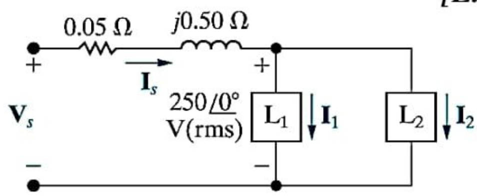
$Q_{line} = Q_{IM} + Q_{SM} = P_{IM} \tan\theta_{IM} + P_{SM} \tan\theta_{SM}$

$= 200 \tan(\cos^{-1} 0.8) - 150 \tan(\cos^{-1} 0.85)$

≈ 57 kVAR

$$S_{line} = \sqrt{P_{line}^2 + Q_{line}^2} = \sqrt{350^2 + 57^2} = 354.61\ kVA$$

$$p.f._{\ line} = \frac{P_{line}}{S_{line}} = \frac{350}{354.61} \approx 0.987\ lagging$$

15	The two loads in the circuit shown in Figure can be described as follows: Load 1 absorbs 8 kW at a leading power factor of 0.8. Load 2 absorbs 20 kVA at a lagging power factor of 0.6. Given that the frequency of the source is 60 Hz, compute the value of the capacitor that would correct the power factor to 1 if placed in parallel with the two loads. ***[Example 10.6, Nilsson]***  	BUET M.Sc.-19

Solution:

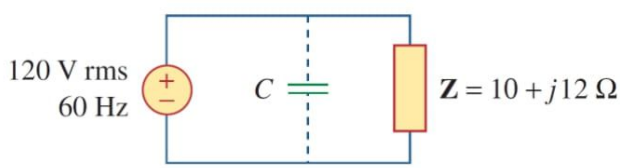
$$S_1 = P_1 + jQ_1 = 8 - 8\tan(\cos^{-1}0.8) = 8 - j6 \ \ kVA \qquad \text{('–' sign is for leading p.f.)}$$

$$S_2 = P_2 + jQ_2 = (20 \times 0.6) + j\,\{20 \times \sin(\cos^{-1}0.6)\} = 12 + j16 \ \ kVA$$

$$S_{1+2} = S_1 + S_2 = (8 - j6) + (12 + j16) = 20 + j10 \quad kVA$$

So, to correct power factor to unity, 10 kVAR (= Q_C) reactive power should be compensated by Capacitor (= C).

$$\therefore \quad C = \frac{Q_C}{\omega V_{rms}^2} = \frac{10{,}000}{(2 \times 3.1416 \times 60) \times 250^2} = 424.4\ \mu F$$ **Ans.**

16	Find the value of C needed to make the power factor unity. *[Exercise 11.69, Sadiku]*  	BWDB-18

Solution:

Z = 10 + j12

$$\therefore \quad S = \frac{V_{rms}^2}{Z^*} = \frac{120^2}{(10+j12)^*} = \frac{120^2}{10-j12} = 590.16 + j\,\mathbf{708.2}$$

So, to make power factor unity, 708.2 VAR (= Q_C) reactive power should be compensated by Capacitor (= C).

$$\therefore \quad C = \frac{Q_C}{\omega V_{rms}^2} = \frac{708.2}{(2 \times 3.1416 \times 60) \times 120^2} = 130.45\ \mu F$$ **Ans.**

17	A 50Hz capacitor is added in parallel with 11KV bus. The reactive power injected by a capacitor is 50KVAR. What is the value of capacitor?	BPDB-13

Solution:

$$C = \frac{Q_C}{\omega V_{rms}^2} = \frac{50{,}000}{(2 \times 3.1416 \times 50 \times 11000^2)} = 2.315\ \mu F$$ **Ans.**

18	A three-phase 440-V, 51-kW, 60-kVA inductive load operates at 60 Hz and is Y-connected. It is desired to correct the power factor to 0.95 lagging. What value of capacitor should be placed in parallel with each load impedance?	BCIC-19

Solution:

Capacitor needs to be placed in each phase of the three phases is

$$C = \frac{1}{3}\frac{Q_C}{\omega V_{rms}^2} = \frac{1}{3}\frac{P\,(\tan\theta_1 - \tan\theta_2)}{\omega V_{rms}^2}$$

$$= \frac{1}{3} \times \frac{[51{,}000 \times \{\tan\left(\cos^{-1}\frac{51{,}000}{60{,}000}\right) - \tan(\cos^{-1} 0.95)\}]}{(2 \times 3.1416 \times 60) \times 440^2} = 67.79\ \mu F \quad \textbf{\textit{Ans.}}$$

19	A 3-phase induction motor takes 400 V and the load 100 + j20 Ω in each phase is connected in delta. Determine the phase current, Real power drawn by the motor and amount of kVAR consumed.	MPL-17

Solution:

$Z_\varphi = 100 + j20\ \Omega$

For Delta Connection,

$V_\varphi = V_L = 400$ V

∴ $I_\varphi = \frac{V_\varphi}{Z_\varphi} = \frac{400}{100 + j20} = 3.92\ \angle -11.3° \approx 3.92$ A **Ans.**

∴ $S_{3\varphi} = 3\,V_\varphi\,I_\varphi^* = 3 \times 400 \times 3.92\angle 11.3 = 4612.81 + j921.73$ VA

∴ Real power drawn by motor, P = 4612.81 W = 4.61 kW **Ans.**
kVAR consumed, Q = 921.73 W = 0.922 kVAR **Ans.**

20	The following three phase loads are connected in parallel across a balanced three phase source. Load 1: 24 kW at 0.7 lagging power factor, Load 2: 12 kW at 0.6 lagging power factor and Load-3: 12 kVA at 0.85 leading power factor. If the line voltage at the load is 400 V rms at 50 Hz, find the line current and the resultant power factor.	DPDC-19

Solution:

For each phase,

$P_{total} = P_1 + P_2 + P_3 = 24 + 12 + (12 \times 0.85) = 46.2$ kW

$Q_{total} = Q_1 + Q_2 + Q_3 = P_1 \tan\theta_1 + P_2 \tan\theta_2 + S_3 \sin\theta_3$

$= 24 \tan(\cos^{-1} 0.7) + 12 \tan(\cos^{-1} 0.6) - 5 \sin(\cos^{-1} 0.85) = 37.85$ kVAR

$$S_{total} = \sqrt{P_{total}^2 + Q_{total}^2} = \sqrt{46.2^2 + 37.85^2} = 59.72\ kVA$$

$$p.f._{total} = \frac{P_{total}}{S_{total}} = \frac{46.2}{59.72} = 0.77 \quad lagging \qquad \textbf{Ans.}$$

$$|I_\varphi| = \frac{|S_\varphi|}{|V_\varphi|} = \frac{59{,}720}{400} = 149.3\text{ A}$$

Let, the loads are connected in Δ connection.

∴ Line current, $I_L = \sqrt{3}\, I_\varphi = \sqrt{3} \times 149.3 = 258.6\ \text{A}$ ***Ans.***

21	When connected to a 120-V (rms), 60-Hz power line, a load absorbs 4 kW at a lagging power factor of 0.8. Find the value of capacitance necessary to raise the pf to 0.95. *[Example 11.15, Sadiku]*	BCPCL-18

Solution:

$$C = \frac{Q_C}{\omega V_{rms}^2} = \frac{P(\tan\theta_1 - \tan\theta_2)}{\omega V_{rms}^2} = \frac{[4000 \times \{\tan(\cos^{-1} 0.8) - \tan(\cos^{-1} 0.95)\}]}{(2 \times 3.1416 \times 60 \times 120^2)} = 310.44\ \mu F \quad \textbf{Ans.}$$

22	A Power Station has an annual load factor of 0.7. It's total output in a year is 1000 million kWh. Find the capacity of the station. The utilization factor is 0.6 .	EGCB-20

Solution:

$$\text{Average Load} = \frac{\text{kWh generated / annum}}{Hours\ in\ a\ year} = \frac{1000 \times 10^6}{365 \times 24} \approx 114155\text{ W}$$

$$\text{Maximum Demand} = \frac{Average\ Load}{Load\ Factor} = \frac{114155}{0.7} = 163079\text{ W}$$

$$\text{Plant Capacity} = \frac{Maximum\ Demand}{Utilization\ Factor} = \frac{163079}{0.6} = 271798\text{ W} \approx 271.8\text{ kW} \qquad \textbf{Ans.}$$

