

1. (a) In cellular communication, the term Handover or Handoff refer to the process of transferring an ongoing call or data session from one channel connected to the core network to another channel.

When a mobile moves in to different cell while the conversation is in progress then MSC Mobile switching center transfer the call to a new channel belonging to new base station.

When a mobile user A moves from
There are basically two types of Handoff. ✓

1. Hard Handoff

When there is actual break in connectivity while switching from one base station to another base station, the connection quality is not that good. Hard Hand off adopted "break before make" policy. ✓

2. Soft Handoff : In this technique atleast one of the links is kept when radio signals are added or removed to the base station. Soft Hand off adopted the 'make before break policy'. Soft Handoff is more costly than Hard Handoff. ✓

Handoff failure rate can be reduced by with handoff prioritization. Handoff protocols like network controlled handoff, mobile-assisted handoff, mobile-controlled handoff is used in handling various handoff.

- (b) (i) In DBMS, data independence helps us to keep data separated from all programs that makes use of it. It is very important to maintain independence. Some of the importance is described as below.
- (i) It helps you to improve quality of data.
 - (ii) Database system maintenance ~~becomes~~ becomes affordable.
 - (iii) Improvement in data security.
 - (iv) Altering of data structures in application program needn't required.
 - (v) focus on general structure of the database rather than worrying about internal implementation.
 - (vi) It allows to improve state which is undamaged or undivided.

(ii) Logical data Independence

- (5) Logical data independence is mainly concerned with the structure or changing the data definition.
- (1) It is difficult as retrieving of data is mainly dependent on the logical structure.
- (c) require to make changes if new fields are added or deleted from the database.
- (d) modifications at the logical levels is significant whenever the logical structures of the data base are changed.
- (e) concerned with the conceptual schema.
- (f) Example: Add/modify/Delete

physical data independence

- (a) It is mainly concerned with storage of the data.
- (b) It is easy to retrieve.
- (c) Change in the physical level doesn't need change at the application program level.
- (d) modification at internal level generally not required.
- (e) concerned with the internal schema.
- (f) change in compression techniques, hashing algorithms etc.

(C)

Given data

100 KB, 500 KB, 200 KB, 300 KB, 600 KB (in order)

Processes of

212 KB, 417 KB, 112 KB, 426 KB (in order)

(i) First-fit method / Algorithm:

In order

a) 212 K is put in 500 K

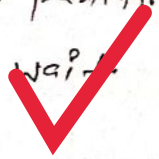
Remaining = $\frac{500}{212}$
288 K

b) 417 K — 600 K

c) 112 K — 288 K

d) 426 K — (No position current)

Hence, it has to wait.



Conclusion

Best-fit turns out to be the best.

(ii) Best-fit

212 K — 300 K

417 K — 500 K

112 K — 200 K

426 K — 600 K

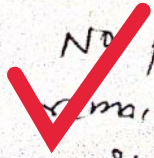
(iii) Worst-fit

212 K — 600 K

417 — 500 K

112 — 388 K

426 — No portion of this size remains hence, 426 K has to wait.



(5) 7

(d) Given data

$$a = 25 \mu\text{m}$$

$$n_1 = 1.48$$

$$\Delta = 0.01$$

$$\lambda = 860 \text{ nm}, 1310 \text{ nm},$$

$$1550 \text{ nm}$$

We know that

$$(i) \quad V = \frac{2\pi a n_1 \sqrt{2\Delta}}{\lambda}$$

$$V_1 = \frac{2\pi \times 25 \times 10^{-6} \times 1.48 \sqrt{2 \times 0.01}}{860 \times 10^{-9}}$$

$$V_1 = 38.22$$

$$\text{no. of modes supported} = \frac{V_1^2}{2} = 730.74$$

$$\text{or } \boxed{\text{no. of modes} = 730} \quad \underline{\underline{\text{Ans}}}$$

$$(ii) \quad V = \frac{2\pi a n_1 \sqrt{2\Delta}}{\lambda_2}$$

$$= \frac{2\pi \times 25 \times 10^{-6} \times 1.48 \times \sqrt{2 \times 0.01}}{1310 \times 10^{-9}}$$

$$\boxed{V_2 = 3.28 \times 10^{-5} / 1310 \times 10^{-9} = 25.03}$$

$$\text{no. of modes} = \frac{V_2^2}{2} = 314.93$$

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Hence

$$\left[\begin{array}{l} \text{no. of modes supported in fiber} \\ = 314 \end{array} \right] \quad \underline{\text{Ans}}$$

(ii) Similarly, $\lambda_3 = 1550 \text{ nm}$

$$V_3 = \frac{2\pi a n_1 \sqrt{2\Delta}}{\lambda_3}$$
$$= \frac{3.28 \times 10^{-5}}{1550 \times 10^{-9}} = 21.16$$

$$\text{no. of modes} = \frac{V_3^2}{2} = \frac{21.16^2}{2}$$
$$= 223.30$$

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$$\left[\text{Hence no. of modes} = 223 \right] \quad \underline{\text{Ans}}$$

② ~~It is strongly recommended.~~

(e) All one and All zero subnets are not used because of the following reasons
It is useful to preserve and extend the interpretation of these special addresses in subnetted networks.

for example

All zero is reserved for Network address
It also prohibits the confusion with subnet zero with network address.

e.g. 172.16.1.10 subnet address

172.16.0.0 this subnet address

is ~~also~~ identical to network address.

172.16.0.0. Hence, it is conflicting.

All-ones subnet

Broadcast address Address and all-ones address is same. Hence it is conflicting.

e.g. last subnet
172.16.224.0 is

172.16.255.255



which is also
Broadcast Address
of class B.

05

3 9 Given data

$$l = 610 \text{ m}$$

$$n_1 = 1.5$$

$$\Delta = 0.01$$

(i) we know that
delay difference

$$\begin{aligned} \delta t_d &= \frac{l n_1 \Delta}{c} \\ &= \frac{610 \times 10^3 \times 1.5 \times 0.01}{3 \times 10^8} \\ &= 3 \times 10^{-7} \end{aligned}$$

$$\boxed{\delta t_d = 300 \text{ ns}} \quad \underline{\underline{\text{Ans}}}$$

(ii) RMS pulse broadening due to
intermodal dispersion

$$\begin{aligned} \sigma_s &= \frac{l n_1 \Delta}{2\sqrt{3} c} \\ &= \frac{610 \times 10^3 \times 1.5 \times 0.01}{2\sqrt{3} \times 3 \times 10^8} \end{aligned}$$

$$\boxed{\sigma_s = 8.66 \times 10^{-8}}$$

$$\boxed{\sigma_s = 86.7 \text{ ns}} \quad \underline{\underline{\text{Ans}}}$$

(iii) the maximum bit rate

We know that

$$B_s(\text{max}) = \frac{1}{2\pi T_s} = \frac{1}{2 \times 300 \times 10^{-9}}$$

$$B_s(\text{max}) = 1.7 \text{ MS/s}^{-1}$$

exact

$$B_s(\text{max}) = \frac{0.2}{T_s} = \frac{0.2}{86.7 \times 10^{-3}}$$

$$B_{s\text{max}} = 2.3 \text{ MS/s}^{-1}$$

(iv) Bandwidth-length product

$$= 2.3 \times 10^6 \times 6 \times 10^3$$

$$B_{\text{opt}} L = 13.8 \text{ MHz km}$$

Ans

18

(b)

Given data

$$TLB \text{ access time} = 20 \text{ nsec}$$

$$M.M \text{ Access time} = 100 \text{ nsec}$$

$$\text{Hit ratio} = 95\% = 0.95$$

We know that

Effective memory

$$\text{Access time} = 0.95 \times 20 + (1 - 0.95) \times (100 + 20)$$

$$= 19 + 0.05 \times 120$$
$$= 25 \text{ nsec}$$

~~12-4~~

Hence,

Effective memory access time

25 nsec

Ans

(ii) Given data

no. of pages = 2048 pages (Mem.)

Each page = 4 KB

no. of bits in physical Address = 18 bits

logical address space

Size of logical address space = 2^m

= # no. of pages $\times$ page size

$$= 2048 \times 4 \times 2^{10}$$

$$= 2^{11} \times 2^2 \times 2^{10}$$

$$= 2^{23}$$

$m = 23 \text{ bits}$



Ans

no. of frames = ?

We know that

$$\text{Physical address space} = \# \text{ of frames} \times \text{frame size}$$

$$\text{frame size} = \text{page size}$$

$$\Rightarrow 2^{18} = \text{no. of frame} \times \text{page size}$$

$$\Rightarrow \text{no. of frame} = \frac{2^{18}}{2^2 \times 2^{10}} = \frac{2^{18-6}}{2^{12}}$$

$\# \text{ no. of frames} = 64 \text{ frames}$

Ans

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(C)

Given data

$$(CNR)_{up} = 27 \text{ dB}$$

$$(CNR)_{down} = 17.4 \text{ dB}$$

$$T_{sky} = 33 \text{ K}$$

$$T_{LNA} = 75 \text{ K}$$

$$T_0 = 270 \text{ K}$$

$$f = 11.45 \text{ GHz}$$

$$L_{min} = 0.5 \text{ dB}$$

for 0.01% of the year

$$L_{gases} = 0.5 \text{ dB}$$

(c)

$$T_{\text{sky, rain}} = T_0(1 - \epsilon)K$$

$$\text{Total loss} = 0.5 + 5 = 5.5 \text{ dB}$$

$$L = 10^{-0.55} = 0.282$$

$$T_{\text{sky, rain}} = 270(1 - 0.282) \\ = 194.1 \text{ K} \approx 194 \text{ K}$$

$$T_{e2} = 194 + 75 = 269 \text{ K}$$

Without rain

$$T_{e2} = 33 + 75 = 108 \text{ K}$$

the increase in noise power

$$\Delta N = 10 \log_{10} \left(\frac{269}{108} \right) = 4.0 \text{ dB}$$

the signal is attenuated by 5 dB

$$(CNR)_{\text{down, rain}} = 17.4 - 5 - 4$$

$$= 8.4$$

$$= 17.4 - 9$$

$$= 8.4 \text{ dB}$$

We know that

Overall CNR

$$\frac{1}{(CNR)_{\text{overall}}} = \frac{1}{(CNR)_{\text{up}}} + \frac{1}{(CNR)_{\text{down}}}$$

$$\Rightarrow \frac{1}{(CNR)_{overall}} = \frac{1}{10^{2.7}} + \frac{1}{10^{0.84}}$$

$$\Rightarrow \frac{1}{(CNR)_{overall}} = 0.146$$

$$\Rightarrow (CNR)_{overall} = \frac{1}{0.146}$$

$$\Rightarrow (CNR)_{overall} = 6.84 \text{ dB}$$

$(CNR)_{0, \text{rain}} = 8.3 \text{ dB}$

Ans

(11)

Available downlink fade margin

$$= (CNR)_{\text{down}} - (CNR)_{\text{in rain (down)}}$$

$$= 17.4 - 8.4$$

$= 9 \text{ dB}$

Ans

18

(5)

(9)

Given data

$$T = 1 \text{ sec}$$

$$H(z) \text{ if } H(s) = \frac{1}{s^2 + \sqrt{2}s + 1}$$

$$H(s) = \frac{1}{s^2 + \sqrt{2}s + 1}$$

Partial fraction

$$H(s) = \frac{A}{s - (-1+j)/\sqrt{2}} + \frac{B}{s - (-1-j)/\sqrt{2}}$$

$$= \frac{j/\sqrt{2}}{s - (-1+j)/\sqrt{2}} + \frac{-j/\sqrt{2}}{s - (-1-j)/\sqrt{2}}$$

Impulse response function

$$H(z) = \frac{-j/\sqrt{2}}{1 - e^{(-1+j)/\sqrt{2}} z^{-1}}$$

$$H(z) = \frac{-j/\sqrt{2}}{1 - e^{(-1+j)/\sqrt{2}} z^{-1}} + \frac{j/\sqrt{2}}{1 - e^{(-1-j)/\sqrt{2}} z^{-1}}$$

$$= \frac{\sqrt{2} \sin\left(\frac{1}{\sqrt{2}} n\right) e^{-n/\sqrt{2}} z^{-1}}{1 - 2e^{-1/\sqrt{2}} \cos\left(\frac{1}{\sqrt{2}}\right) z^{-1} + 2e^{-2/\sqrt{2}} z^{-2}}$$

Hence

$$H(z) = \frac{\sqrt{2} \sin(1/\sqrt{2}) e^{-1/\sqrt{2}} z^{-1}}{1 - 2 e^{-1/\sqrt{2}} \cos(1/\sqrt{2}) z^{-1} + e^{-2/\sqrt{2}} z^{-2}}$$