23	Find the Plant Capacity Factor and Load Factor of a 10 GW power station whose annual load varies linearly from 8 GW to 4 GW.	BUET M.Sc.-17

Solution:

As the load varies linearly, Average load $= \frac{8+4}{2} = 6$ GW

∴ Load factor $= \frac{Average\ Load}{Maximum\ Load} = \frac{6}{8} = 0.75$ **Ans.**

∴ Capacity factor $= \frac{\text{Average load}}{\text{Plant Caparity}} = \frac{6}{10} = 0{\cdot}6$ **Ans.**

24	A new load is to be added to a power station. There are two types of loads: 5MW and 10MW. The demand factors are: 50% and 70% respectively. The group diversity factors are 1.1 & 1.4 respectively. The peak diversity factors of each type of loads are 0.45 & 0.30. Considering 4% transmission loss, find the transformer rating for supplying the load. Consider 0.8 p.f. lagging.	NWPGCL-19

Solution:

System peak demand = $\frac{\sum L_1 \times d_1}{G_1 \times p_1} + \frac{\sum L_2 \times d_2}{G_2 \times p_2} = \frac{(5\ MW \times 0.5)}{1.1 \times 0.45} + \frac{(10\ MW \times 0.7)}{1.4 \times 0.30}$ = 21.71 MW

4% transmission loss will occur before consumer's consumption. So, after loss (100% – 4% =) 96 % (which is 21.71 MW in this case) will be available for consumer's use.

So, the transformer needs to supply $\frac{21.71 \text{ MW}}{0.96}$ = 22.6146 MW (including transmission loss + consumption)

Considering 0.8 p.f., the transformer rating should be $\frac{22.6146}{0.8}$ = 28.268 MVA **Ans.**

25	**Updated Question:** A laundry has 10 lamps of 60 W each and two heaters of 1500 W each. It's maximum demand is 2 kW. On average, it uses 10 lamps for 7 hours a day, and each heater for 5 hours a day. Determine: (i) average load. (ii) monthly energy consumption, and (iii) load factor.	BPDB-12

Solution:

$$Maximum\ demand\ =\ 2\ kW$$

$$Connected\ load\ =\ 10 \times 60\ +\ 2 \times 1500 = 3600\ W$$

$$Daily\ energy\ consumption\ = (10 \times 60 \times 7) + (2 \times 1500 \times 5) = 19200\ Wh = 19.2\ kWh$$

(i) $Average\ load\ = \frac{daily\ energy\ consumption\ in\ kWh}{24} = \frac{19.2}{24} = 0.8\ kW$

(ii) $Monthly\ energy\ consumption\ =\ daily\ energy\ consumption\ \times\ no.of\ days\ in\ a\ month$

$$= 19.2\ \times\ 30\ =\ 576\ kWh$$

(iii) $Monthly\ load\ factor\ = \frac{monthly\ energy\ consumption}{maximum\ \ demand \times 24 \times 30} = \frac{576}{2 \times 24 \times 30} = 0.4 = 40\%$

26	The annual load duration curve of a substation can be considered as a straight line from 20 MW to 4 MW. Determine total energy supplied in the year and load factor of the substation.	DPDC-19

Solution:

As the load duration curve varies linearly (straight line),

Average load $= \frac{20+4}{2}$ = 12 MW

∴ Energy supplied in the year = Average load × Hours in a year

$= (12\times 10^6 \text{ W}) \times (365 \times 24 \text{ hours})$

$= 105.12 \times 10^9 \text{ Wh} = 105.12 \text{ GWh}$ **Ans.**

∴ Load factor $= \frac{Average\ Load}{Maximum\ Load} = \frac{12}{20} = 0.6$ **Ans.**

27	The annual load duration curve of a certain power station can be considered as a straight line from 20 MW to 4 MW. To meet this load, three turbine generator units, two rated at 10 MW each and one rated at 5 MW are installed. Determine load factor.	BCIC-19

Solution:

As the load duration curve varies linearly (straight line),

Average load $= \frac{20+4}{2} = 12 \text{ MW}$

∴ Load factor $= \frac{Average\ Load}{Maximum\ Load} = \frac{12}{20} = 0.6$ **Ans.**

28	The annual load duration curve of a certain power station can be considered as a straight line from 20 MW to 4 MW. To meet this load, three turbine-generator units, two rated at 10 MW each and one rated at 5 MW are installed. Determine (i) installed capacity (ii) plant factor (iii) units generated per annum (iv) load factor and (v) utilization factor. [Example 3.16, Mehta]	BPDB-14

Solution:

(i) Installed (Rated Plant) Capacity = 10 + 10 + 5 = 25 MW **Ans.**

(ii) As the load duration curve varies linearly (straight line),

Average load $= \frac{20+4}{2} = 12 \text{ MW}$

∴ Plant (capacity) factor $= \frac{Average\ load}{Rated\ (Plant)\ Capacity} = \frac{12}{25} = 0.48$ **Ans.**

(iii) Units generated per annum = Average load × Hours in a year

$= (12\times 10^6 \text{ W}) \times (365 \times 24 \text{ hours})$

$= 105.12 \times 10^9 \text{ Wh} = 105.12 \text{ GWh}$ **Ans.**

(iv) Load factor $= \frac{Average\ Load}{Maximum\ Load} = \frac{12}{20} = 0.6$ **Ans.**

(v) Utilization factor $= \frac{Maximum\ Demand\ (Load)}{Rated\ (Plant)\ Capacity} = \frac{20}{25} = 0.8$ **Ans.**

29	If Average load is 90 MW, Maximum Load is 100 MW and Installed Capacity is 110 MW in a power plant, then what should be it's Capacity factor and Utilization factor?	BUET M.Sc.-12

Solution:

$$\text{Capacity factor} = \frac{Average\ load}{Rated\ (Plant)\ Capacity} = \frac{90}{110} \approx 0.82 \quad \textbf{Ans.}$$

$$\text{Utilization factor} = \frac{Maximum\ Demand\ (Load)}{Rated\ (Plant)\ Capacity} = \frac{100}{110} \approx 0.91 \quad \textbf{Ans.}$$

30	The cost curve of a 600 MW coal fired power plant is $0.003\ P^2 + 6P + 500$ \$/hr/MW. What will be the cost to increase the output of the plant by 1 MW if it is operated at 100MW? If the plant is dispatched for a maximum of 500MW and its annual energy output is 3600 GWh, determine capacity factor and load factor.	CPGCBL-18

Solution:

$$\text{Incremental Fuel Cost, } \lambda = \frac{dC}{dP} = \frac{d}{dP}(0.003P^2 + 6P + 500) = 0.006\ P + 6 = 0.006\times100 + 6 = \$\ 6.6\ \$/hr/MW$$

Ans.

$$\text{Average load} = \frac{\text{kWh generated / annum}}{Hours\ in\ a\ year} = \frac{3600 \times 10^9}{365 \times 24} = 410{\cdot}96\ \text{MW}$$

$$\therefore \text{Capacity factor} = \frac{\text{Average load}}{\text{Plant Caparity}} = \frac{410.96}{600} = 0{\cdot}685 \quad \textbf{Ans.}$$

$$\therefore \text{Load factor} = \frac{\text{Average load}}{\text{Max. demand}} = \frac{410.96}{500} = 0{\cdot}822 \quad \textbf{Ans.}$$

31	What is the shape of condition in case of sag between two towers?	BPDB-10

Solution:

The shape of sag between two towers are catenary.