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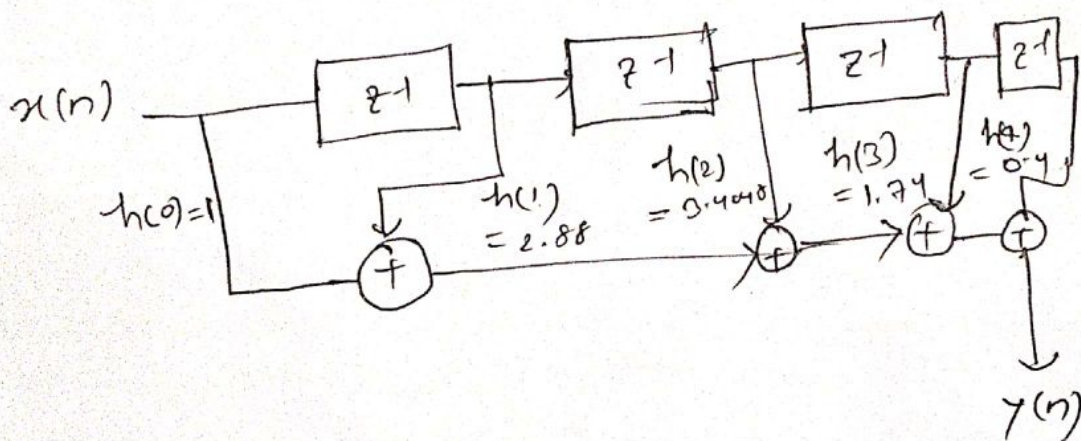
Ans:

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Given:

$$H(z) = 1 + 2.88 z^{-1} + 3.4048 z^{-2} + 1.74 z^{-3} + 0.4 z^{-4}$$

Direct form realization of FIR filter



$$h(0) = 1$$

$$h(1) = 2.88$$

$$h(2) = 3.4048$$

$$h(3) = 1.74$$

$$h(4) = 0.4$$

Lattice Structure

$$H(z) = 1 + 2.88z^{-1} + 3.4048z^{-2} + 1.74z^{-3} + 0.4z^{-4} = A_4(z)$$

So, ~~$k_4 = 0.4$~~

$$k_4 = 0.4$$

— (1)

$$B_4(z) = 0.4 + 1.74z^{-1} + 3.4048z^{-2} + 2.88z^{-3} + z^{-4}$$

— (2)

We know that

$$A_3(z) = \frac{A_4(z) - k_4 B_4(z)}{1 - k_4^2}$$

$$= \frac{1 + 2.88z^{-1} + 3.4048z^{-2} + 1.74z^{-3} + 0.4z^{-4} - 0.4(0.4 + 1.74z^{-1} + 3.4048z^{-2} + 2.88z^{-3} + z^{-4})}{1 - 0.4^2}$$

$$= \frac{0.84 + 2.184z^{-1} + 2.04z^{-2} + 0.568z^{-3}}{0.84}$$

$$= 1 + 2.6z^{-1} + 2.488z^{-2} + 0.7z^{-3}$$

$$A_3(z) = 1 + 2.6z^{-1} + 2.488z^{-2} + 0.7z^{-3}$$

$$K_3 = 0.7$$

A

$$B_3(z) = 0.7 + 2.488z^{-1} + 2.6z^{-2} + z^{-3}$$

$$A_2(z) = \frac{A_3(z) - K_3 B_3(z)}{1 - K_3^2}$$

$$= \frac{1 + 2.6z^{-1} + 2.488z^{-2} + 0.7z^{-3} - 0.7(0.7 + 2.488z^{-1} + 2.6z^{-2} + z^{-3})}{1 - 0.49}$$

$$= \frac{1 + 2.6z^{-1} + 2.488z^{-2} + 0.7z^{-3} - 0.49 - 1.74z^{-1} - 1.82z^{-2} - 0.7z^{-3}}{0.51}$$

$$= \frac{0.51 + 0.86z^{-1} + 0.668z^{-2}}{0.51}$$

$$A_2(z) = 1 + 1.68z^{-1} + 1.30z^{-2}$$

$$B_2(z) = 1.30 + 1.68z^{-1} + z^{-2}$$

$$k_2 = 1.30$$

$$A_1(z) = \frac{A_2(z) - k_2 B_2(z)}{1 - k_2^2}$$

$$= \frac{1 + 1.68z^{-1} + 1.30z^{-2} - 1.3(1.30 + 1.68z^{-1} + z^{-2})}{1 - 1.3^2}$$

$$= \frac{-0.63 - 0.504z^{-1}}{-0.63}$$

$$= 1 + 0.73z^{-1}$$

$$k_1 = 0.73$$

hence, lattice filter coefficient

$k_4 = 0.4$
$k_3 = 0.7$
$k_2 = 1.3$
$k_1 = 0.73$

Ans

(c) (i)

fringing flux

a) It is defined as the flux bulges out at the corner of gap and effectively area air gap increases and hence flux density of the air gap decreases this effect is known as fringing.

b) fringing is directly proportional to the length of air gap that means if the length increases fringing effect will also be more

leakage flux

a) It is defined as magnetic flux which doesn't follow particularly intended path in a magnetic circuit.

b) this depends on the flux outside magnetic circuit which is not useful

(ii)

Given data

$$N = 50 \text{ turns}$$

$$D = 30 \text{ mm}$$

$$l = 0.6 \text{ m}$$

$$N_2 = 250 \text{ turns}$$

$$I = 2 \text{ A}$$

(a)

We know that

$$B = \mu_0 H = \frac{\mu_0 N I}{l} = \frac{2500 \times \mu_0 I}{l} \text{ T/m}$$

$$B = \mu_0 \times 2500 \times 2$$

$$B = \mu_0 \times 5000 \quad \text{Wb/m}^2$$

flux linked with search coil

$$\phi = BA_1$$

$$= 2500 \mu_0 I_1 \times \frac{\pi \times (30 \times 10^{-3})^2}{4}$$

$$= \frac{5000 \times 4\pi \times 10^{-7} \times \pi \times 9 \times 10^{-4}}{4}$$

$$= \frac{5000 \times 4\pi^2 \times 9 \times 10^{-11}}{4}$$

$$= 9 \times 9.8 \times 5 \times 10^{-8}$$

$$= 441 \times 10^{-8} \quad \text{Wb}$$

flux linked with search coil

Now

$$\text{Mutual inductance} = \frac{N_2 \phi_1}{I_1} = \frac{50 \times 441 \times 10^{-8}}{2}$$

$$= 11025 \times 10^{-8}$$

$$M = 11025 \mu H$$

09

Ans

(d)

Given data

$$E_0 = 3.0 \text{ volt}$$

$$R = 400 \Omega$$

$$L = 200 \text{ cm}$$

$$E = 1.018 \text{ volt}$$

$$l_1 = 101.8 \text{ cm}$$

$$L.C. = \frac{1}{5}^{\text{th}} \text{ of division}$$

$$1 \text{ mm} / \text{Scale division}$$

(e) Working current

$$\text{Resistance of } 101.8 \text{ cm length wire} = \frac{101.8}{200} \times 400 = 203.6 \Omega$$

$$\text{Working current, } I_m = \frac{101.8}{203.6} = 0.5 \text{ A}$$

=

$$I_m = \frac{1.018}{203.6} = 5 \text{ mA}$$

(f)

Resistance of series rheostat

$$\text{Resistance} = \frac{101.8}{200} \times 400 = 203.6 \Omega$$

R_e

(iii) the measurement Range

Resolution i.e. $= 0.2 \text{ mV}$ to 2 V

200 cm

(iv) Measurement Range

200 cm ——— 2 Volt

1 mm ——— $\frac{2}{200} \times \frac{1}{10} = 1 \text{ mV}$

$\frac{1}{5} \times 1 \times 10^{-3} = 0.2 \text{ mV}$ to

0.2 mV to 0.2×200

0.2 mV to 40 mV

(v) Resolution of instrument

$\frac{2}{200} \times 10^{-1} = 1 \text{ mV}$

$\frac{1}{5} \text{ of div.} = \frac{1}{5} \times 1 = 0.2 \text{ mV}$

09

(e)

Given data

$$p = 4$$

$$f = 50 \text{ Hz}$$

$$P = 1000 \text{ hp motor} \quad 1000 \times 746 = 746 \text{ kW}$$

$$\tau_{st} = 160\% \text{ of } \tau_{fl}$$

$$T_m = 200\% \tau_{fl}$$

(i) speed at maximum torque

$$N_s = \frac{120 f}{p} = \frac{120 \times 50}{4} = 1500 \text{ rpm}$$

Now

$$\frac{\tau_{st}}{\tau_{max}} = \frac{2}{\frac{1}{s_m} + 1} \quad \text{--- (7)}$$

$$\Rightarrow \frac{\tau_{fl}}{\tau_{max}} = \frac{2}{\frac{s_{fl}}{s_m} + \frac{s_m}{s_{fl}}} \quad \text{--- (7)}$$

Division of (i) and (ii)

$$\Rightarrow \frac{\tau_{st}}{\tau_{fl}} =$$

$$\text{or } \frac{\tau_{st}}{\tau_m} = \frac{\frac{160}{200}}{\frac{8}{10}} = \frac{2}{\frac{1}{s_m} + 1}$$

$$\Rightarrow 0.8 = \frac{2 s_m}{1 + s_m}$$

$$\Rightarrow 0.8(1 + s_m) = 2.4m$$

$$\Rightarrow 0.8 + 0.8s_m = 2.4m$$

$$\Rightarrow 0.8 = 1.2s_m$$

$$\Rightarrow \boxed{s_m = \frac{0.8}{1.2} = 0.66}$$

$$N_r = N_s(1 - s_m)$$

$$= 1500(1 - 0.66)$$

$$\boxed{N_{rm} = 510 + 4m} \quad \underline{\underline{Ans}}$$

① Full-load speed

$$\frac{z_{f1}}{c_{max}} = \frac{2}{\frac{s_m}{s_{f1}} + \frac{s_{f1}}{s_m}}$$

$$\Rightarrow \frac{1}{2} = \frac{2}{\frac{0.66}{s_{f1}} + \frac{s_{f1}}{0.66}}$$

$$\Rightarrow \frac{0.66}{s_{f1}} + \frac{s_{f1}}{0.66} = 4$$

$$\Rightarrow \frac{0.66^2 + s_{f1}^2}{0.66s_{f1}} = 4$$

$$\Rightarrow s_{f1}^2 - 2.64s_{f1} + 0.4356 = 0$$

$$s_{f1} = 2.46, 0.17$$

Discrepancy $S = 2.56$ as 0.5561

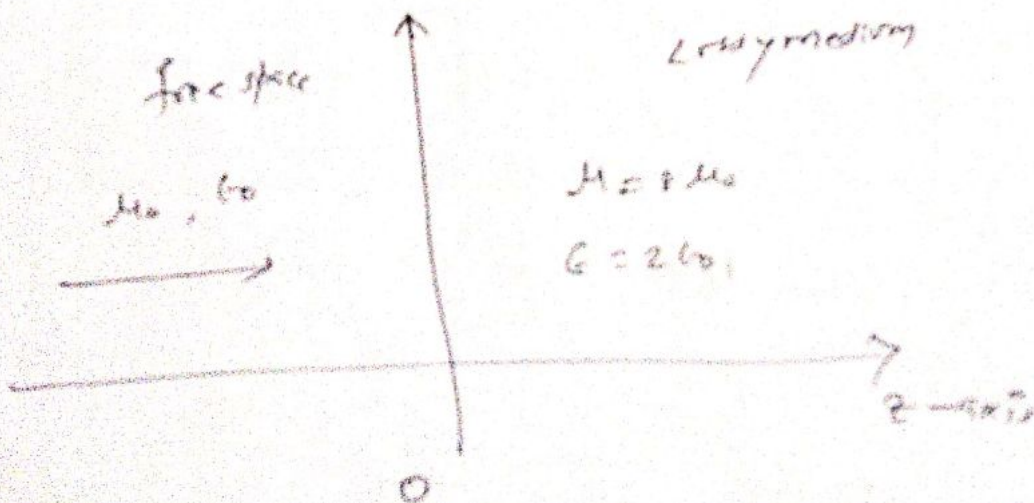
$$S_f = 0.17$$

$$\begin{aligned} N_g &= N_i (1 - S_f) \\ &= 1500 (1 - 0.17) \\ &= 1500 (1 - 0.17) \end{aligned}$$

$$N_T = 1245 \text{ ppm}$$

06

⑥ Given data



the normal incident wave is represented

$$\vec{H}_i = 10 \cos(10^8 t - \beta z) \hat{z} \text{ mA/m}$$

$$\vec{E}_i = 1300\pi \cos(10^8 t - \beta z) (-\hat{y}) \text{ V/m}$$

$$\vec{H}_i = 10 \cos(10^8 t + \beta z) \hat{a}_y \text{ mA/m}$$

$$\vec{E}_i = \eta_1 H_i(z) \hat{a}_y \times (-\hat{a}_z)$$

$\eta_1 = \text{medium 1}$
lossless medium

$$\vec{E}_i = 120\pi \times 10 \cos(10^8 t + \beta z) \hat{a}_y$$

$$\boxed{\vec{E}_i = 1200\pi \cos(10^8 t + \beta z) \hat{a}_y} \quad \underline{\underline{mV}}$$