When the conductor supports are at equal level,

$$\text{Sag, S} = \frac{WL^2}{8T}$$

Where
L = Horizontal distance between the towers i.e. Span
W = Weight per unit length of conductor
T = Tension in the conductor

When the conductor supports are at unequal level,

$$\text{Sag } S_1 = \frac{WX_1^2}{2T}$$

$$\text{and Sag } S_2 = \frac{WX_2^2}{2T}$$

Where,
L = Horizontal distance between the towers i.e. Span
T = Tension in the conductor
X_1 = Horizontal distance of lowest point from 1st support
X_2 = Horizontal distance of point lowest point from 2nd support
W = Weight per unit length of conductor

32	In a 3-phase motor, P = 0.6 p.u., V = 0.95 p.u. What is the value of I in p.u.?	BUET M.Sc.-13

Solution:

As, power factor is not given, let p.f. = 1.

$$I_{p.u.} = \frac{P_{p.u.}}{V_{p.u.}} = \frac{0.6}{0.95} = 0.63\ p.u. \quad \textbf{Ans.}$$

33	Two line currents of an unbalanced 3-phase, 3-wire system are 100∠90° A and 110∠-10° A. Find the third line current.	BUET M.Sc.-14

Solution:

In, 3-phase, 3-wire system, $I_{L1} + I_{L2} + I_{L3} = 0$

$$I_{L3} = -(I_{L1} + I_{L2}) = -(100\angle 90° + 110\angle -10°) = 135.2\angle -143.25° \quad \textbf{Ans.}$$

34	**Updated Question:** Three Phase currents are given as: 11 ∠35°, 30 ∠150° and 8 ∠240°. Find out the neutral current.	BUET M.Sc.-11

Solution:

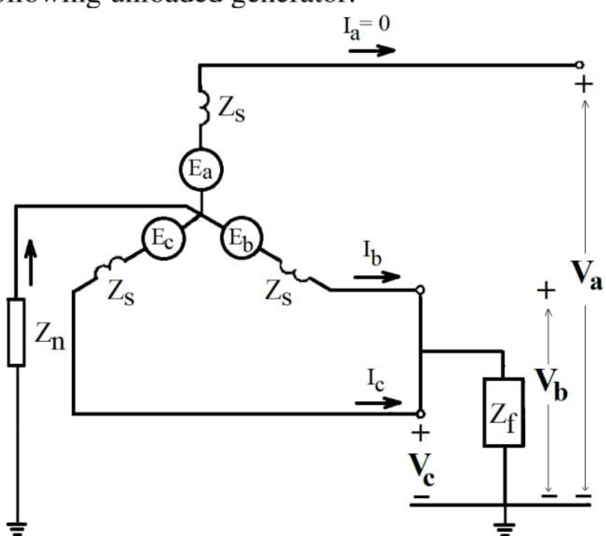
$$\textit{Current in neutral wire,} \quad I_n = (I_a + I_b + I_c) = 11\angle 35° + 30\angle 150° + 8\angle 240° = 25.43\angle 145.55°$$

35	In a 33 kV bus, the voltage is 1 p.u. in a base line voltage of 33 kV. If a L-L-L-G fault occurs at this bus, the fault current flowing to the fault is 30 kA. The three phase base MVA is 100 MVA. What is the thevenin's equivalent impedance seen looking to the network from the bus. (6 marks)	PGCB-14

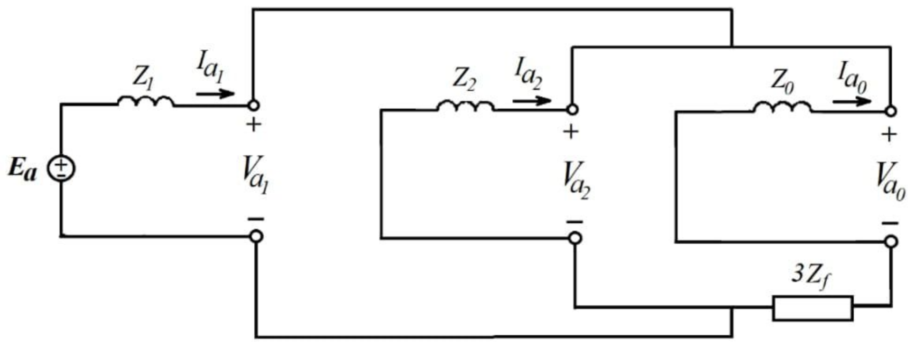
Solution:

L-L-L-G fault means symmetrical fault.

$$Z_{fault} = \frac{V_{fault}}{I_{fault}} = \frac{33}{30} = 1.1\ \Omega \quad \textbf{Ans.}$$

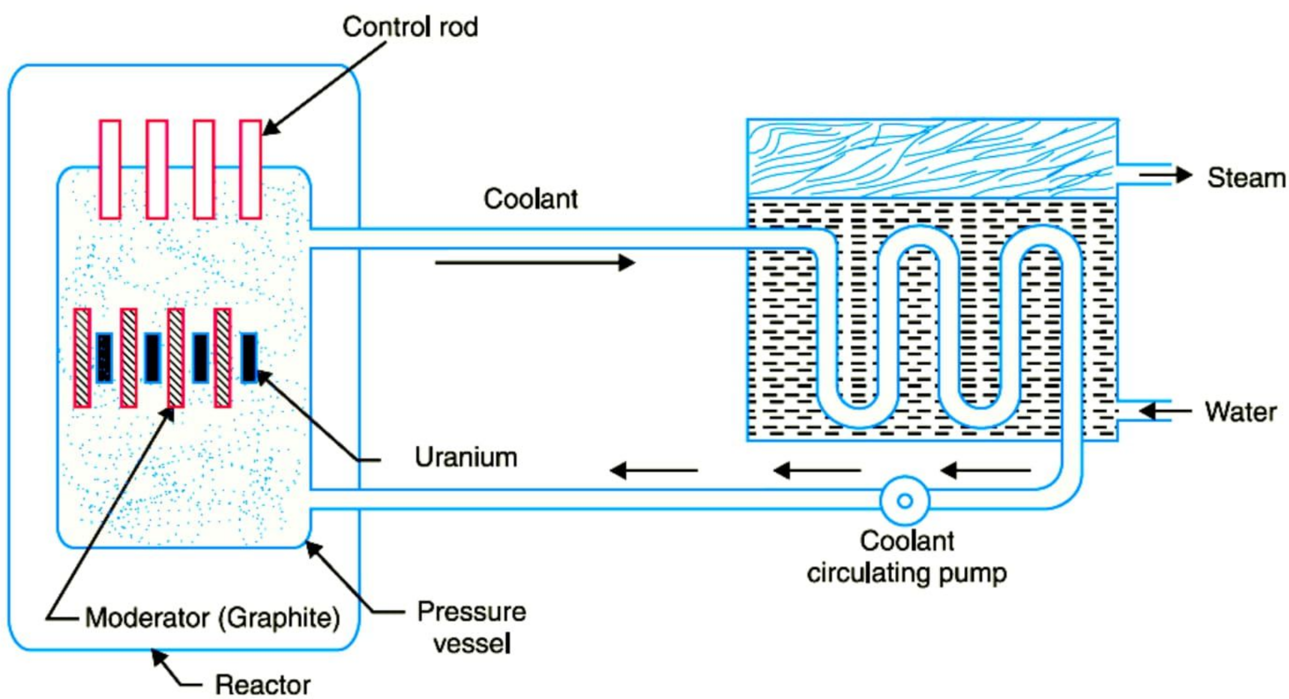
36	**Updated Question:** Draw the sequence network for a double line to ground fault occurred in the following unloaded generator. 	BUET M.Sc.-17

Solution:



37	Draw the diagram of Heavy Pressurized Water Reactor.	NPCBL-18

Solution:



38	What is pulverization? Why demineralized water is essential for boiler of a Steam Turbine power plant?	BPDB-12

Solution:

"Pulverization" (comminution, crushing, grinding) is the process of applying an external force to a (solid) material of a certain size to reduce it into pieces that are smaller than the original size.

The hardness, TDS (Total dissolved solids), TSS (Total suspended solids), specific conductivity etc of the water used in boiler of a steam turbine power plant, should kept under permissible limits. The amount of chlorides, sulphates and calcium should be kept under limits to prevent scaling of boiler tubes. Silica is also a major concern for boiler and condenser tube scaling and should be within a range of 0.01–0.3 mg/l to prevent scaling. So, because of these stringent criteria required for steam generation, demineralized water is essential in a steam turbine power plant.