②

Transmitted wave

$$\vec{E}_t(z) = \hat{a}_y E_{t0} e^{-j\beta_2 z}$$

$$\boxed{E_t(z) = -\hat{a}_y E_{t0} \cos(10^8 t - \beta_2 z)}$$

$$\boxed{H_t(z) = \frac{1}{\eta_2} E_{t0} \cos(10^8 t - \beta_2 z) \hat{a}_y}$$

Where

$$E_{t0} = \frac{2\eta_2}{\eta_2 + \eta_1} E_{i0}$$

$$= \frac{2 \times 2\eta_1}{2\eta_1 + \eta_1} \times E_{i0}$$

$$= \frac{4}{3} E_{i0}$$

$$\begin{aligned}
 H_{10} &= \eta_2 \times \frac{4}{3} E_0 \\
 &= 2 \eta_1 \times \frac{4}{3} E_0 \\
 &= \cancel{2 \times 1200 \pi}
 \end{aligned}$$

$$H_{10} = \frac{8}{3} \times 1200 \pi E_0$$

Hence

$$\begin{aligned}
 E_+(z) &= E_{10} \cos(10^8 t - \beta_2 z) (-\hat{a}_y) \\
 H_+(z) &= H_{10} \cos(10^8 t - \beta_2 z) \hat{a}_y
 \end{aligned}$$

$$\frac{10^8}{\beta_2} = \frac{c}{\sqrt{\mu_0 \epsilon_0}}$$

$$\Rightarrow \beta_2 = \frac{4 \times 10^8}{3 \times 10^8}$$

$$\beta_2 = \frac{4}{3}$$

(ii)

Given data

$$\vec{E} = 2 e^{-\alpha z} \sin(10^8 t - \beta z) \hat{a}_y \text{ V/m}$$

$$\epsilon_r = 1$$

$$\mu_r = 20$$

$$c = 3 \text{ s/m}$$

We know that

$$\frac{10^8}{\beta} = \frac{c}{\sqrt{\epsilon_r \mu_r}}$$

$$\Rightarrow \beta = \frac{10^8 \times \sqrt{20}}{3 \times 10^8}$$

$$\Rightarrow \boxed{\beta = \frac{\sqrt{20}}{3} \text{ rad/m}} \quad \text{Q}$$

$\Rightarrow$ We know that

$$\alpha = \omega \sqrt{\frac{\mu_r}{2} \left(\sqrt{1 + \left(\frac{\sigma}{\omega \epsilon} \right)^2} - 1 \right)}$$

$$= \frac{10^8}{3 \times 10^8} \sqrt{\frac{20}{2} \left(\sqrt{1 + \left(\frac{3}{10^8 \times 5.85 \times 10^{-2} \times 1} \right)^2} - 1 \right)}$$

$$= \frac{1}{3} \sqrt{10 (3388 \cdot 20 - 1)}$$

$$\text{Input output} = 0 + \pi \cdot 20 \times 500$$

$$\boxed{\alpha = \frac{1.84}{3} = 61.34 \text{ N/m}}$$

Q We know that

$$\vec{H} = \eta \vec{E} (\hat{a}_z \times \hat{a}_y)$$

$$= 120\pi \times 2 e^{-\alpha z} \sin(10^8 t - \beta z) (-\hat{a}_x)$$

$$\boxed{\vec{H}_m = - \underline{240\pi} e^{-61.34 z} \sin(10^8 t - 1.432 z) \hat{a}_x}$$

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b

Given data

$$2300 \text{ V} / 230 \text{ V}$$

$$500 \text{ kVA} / 500 \text{ kVA}$$

$$P_i = 1600 \text{ WSH}$$

$$f = 50 \text{ Hz}$$

$$P_{cu} = 7.5 \text{ kWSH}$$

$$\begin{aligned} \underline{\text{Energy output}} &= 2 \text{ hours of load} \\ &= 2 \times 10 \times 500 \times 10^3 \times \\ &= 0 \end{aligned}$$

$$\begin{aligned} \text{Total output} &= 0 + 4 \times \frac{20}{100} \times 500 \\ &+ 4 \times \frac{500}{2} + 5 \times 0.8 \times 500 \end{aligned}$$

$$= 400 + 1000 + 2000 + 72500 + 2 \times 1.25 \times 500$$

$$= 11150 \text{ kWh} = 11150$$

for (a) (b)

$$\frac{100}{0.7} = 142.85$$

$$P_{cu1} = 7.5 \times \left(\frac{142.85}{500} \right)^2$$

$$= 7.5 \times 0.612 \text{ kWh}$$

$$= 612 \text{ kWh}$$

$$\frac{250}{0.8} = 312.5$$

$$P_{cu2} = 7.5 \times \left(\frac{312.5}{500} \right)^2 = 2.92 \text{ kWh}$$

$$\frac{400}{0.9} = 444.4$$

$$P_{cu3} = 7.5 \times \left(\frac{444.4}{500} \right)^2$$

$$= 5.92 \text{ kWh}$$

$$P_{cu4} = 7.5 \times 1.57$$

$$\frac{500 \times 1.25}{0.85} = 735.29$$

$$P_{cu5} = 7.5 \times \left(\frac{735.29}{500} \right)^2$$

$$= 16.21 \text{ kWh}$$

$$P_{cu}(\text{total}) = 0.612 \times 4 + 2.32 \times 4 + 5.32 \times 5 + 7.5 \times 7 + 16.21 \times 2$$

$$= \frac{22.162}{127.424} \text{ kWh}$$

$$P_{loss} = 1.6 \times 24$$

$$= 38.4 \text{ kWh}$$

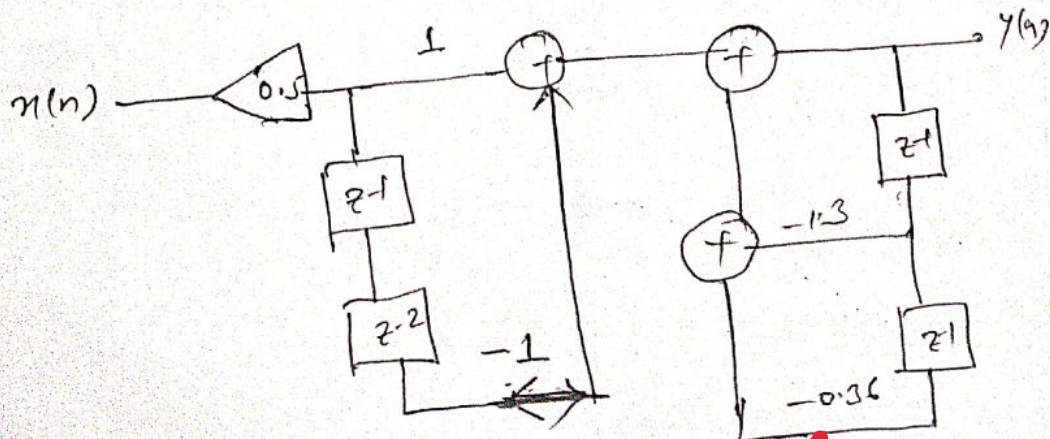
$$\therefore \text{All day efficiency} = \frac{8150}{8150 + 38.4 + 127.424} \times 100$$

$$\therefore \text{All day efficiency} = 98\% \quad \checkmark$$

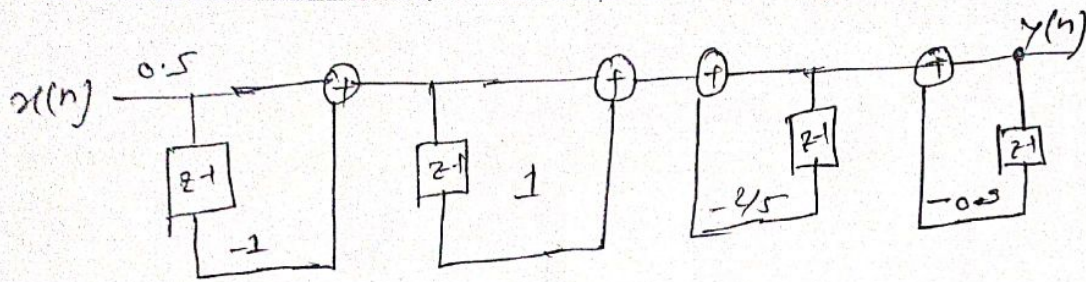
c

Given

$$H(z) = \frac{0.5(1 - z^{-2})}{1 + 1.3z^{-1} + 0.36z^{-2}}$$



Direct Form-I



Cascade form

ii)

parallel form

$$H(z) = \frac{0.5(z^2 - 1)}{z^2 + 1.3z + 0.36}$$

$$= 0.5 \left(1 - \frac{1.3z + 1.36}{z^2 + 1.3z + 0.36} \right)$$

$$= 0.5 \left(1 - \frac{A}{z + \frac{2}{5}} + \frac{B}{z + 0.9} \right)$$

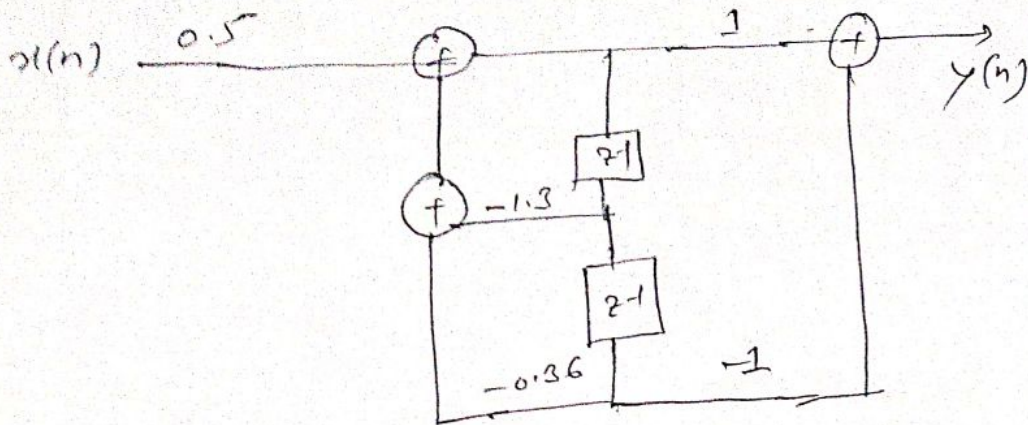
$$= 0.5 \left(1 - \right.$$

$$\frac{H(z)}{z} = \frac{0.5(z^2 - 1)}{z(z^2 + 1.3z + 0.36)}$$

$$= \frac{A}{z + \frac{2}{5}} + \frac{B}{z + 0.9}$$

$$= \frac{1.42}{z + \frac{2}{5}} + \frac{0.21}{z + 0.9}$$

Direct form II



Direct form II

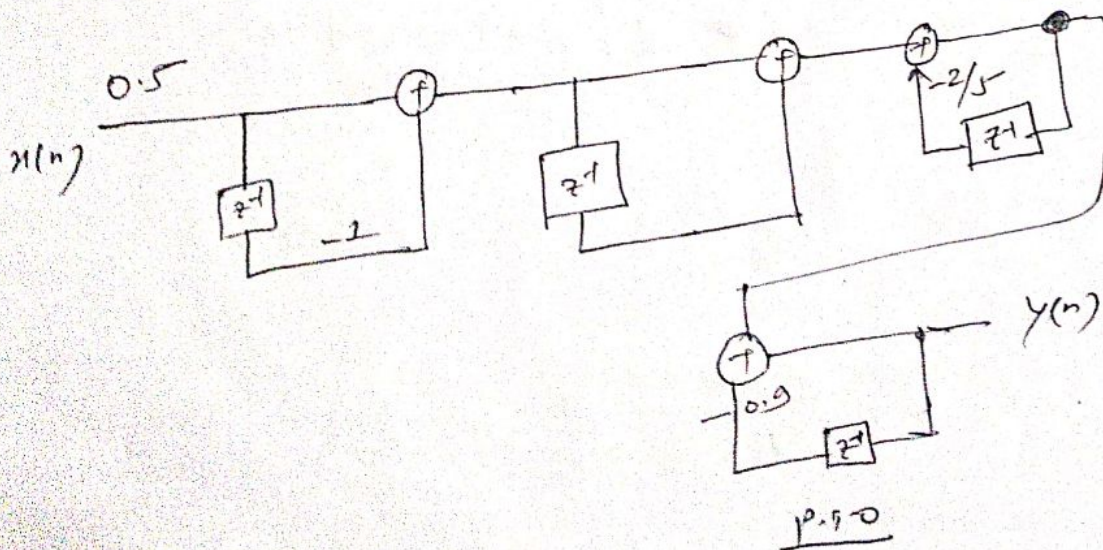


(ii)