39	Why transformer is rated in kVA? What are the instrument transformers?	PGCL-11

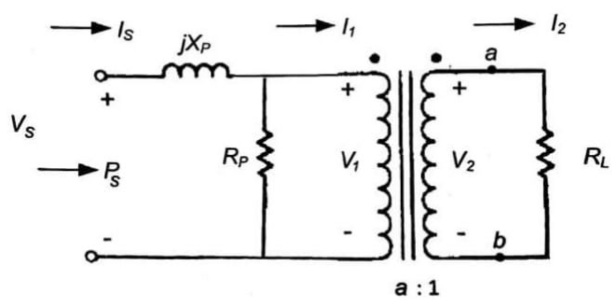
Solution:

Cu loss of a transformer depends on current and iron loss on voltage. Hence, total transformer loss depends on volt-ampere (VA) and not on phase angle between voltage and current i.e. it is independent of load power factor. That is why rating of transformers is in kVA and not in kW. *(Reference: Theraja's topic 32.23)*

Instrument Transformers are used in AC system for measurement of electrical quantities i.e. voltage, current, power, energy, power factor, frequency. Instrument transformers are also used with protective relays for protection of power system.

Instrument transformers are of two types –

1. Current Transformer (C.T.)
2. Potential Transformer (P.T.)

40	For the ideal transformer circuit of figure, $R_P = 18\ \Omega$, $R_L = 6\ \Omega$ and $X_P = 0.5\ \Omega$. If, $V_2 = 120\,\underline{/0^\circ}$ V and $P_S = 5600$W, determine (a) the turn ratio, (b) the source voltage V_S, and (c) the input power factor. 	DWASA-17

Solution:

$$\frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{1}{a} \qquad \Rightarrow V_2 = aV_1$$

$$I_S = \frac{V_1}{R_P} + \frac{I_2}{a} = \frac{aV_2}{R_P} + \frac{V_2}{R_L\, a} = \frac{120a}{18} + \frac{120}{6a} = \frac{20}{3}\left(\frac{3+a^2}{a}\right)$$

$$R_{total} = R_P\ ||\ (a^2 R_L) = 18\ ||\ (6a^2) = \frac{18 \times 6a^2}{18 + 6a^2} = \frac{18a^2}{3 + a^2}$$

$$P_S = I_S^2\, R_{Total} = \left\{\frac{20}{3}\left(\frac{3+a^2}{a}\right)\right\}^2 \times \left(\frac{18a^2}{3+a^2}\right) = 5600$$

$$\Rightarrow \quad \frac{400}{9} \times \frac{(3+a^2)^2}{a^2} \times \frac{18a^2}{(3+a^2)} = 5600$$

$$\Rightarrow \quad 3+a^2 = \frac{5600}{18} \times \frac{9}{400} = 7$$

$$\Rightarrow \quad a = 2$$

$(a) \quad turn\,ratio, a : 1 = 2 : 1$ ***Ans.***

$$I_S = \frac{20}{3}\left(\frac{3+a^2}{a}\right) = \frac{20}{3}\left(\frac{3+2^2}{2}\right) = \frac{20}{3} \times \frac{7}{2} = \frac{70}{3} \angle 0^\circ$$

$(b) \quad Source\ Voltage\ \ V_S = I_S \times (jX_P) + V_1 = \left(\frac{70}{3}\angle 0^\circ\right) \times \left(0.5\angle 90^\circ\right) + \left(2 \times\ 120\angle 0^\circ\right)$

$= 240.28\angle 2.78^\circ$ ***Ans.***

$(c) \quad Power\ factor, \quad Cos\ \theta_s = \cos 2.78^\circ = 0.998\ \ lagging$ ***Ans.***

41	A 2300/230 V, 200 kVA transformer has a primary resistance of 0.4 Ω in high voltage side and secondary resistance of 3.5 Ω in low voltage side. Determine (a) Low and High voltage side currents. (b) Equivalent resistance referred to high voltage side.	BUET M.Sc.-16

Solution:

Turn Ratio, $a = N_1/N_2 = V_1/V_2 = 2300/230 = 10$
$VA_1 = VA_2 = 200$ kVA
$R_1 = 0.4\ \Omega$
$R_2 = 3.5\ \Omega$
(a) $I_1 = ?\ ;\ I_2 = ?$
(b) $R_{01} = ?$

$I_1 = VA_1 / V_1 = (200 \times 10^3)/2300 = 86.9565$ A **Ans.**
$I_2 = VA_2 / V_2 = (200 \times 10^3)/230 = 869.565$ A **Ans.**

$R_{01} = R_1 + R_2' = R_1 + a^2 R_2 = 0.4 + 10^2 \times 3.5 = 350.4\ \Omega$ **Ans.**

42	How a synchronous machine of 400V, 60Hz can be run at 50 Hz frequency?	BUET M.Sc.-16

Solution:

A 60Hz motor will run 20% slower on 50Hz power supply. This results in 20% less power and the slowing down of cooling fan. But the critical factor here is the V/Hz ratio. It will go 20% up which is not good. This means that during parts of every power line cycle the magnetic structure of the motor will probably be overloaded. To correct the V/Hz with the variable value, we change the voltage, V. Lowering the voltage with a transformer will correct the V/Hz ratio.

43	A 3 phase, 5hp, 220V Y-connected motor has an efficiency of 85%. Determine power factor when it draws 15A current from line.	DESCO-16

Solution:

Output Power, $P_{out} = 5\ hp = 5 \times 746\ W = 3730\ W$

Input Power, $P_{in} = \frac{P_{out}}{\eta} = \frac{3730}{0.85} = 4388.23\ W$

For a 3 phase, Y-connected motor,

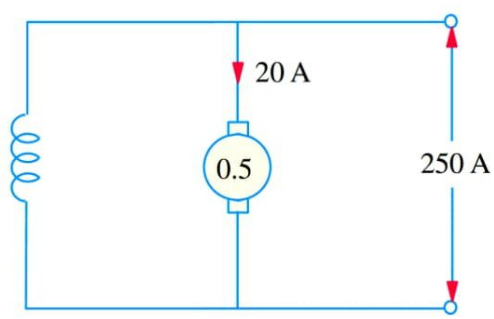
$$P_{in} = \sqrt{3}\, V_L I_L \cos\theta$$

$$\Rightarrow \quad \cos\theta = \frac{P_{in}}{\sqrt{3}\, V_L I_L} = \frac{4388.23}{\sqrt{3} \times 220 \times 15} = 0.7677 \quad lagging \qquad \textbf{Ans.}$$

44	A 250-V shunt motor has an armature current of 20 A when running at 1000 r.p.m. against full load torque. The armature resistance is 0.5 Ω. What resistance must be inserted in series with the armature to reduce the speed to 500 r.p.m. at the same torque and what will be the speed if the load torque is halved with this resistance in the circuit? Assume the flux to remain constant throughout and neglect brush contact drop. *[Example 30.20, Theraja]*	DNCC-16

Solution:

Let R_t to be total resistance in the armature circuit i.e. $R_t = R_a + R$, where R is the additional resistance.



$$E_{b1} = V - I_{a1} R_a = 250 - 20 \times 0.5 = 240\ V$$

$$\therefore \quad E_{b2} = V - I_{a2} R_t = 250 - 20\, R_t$$

It should be noted that $I_{a1} = I_{a2} = 20\ A$ because torque remains the same and $\Phi_1 = \Phi_2$ in both cases.

$$\therefore \quad \frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}} \times \frac{\Phi_1}{\Phi_2} = \frac{E_{b2}}{E_{b1}}$$

$$\Rightarrow \quad \frac{500}{1000} = \frac{250 - 20\, R_t}{240}$$

$$\therefore R_t = 6.5\, \Omega\, ; \quad \Rightarrow R = 6.5 - 0.5 = 6\, \Omega \qquad \textbf{Ans.}$$

Since the load is halved, armature current is also halved because flux remains constant. Hence, $I_{a3} = \frac{20}{2} = 10\ A.$

$$\therefore \quad \frac{N_3}{N_1} = \frac{E_{b3}}{E_{b1}} \times \frac{\Phi_1}{\Phi_3} = \frac{E_{b3}}{E_{b1}} = \frac{V - I_{a3} R_t}{E_{b1}} = \frac{250 - 10 \times 6.5}{240} = 0.7708$$

$$\therefore \quad N_3 = 0.7708\, N_1 = 0.7708 \times 1000 \approx 771\ r.p.m. \qquad \textbf{Ans.}$$