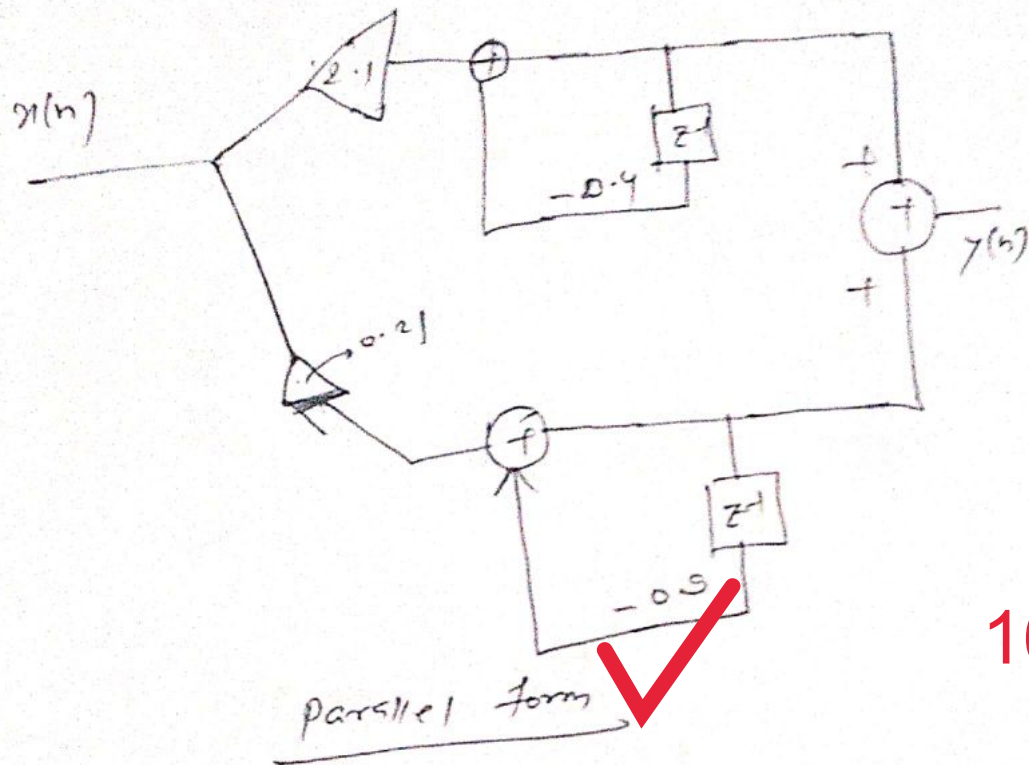
Cascade form

$$H(z) = 0.5(1-z^{-2}) \times \frac{1}{1+1.3z^{-1}+0.36z^{-2}}$$

$$= \frac{0.5(1-z^{-1})(1+z^{-1})}{\left(1+\frac{2}{5}z^{-1}\right)(1+0.9z^{-1})}$$



$$H(z) = \frac{2.1}{1 + \frac{2}{5}z^{-1}} + \frac{0.21}{1 + 0.9z^{-1}}$$



16

8) 9) Given data
 30 kVA
 2400V / 240 V
 50 Hz

O.C. test $V = 2400 \text{ V}$, $I = 0.3 \text{ A}$ $P = 230 \text{ W}$

S.C. test $V = 70 \text{ V}$, $I = 18.8 \text{ A}$ $P = 1050 \text{ W}$

from o.c. test

$$V_o I_o \cos \phi_o = W_o$$

$$\Rightarrow 2400 \times 0.3 \cos \phi_o = 230$$

$$\cos \phi_o = \frac{230}{2400 \times 0.3} = 0.319$$

$$I_w = I_0 \cos \phi_0 = 0.3 \times 0.37 = 0.095 \text{ A}$$

$$I_M = I_0 \sin \phi_0 = 0.3 \times 0.25 = 0.285 \text{ A}$$

$$R_0 = \frac{2400}{0.095} = 25.263 \text{ k}\Omega$$

$$X_0 = \frac{2400}{I_M} = \frac{2400}{0.285} = 8.421 \text{ k}\Omega$$

Sc. test

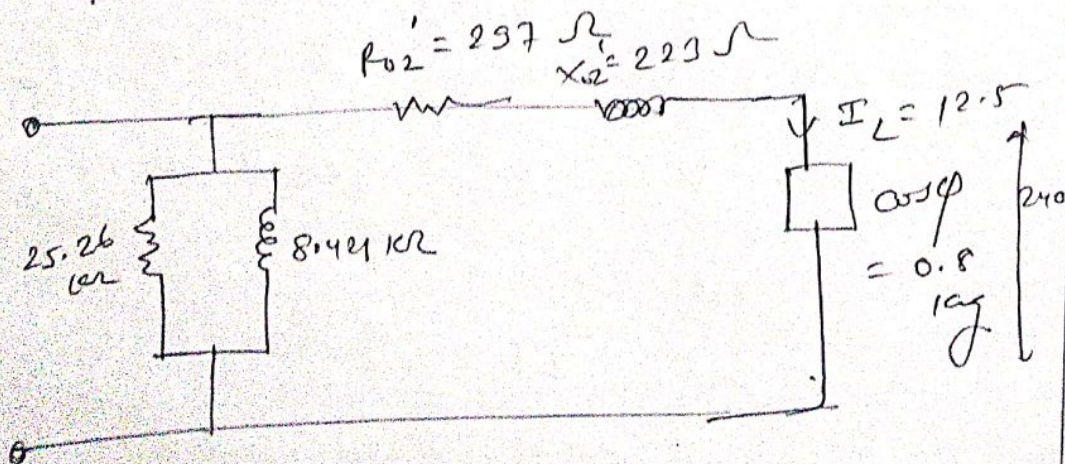
$$Z_{02} = \frac{V_{02}}{I_2} = \frac{70}{18.8} = 3.72 \Omega$$

$$W_R = I_2^2 R_{02}$$

$$\Rightarrow R_{02} = \frac{1050}{18.8^2} = 2.97 \Omega$$

$$X_{02} = \sqrt{3.72^2 - 2.97^2}$$

$$X_{02} = 2.23 \Omega$$



$$V_t - I_L (R'_L + jX'_L) = 240 (\cos \phi + j \sin \phi)$$

$$V_t - I_L \angle -36.86^\circ 3.72 \angle 16.30^\circ = 240$$

$$V_t - 12.5 \times 2.72 = 240$$

$$V_t = 286.5 \text{ volt}$$

Primary voltage

09

$$\text{Real power} = 286.5 \text{ volt}$$

$$\text{efficiency} = \frac{\text{Output}}{\text{Input}} \times 100$$

$$= \frac{240 \times 12.5 \times \cos \phi}{286.5 \times (12.5 + 0.38)} \times 100$$

$$= 65\%$$

Ans

(b)