45	Determine the values of time constant, settling time and rise time of a system represented by the following transfer function when subject to a unit step input.	SGFL-17

	$T(s) = \frac{50}{s+50}$	

Solution:

$$T(s) = \frac{C(s)}{R(s)} = \frac{50}{s+50}$$

The response for unit step function, $R(s) = \frac{1}{s}$

$$\therefore\ C(s) = T(s)R(s) = \frac{50}{s+50} \times \frac{1}{s} = \frac{50}{s(s+50)} = \frac{1}{s} - \frac{1}{s+50}$$ (আংশিক ভগ্নাংশে রূপান্তর করে)

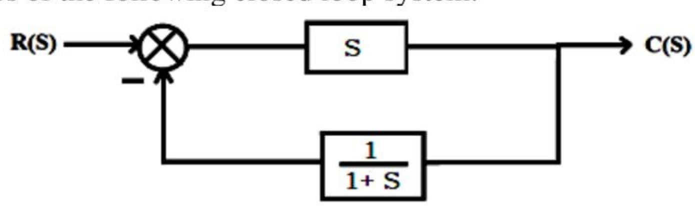
$$\therefore\ C(t) = 1 - e^{-50t}$$

Comparing this with $C(t) = 1 - \frac{e^{-\zeta\omega_n t}}{\sqrt{1-\zeta^2}}\sin[\left(\omega_n\sqrt{1-\zeta^2}\right)t + \theta]$, we get $\zeta\omega_n \approx 50$

$$\therefore Time\ constant, \tau = \frac{1}{\zeta\omega_n} = \frac{1}{50} = 0.02\ second$$ ***Ans.***

$$\therefore Settling\ time, T_s = \frac{4}{\zeta\omega_n} = \frac{4}{50} = 0.08\ second$$ ***Ans.***

$$\therefore Rise\ time, T_r = \tau \ln 9 = \frac{\ln 9}{\zeta\omega_n} = \frac{2.197}{50} \approx 0.44\ second$$ ***Ans.***

46	Find the poles of the following closed loop system: 	BCPCL-16

Solution:

$$Here, G\ (s) = \ s, H\ (s) = \frac{1}{1+s}$$

$$T(s) = \frac{G(s)}{1+G(s)H(s)} = \frac{s}{1+s\times\frac{1}{1+s}} = \frac{s}{1+\frac{s}{1+s}} = \frac{s}{\frac{1+s+s}{1+s}} = \frac{s(1+s)}{1+2s}$$

For Pole,

$s(1+s) = 0;$

⇒ $s = 0, -1;$

⇒ Poles are at 0 & – 1 **Ans.**

For Zero,

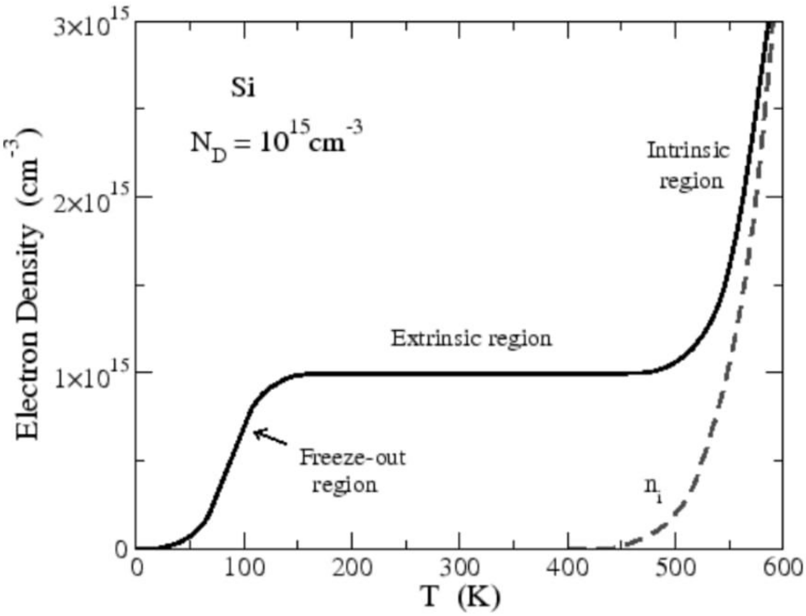
$1 + 2\ s = 0;$

⇒ $s = -\frac{1}{2}$;

⇒ Zero is at $-\frac{1}{2}$ **Ans.**

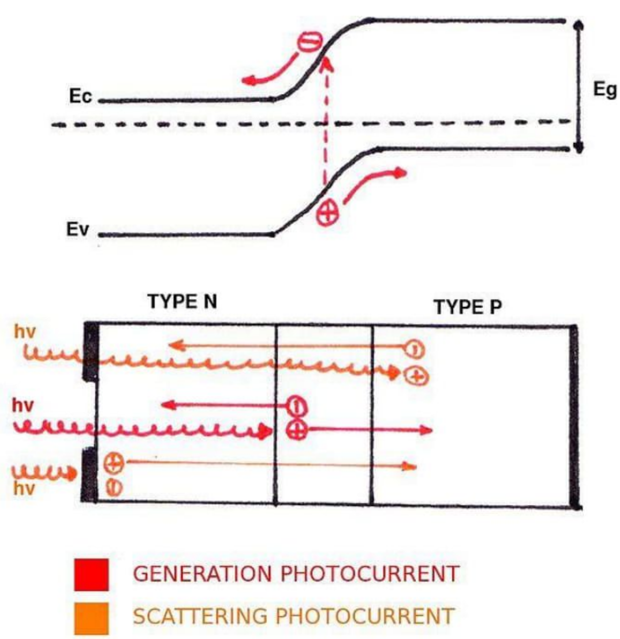
47	Draw electron concentration versus temperature graph for Si.	BUET M.Sc.-19

Solution:



48	Draw Energy Band diagram of a solar cell showing electron-hole junctions.	MPL-17

Solution:



49	(Similar) Consider germanium with an acceptor concentration of $N_a = 10^{15}$ cm^{-3} and a donor concentration of $N_d = 0$. Consider temperatures of T = 200, 400, and 600 K. Calculate the position of the Fermi energy with respect to the intrinsic Fermi level at these temperatures. *[Problem 4.48, Semiconductor Physics And Devices: Basic Principles 4th Edition by Donald A. Neamen]*	BUET M.Sc.-19

Solution:

We Know,

$$E_{FI} - E_F = kT \ln\left(\frac{p_0}{n_i}\right)$$

$$p_0 = \frac{N_a}{2} + \sqrt{\left(\frac{N_a}{2}\right)^2 + n_i^2}$$

Applying These formulas, we get,

$T(°K)$	$kT\ (eV)$	$n_i\ (cm^{-3})$	$p_0 (cm^{-3})$	$E_{FI} - E_F\ (eV)$	
200	0.01727	2.16×10^{10}	10^{15}	0.1855	***Ans.***
400	0.03454	8.6×10^{14}	1.49×10^{15}	0.01898	***Ans.***
600	0.0518	3.82×10^{16}	3.87×10^{16}	0.000674	***Ans.***

50	Potassium has a work function of 2.3 eV. What is the longest wavelength of light that will release an electron from a potassium surface?	BUET M.Sc.-19

Solution:

$$KE_{max} = E - \varphi = hf - \varphi$$

$$\therefore \quad \varphi = hf = h\frac{c}{\lambda} \quad \text{[during electron release]}$$

$$\therefore \lambda = \frac{hC}{E} = \frac{(6.626 \times 10^{-34}) \times (3 \times 10^8)}{2.3 \times (1.6 \times 10^{-19})}$$

$= 5.402 \times 10^{-7}$ m

$= 540.2$ nm **Ans.**

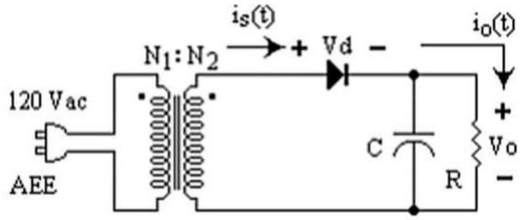
φ = 2.3 eV = 2.3 × (1.6 × 10^{-19}) J
= work function
= amount of energy binding the electron to the metal

h = 6.626 × 10^{-34} m^{2}kg s^{-1}
= Plank's Constant

C = 3 × 10^8 ms^{-1}
= Speed of light

KE_{max} = maximum kinetic energy of electron
= 0; when electron will be just released

51	For the power supply shown in figure, determine: (a) the ripple voltage, (b) the average output voltage, (c) the peak diode current.	MPL-17

	Allow 0.7 V for forward diode voltage drop. Assume: 60 Hz supply frequency, R= 100 Ω, C = 3300 μF, $\frac{N_1}{N_2} = 9$. 	

Solution:

At secondary

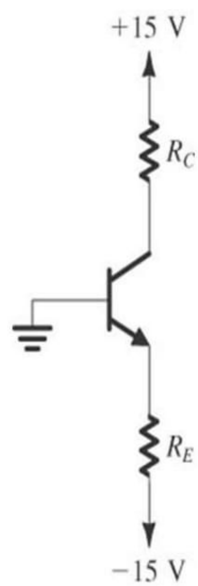
$$V_{rms} = \frac{N_2}{N_1} \times 120 = \frac{1}{9} \times 120 = 13.333\,V$$

$$V_{peak} = \sqrt{2} \times V_{rms} = \sqrt{2} \times 13.333 = 18.856\,V$$

(a) Ripple Voltage, $V_{ripple} = \frac{V_{peak} - V_D}{fRC} = \frac{18.856 - 0.7}{60 \times 100 \times (3300 \times 10^{-6})} = 0.917\,V$ **Ans.**

(b) Average output Voltage, $V_o = \frac{V_{peak} - V_D}{\pi} = \frac{18.856 - 0.7}{3.1416} = 5.78\,V$ **Ans.**

(c) Peak diode current, $I_{Dmax} = \frac{V_{peak} - V_D}{R} = \frac{18.856 - 0.7}{100} = 0.18156\,A$ **Ans.**

52	Design the circuit to obtain collector current of 2 mA and collector voltage of 5 V. (β = 100). 	BUET M.Sc.-16

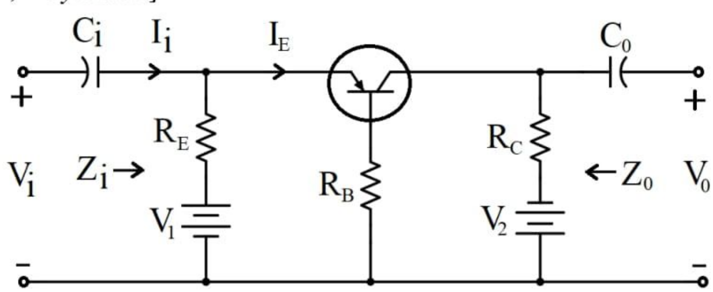
Solution:

$$R_C = \frac{V_{CC} - V_C}{I_C} = \frac{15 - 5}{2 \times 10^{-3}} = 5\ k\Omega \qquad \textbf{Ans.}$$

$$I_B = \frac{I_C}{\beta} = \frac{2 \times 10^{-3}}{100} = 0.02\ mA$$

$$I_E = (\beta + 1) I_B = 101 \times 0.02 = 2.02\ mA$$

$$R_E = \frac{V_B - B_{BE} - V_{EE}}{I_E} = \frac{0 - 0.7 - (-15)}{2.02 \times 10^{-3}} = 7.079\ k\Omega \qquad \textbf{Ans.}$$

53	Find voltage gain and current gain in the following circuit. Given, $C_i = 10\mu F$, $R_E = 1\ k\Omega$, $V_1 = 2V$, $R_B = 0\ k\Omega$, $R_C = 5\ k\Omega$, $V_2 = 8\ V$, $\alpha = 0.98$, $r_0 = 1\ M\Omega$. *[Similar to Example 8.1, Boylestad]* 	BTCL-17

$$I_E = \frac{V_1 - V_{BE}}{R_E + R_B} = \frac{2 - 0.7}{1 + 0} = 1.3\ mA$$

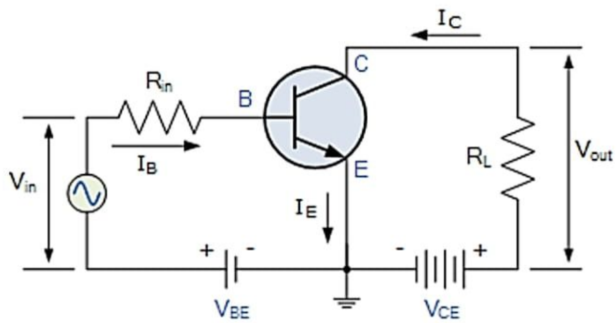
$$r_e = \frac{26\ mV}{I_E} = \frac{26\ mV}{1.3\ mA} = 20\ \Omega$$

As $r_o > 10\ R_C$; Voltage Gain, $A_v = -\frac{R_C}{r_e} = -\frac{5000}{20} = -250$ **Ans.**

Current gain, $A_i = -\alpha = -0.98$ **Ans.**

54	Draw a common emitter amplifier circuit using a bipolar junction transistor.	EGCB-12

Solution:



55	For a class B amplifier providing a 20 V peak signal to a 16 Ω load (speaker) a power supply of V_{CC} = 30 V, determine the input power, output power and the efficiency.	MPL-17

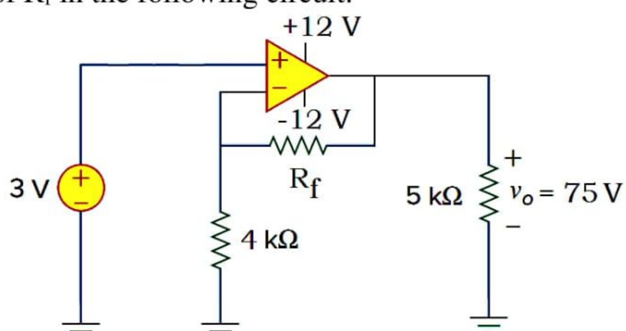
Solution:

$$I_P = \frac{V_P}{R_L} = \frac{20}{15} = 1.25\ A$$

$$P_{i(dc)} = V_{CC}\, I_{dc} = V_{CC} \times \left(\frac{2}{\pi}\, I_P\right) = 20 \times \left(\frac{2}{\pi} \times 1.25\right) = 23.87\ W$$ **Ans.**

$$P_{o(ac)} = \frac{V_{rms}^2}{R_L} = \frac{\left(\frac{V_P}{\sqrt{2}}\right)^2}{R_L} = \frac{V_P^2}{2R_L} = \frac{20^2}{2\times 16} = 12.5\ W$$ **Ans.**

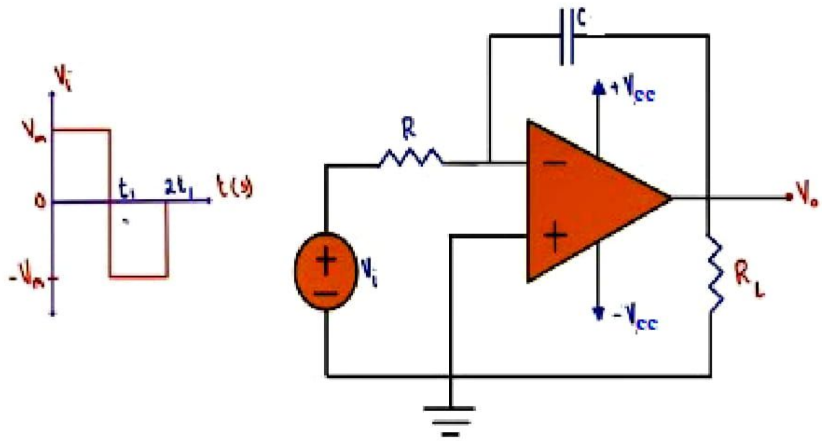
$$\eta = \frac{P_{o(ac)}}{P_{i(dc)}} = \frac{12.5}{23.87} = 52.37\ \%$$ **Ans.**