Given

$$V = 100 e^{-50x} \sin(50y) \text{ Volt} \quad \text{--- (1)}$$

(i) $\nabla \cdot \vec{D}$

$$\nabla \cdot \epsilon \vec{E}$$

$$\Rightarrow \epsilon \nabla \cdot \vec{E}$$

$$\Rightarrow -\epsilon \nabla \cdot \nabla V$$

$$\Rightarrow -\epsilon \nabla \cdot \nabla V$$

$$\begin{aligned} \nabla V &= 100 e^{-50x} \times (-50) \sin(50y) \hat{a}_x \\ &\quad + 100 e^{-50x} \times 50 \cos(50y) \hat{a}_y \end{aligned}$$

$$= 5000 e^{-50x} \left(-\sin(50y) \hat{a}_x + \cos(50y) \hat{a}_y \right)$$

$$\Rightarrow \epsilon \nabla \cdot \left(5000 e^{-50x} (-\sin(50y) \hat{a}_x + \cos(50y) \hat{a}_y) \right)$$

$$\Rightarrow \epsilon \left(25 \times 10^4 \left[e^{-50x} (\cancel{\sin 50y} + (-\cancel{\sin 50y})) \right] \right)$$

$$= 0$$



Hence

$$\boxed{\nabla \cdot \vec{D} = 0} \quad \checkmark$$

(ii)

Show that $y=0$ is an equipotential surface.

Putting the value in (4)

We get

$$V = 0$$

which is equipotential surface.

(iii) To prove

$$\vec{E} \perp y=0 \text{ plane}$$

We know that

$$E = -\nabla V$$

$$= -\nabla (100 e^{-50x} \sin(50y))$$

$$= 5 \times 10^3 e^{-50x} \sin(50y) \hat{a}_x - 5 \times 10^3 e^{-50x} \cos(50y) \hat{a}_y$$

$$= 5 \times 10^3 e^{-50x} (\sin(50y) \hat{a}_x - \cos(50y) \hat{a}_y)$$

for $y=0$

$$= -5 \times 10^3 e^{-50x} \hat{a}_y$$

which is $\perp$ to $y=0$ plane

Proved

(iv) $\nabla \cdot \vec{D} = \rho$

$$\int \vec{D} \cdot d\vec{s} = Q$$

$$\epsilon \iint \vec{E} \cdot d\vec{s} = Q$$

$$\Rightarrow \epsilon \int_0^1 \int_0^\infty 5 \times 10^3 e^{-50x} (\sin(50y) \hat{a}_y - \cos(50y) \hat{a}_x) dx dy$$

for $y=0$

$$= \epsilon \int_0^1 \int_0^\infty 5 \times 10^3 e^{-50x} dx dy$$

$$= \epsilon \times 5 \times 10^3 \left[\frac{e^{-50x}}{-50} \right]_0^\infty$$

$$= - \frac{8.854 \times 10^{-12} \times 5 \times 10^3}{-50} \left[\frac{1}{10} \right]$$

$$= - 8.854 \times 10^{-10} \quad |Q| = 0.8854 \text{ nC}$$

~~$= - 8.854 \times 10^{-10}$~~

$$Q = - 8.854 \times 10^{-10} \text{ coulomb}$$

V

We know that

$$\text{Energy stored} = \iiint \frac{1}{2} \epsilon_0 E^2 dV$$

$$= \int_0^1 \int_0^1 \int_0^1 \frac{1}{2} \epsilon_0 E^2 dx dy dz$$

$$= \frac{1}{2} \epsilon_0 25 \times 10^6 \int_0^1 e^{-100x} dx$$

$$= \frac{1}{2} \times 8.854 \times 10^{-12} \times 25 \times 10^6 \times \left. \frac{e^{-100x}}{-100} \right|_0^1$$

$$= \frac{1}{2} \times 8.854 \times 10^{-12} \times 25 \times 10^6 \times \left(\frac{e^{-100} - 1}{-100} \right)$$

$$= 110.67 \times 10^{-8}$$

$$E = 1.10 \times 10^{-8} \text{ } \mu\text{Joule}$$



(1) Given data

$$A = 200$$

$$V = 10 \text{ volt (voldmeter)}$$

$$\text{① Sensitivity of LVDT} = \frac{5 \text{ mV}}{1 \text{ mm}} = 5 \text{ V/m}$$

Whole setup

$$200 \times 5 = 1000 \text{ V/m}$$

② Voltmeter scale 100 divisions

$$\frac{10 \text{ V}}{100} \text{ ————— } 10$$

$$1 \text{ ————— } \frac{10}{100}$$

$$\frac{1}{10} \text{ ————— } \frac{10}{100} \times \frac{1}{10} = \frac{1}{100}$$

Resolution of the instrument

$$= 0.01$$

② Thermistor:

A thermistor is resistance thermometer, whose resistance changes due to change in temp.

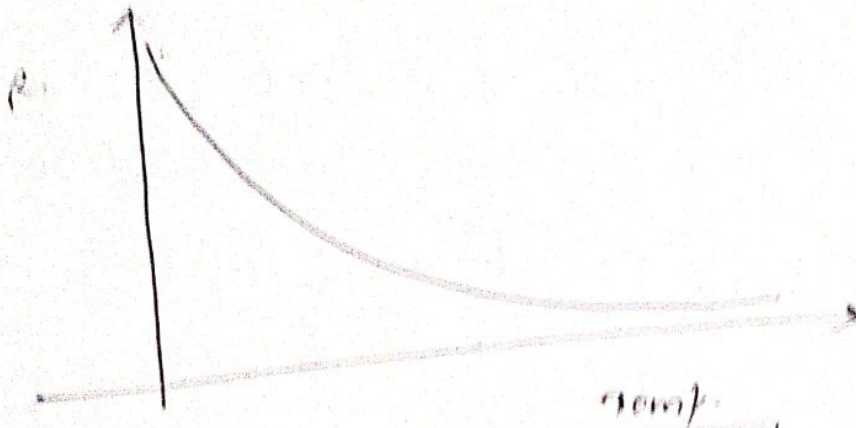
There are two types of thermistors

(i) PTC (positive temperature coefficient)

ie. as temperature increases resistance increases

(ii) NTC (negative temp. coefficient)

ie. as temp. increases resistance decreases.



$$R = R_0 e^{\left(\frac{1}{T_1} - \frac{1}{T_0}\right)}$$



(iii)

why do errors due to temp. variation occur in strain gauge circuit.

due to temp variation Resistance and length of material changes Hence

$$G.F = \frac{\Delta R/R}{\Delta L/L} \quad \text{gt changes due}$$

to temp.

Compensation : self-compensated strain gauge of certain kind of material should be used,

for example : ferritic steel,
Aluminium,
Mo, silica/composite
etc.

material which having low expansion coefficient should be utilised. for

example - manganese