56	Find the value of R_f in the following circuit. 	BCMCL-20

Solution:

$$V_0 = \left(1 + \frac{R_f}{R_i}\right) V_i$$

$$R_f = \left(\frac{V_0}{V_i} - 1\right) R_i = \left(\frac{75}{3} - 1\right) \times 4000 = 96000\ \Omega = 96\ k\Omega$$ ***Ans.***

57	Assume the numerical values for the input voltage are V_m = 1 V and RC = 1 ms. V_i input voltage is applied to the integrator amplifier. $+V_{CC}$ = +14 V and $-V_{CC}$ = -13 V. The initial voltage on capacitor is zero. (a) Calculate the output voltage V_o (t) and (b) plot V_o (t) vs t. 	NPCBL-18

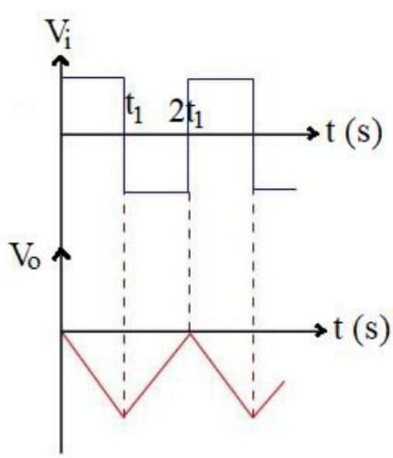
Solution:

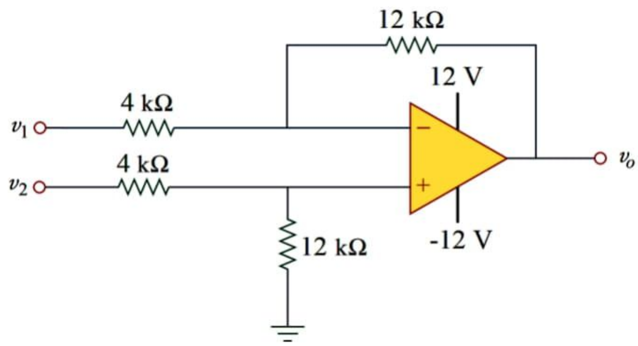
For $0 \leqslant t \leqslant t_1$

$$V_0 = -\frac{1}{\mathrm{RC}}\int_0^t V_i\,dt = -\frac{1}{10^{-3}}\int_0^t 1\,dt = -1000\,\mathrm{t}$$

For $t_1 \leqslant t \leqslant 2t_1$

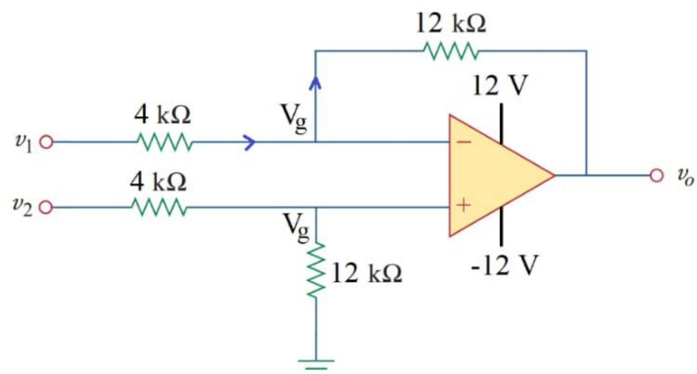
$$V_0 = -\frac{1}{\mathrm{RC}}\int_t^{2t} V_i\,dt = -\frac{1}{10^{-3}}\int_0^t (-1)\,dt = 1000\,\mathrm{t}$$



58	Find V_0 in the following circuit when $V_1 = V_2 = 0.5$ V. 	BTCL-17

Solution:

$$V_g = \frac{12}{4 + 12} \times 0.5 = 0.375\ V$$



At V_g node,

$$\frac{V_1 - V_g}{4} = \frac{V_g - V_0}{12}$$

$$\Rightarrow\ 3\,(V_1 - V_g) = V_g - V_0$$

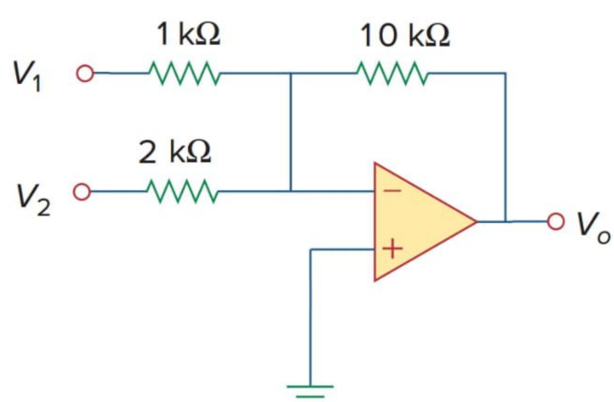
$$\Rightarrow\ V_0 = V_g - 3\,V_1 + 3V_g$$

$$= 4V_g - 3\,V_1$$

$$= 4 \times 0.375 - 3 \times 0.5$$

$$= 4 \times 0.375 - 3 \times 0.5$$

$$= 0\ V \quad \textbf{\textit{Ans.}}$$

59	Find V_o 	BUET M.Sc.-17

Solution:

$$V_0 = -\frac{R_f}{R_1} \times V_1 - \frac{R_f}{R_2} \times V_2 = -\frac{10}{1} \times V_1 - \frac{10}{2} \times V_2 = -10\,V_1 - 5V_2 \qquad \textbf{\textit{Ans.}}$$

60	The output of an integrator having 100 kΩ resistance and 0.1μF capacitance is 10 cos ($2\pi \times 10^3$) t. Find it's input.	DWASA-14

Solution:

$$V_0 = -\frac{1}{RC}\int V_i dt$$

$$\int V_i dt = -V_0 RC = -\{10\cos(2\pi \times 10^3)t\} \times (100 \times 10^3) \times (0.1 \times 10^{-6})$$

$$= -0.1\cos(2\pi \times 10^3)t$$

$$V_i = \frac{d}{dx}\left(\int V_i dt\right) = \frac{d}{dx}\{-0.1\cos(2\pi \times 10^3)t\} = (2\pi \times 10^3) \times 0.1\sin(2\pi \times 10^3)t$$

$$= 628.32\sin(2\pi \times 10^3)t \qquad \boldsymbol{Ans}.$$

61	Configure two XOR gate such that one must function as buffer and other as inverter.	BADC-20

Solution:

Buffer design using XOR gate:

A	B	OUT
0	0	0
0	1	1

Inverter design using XOR gate:

A	B	OUT
1	0	1
1	1	0

62	Why speech bandwidth is restricted between 300-3400 Hz in analog system.	BUET M.Sc.-11

Solution:

The average fundamental frequency for a male voice is 125Hz; for a female voice it's 200Hz; and for a child's voice, 300Hz. When applied to speech, the human voice spans a range from about 125Hz to 8kHz. Consonants take up space between 2kHz and 5kHz. Vowel Sounds are most prominent between 500Hz and 2kHz.

For efficient use of analog system considering cost, 300-3400 Hz is enough to represent human voice. So, speech bandwidth is restricted between 300-3400 Hz in analog system.

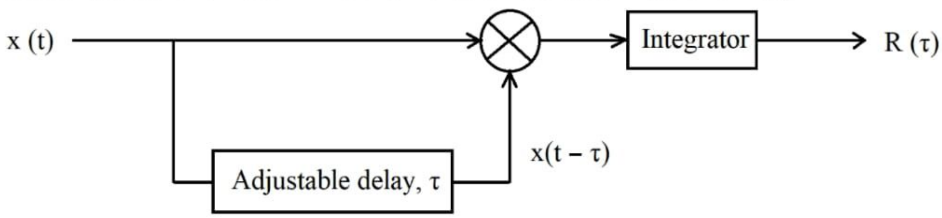
63	Calculate the bit rate of a single channel PCM system that uses the standard band limited telephone channel.	BUET M.Sc.-17

Solution:

$f_s = 8$ kHz (standard sampling frequency)

$n = 8$ (standard no. of bit for PCM is 8. 7 bit is used for encoding and 1 bit is used to indicate sign (MSB)

∴ $R_b = n\, f_s = 8 \times 8 = 64$ kbps is standard bit rate for a single channel PCM.

64	**Updated Question:** Determine the Relation between x(t) and R(τ). 	BUET M.Sc.-18

Solution:

Here R (τ) is the auto-correlation function which measures similarities between the signal x (t) and its time delayed version x (t – τ).

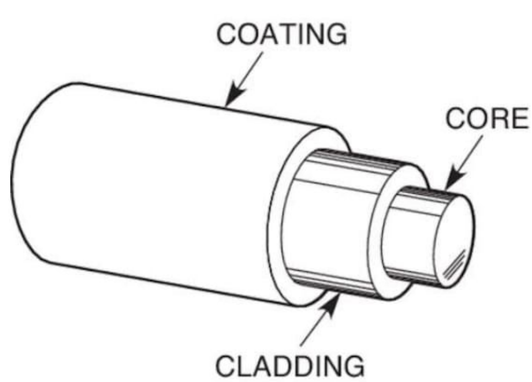
$$R\ (\tau) = \int_{-\propto}^{\propto} x(t)x(t-\tau)d\tau \qquad If\ x(t)\ is\ real\ valued$$

$$R\ (\tau) = \int_{-\propto}^{\propto} x(t).x^{*}(t-\tau)\ dt \qquad If\ x(t)\ is\ complex$$

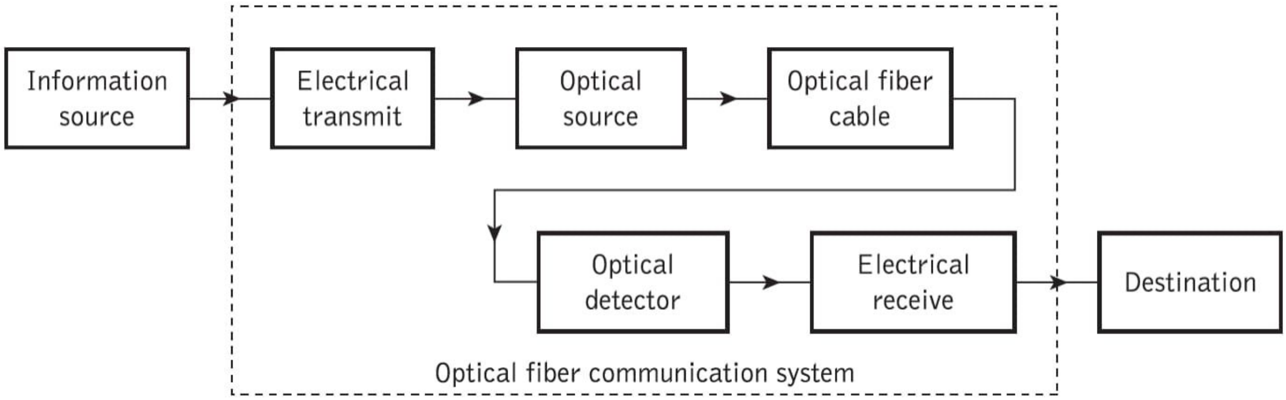
65	Draw the structure of fibre optic cable & write the basic components of fibre optic communication system.	PGCB-14

Solution:

Structure of fibre optic cable:



Basic Components of Fiber Optic Communication System (Guided):



66	Name the principle according to which light wave propagates through optical fiber.	BUET M.Sc.-11

Solution:

Total Internal Reflection

67	Name the principal of light signal transmission. Draw the refractive index profile and ray transmission for the following: (i) Multimode step-index fiber. (ii) Multimode Graded index fiber.	BUET M.Sc.-13

Solution:

Light is propagated through total internal reflection in fiber optic communication.

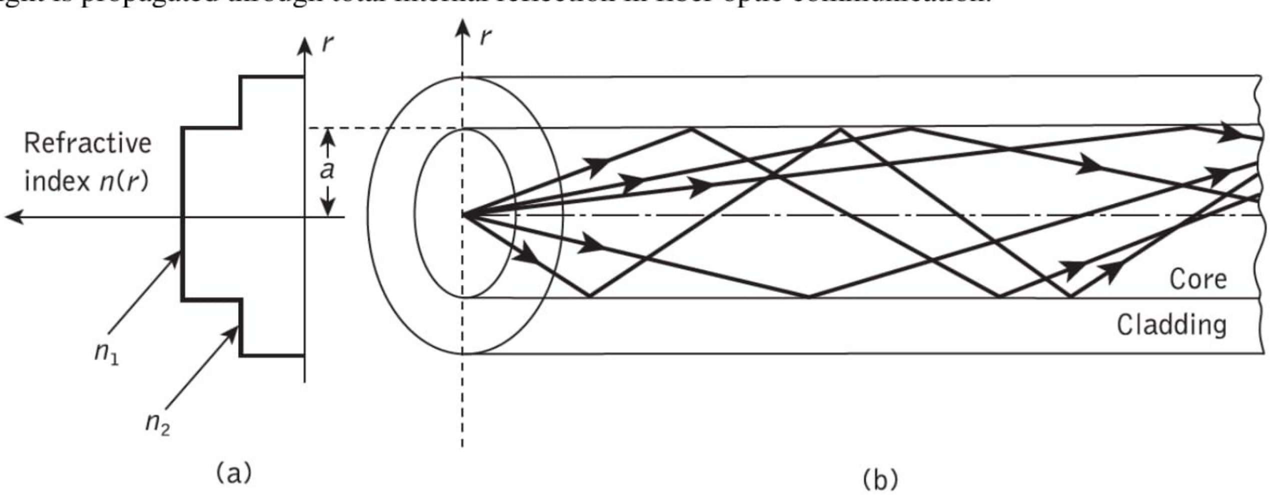


Figure: The (a) refractive index profile and (b) ray transmission in a **multimode step index** fiber

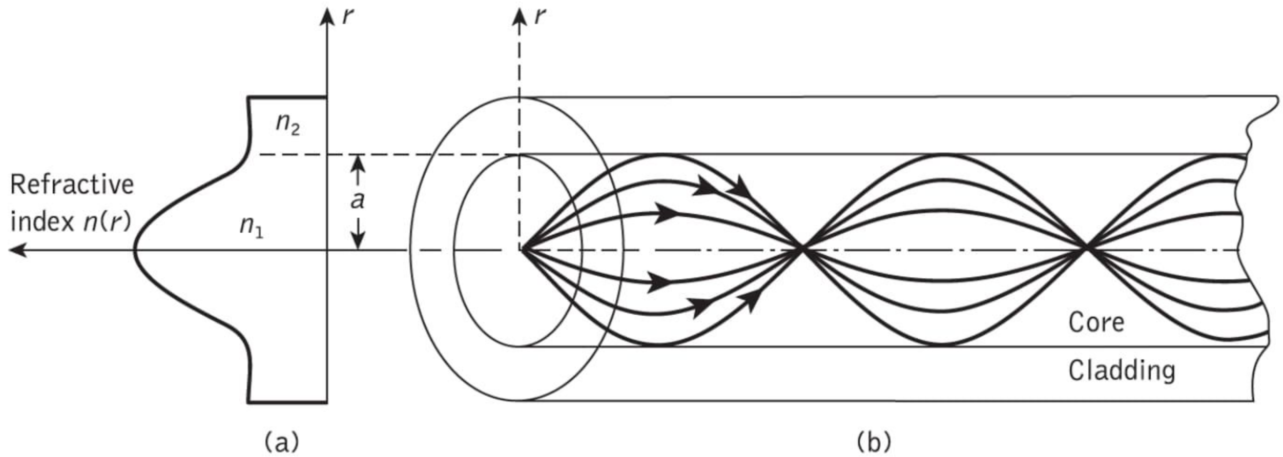


Figure: The (a) refractive index profile and (b) ray transmission in a **multimode graded index** fiber

68	Draw the block diagram of a optical fibre communication system. What type of technique is widely used in multiplexing and what is the most common wavelength used in optical fiber now a days.	BUET M.Sc.-14

Solution: