

**JALPAIGURI GOVERNMENT ENGINEERING COLLEGE**  
[A GOVERNMENT AUTONOMOUS COLLEGE]  
**JGEC/B.TECH/ CE/ CE(OE)701B/ 2022-23**  
**2022**  
**ICT for Development**

Full Marks: 70

Times: 3 Hours

*The figures in the margin indicate full marks.*

*Candidates are instructed to write the answers in their own words as far as practicable.*

**GROUP-A**  
**[OBJECTIVE TYPE QUESTIONS]**

Answer all questions	5x2=10
1. What is community informatics?	2
2. What is E-learning?	2
3. What is open and distance learning?	2
4. What do you mean by E-Government?	2
5. What is Cooperative Learning?	2

**GROUP-B**  
**[LONG ANSWER TYPE QUESTIONS]**

Answer any four questions	4x15 = 60
6. a) Explain 5-C model associated with E-Commerce? What are the features of M-Commerce?	6+3
b) Explain the role of libraries and information in meeting the requirements of modern society? What is information society?	5+1
7. a) Define E-Administration and E-Democracy? Explain different perceptions of information society in details?	3+6
b) What are the impacts of ICT on student achievement?	6
8. a) Discuss various advantages and disadvantages of E-Learning? Discuss various online media creation tools used in E-Learning?	4+4
b) What are the driving and opposing forces of virtual education in the world? In which year MHRD in India had launched NPTEL?	6+1
9. a) What are the major objectives of the National Mission on Education through information and communication technology (NMEICT) launched by MHRD Govt. of India? Discuss 5E model used in cooperative learning?	5+5
b) What is blended learning? What is meant by a learner-centered environment?	2+3
10. a) What is the knowledge society? What are the characteristics of knowledge society? Write a short note on knowledge based economy?	2+3
b) Discuss various business models related to E-Commerce?	+5 5

**JALPAIGURI GOVERNMENT ENGINEERING COLLEGE**  
**[A GOVERNMENT AUTONOMOUS COLLEGE]**  
**JGEC/B.TECH/CIVIL ENGINEERING/CE(PE)701C/2022-23**  
**2023**  
**HYDRAULIC STRUCTURES**

Full Marks: 70

Time: 3 Hours

*The figures in the margin indicate full marks.  
 Candidates are instructed to write the answers in their own words as far as practicable. Use graph paper where necessary.*

**GROUP-A**  
**[OBJECTIVE TYPE QUESTIONS]**

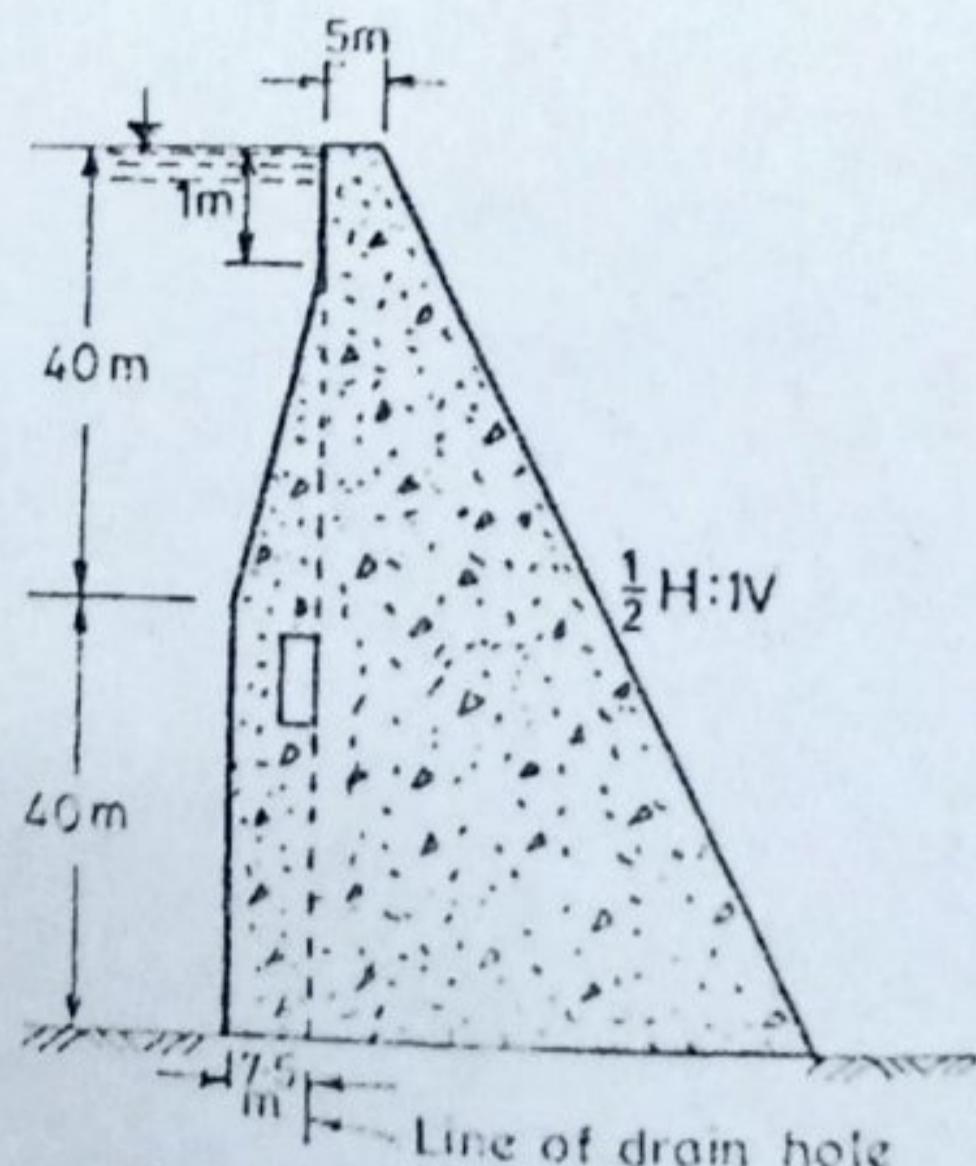
Answer all questions

- |                                                                                                                                                    |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1. Define weir and barrage.                                                                                                                        | 2   |
| 2. What is fish ladder?                                                                                                                            | 2   |
| 3. Give expressions for net effective weight of the gravity dam when it faces earthquake acceleration vertically (upward and downward separately). | 1+1 |
| 4. Give expressions for wave height in a reservoir due to wind action.                                                                             | 1+1 |
| 5. Show hydraulic jump formation over a spillway with a simple sketch.                                                                             | 2   |

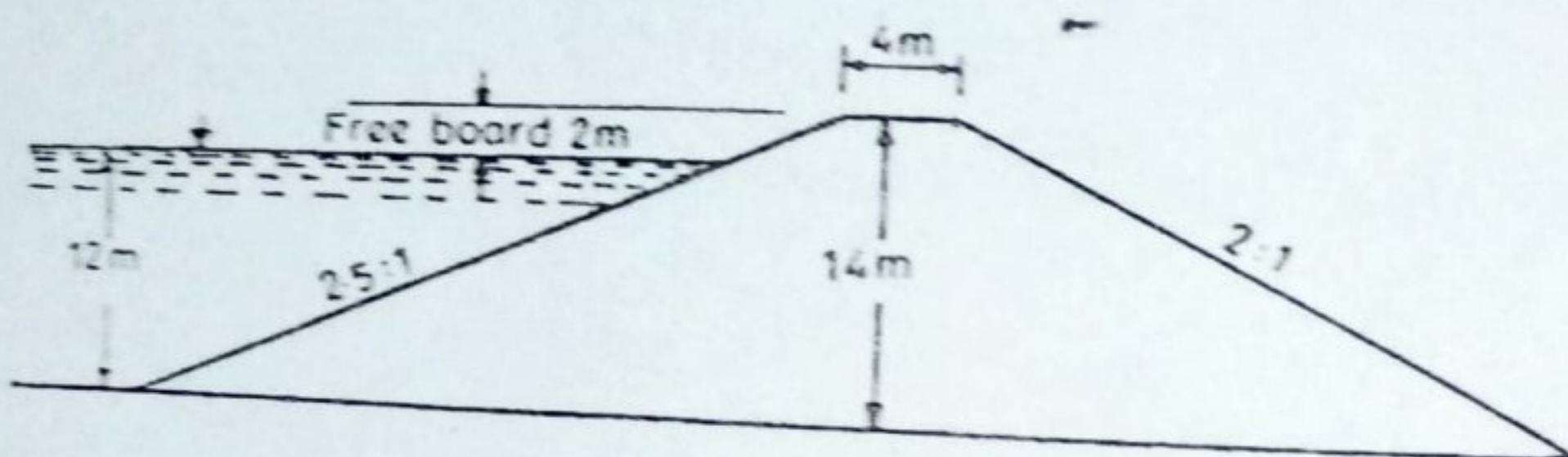
**GROUP-B**  
**[LONG ANSWER TYPE QUESTIONS]**

Answer any five questions

- |                                                                                                                                                                                                                                                                                                                                                                                      |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 6. i) An impervious floor of a weir on permeable soil is 18 m long and has sheet piles at both ends. The upstream pile is 4.5 m deep and downstream pile is 5.5 m deep. The weir creates a net head of 3 m. Neglecting the thickness of the weir floor, calculate the uplift pressures at the junction of the inner faces of the pile with the weir floor, by using Khosla's theory. | 8   |
| ii) Draw layout of a diversion head works and its components.                                                                                                                                                                                                                                                                                                                        | 4   |
| 7. Write short notes (with neat sketch) on a) syphon aqueduct, b) super-passage, c) level crossing d) ogee falls.                                                                                                                                                                                                                                                                    | 12  |
| 8. Write short note on trapezoidal notch fall, side channel spillway, shaft spillway and syphon spillway with neat sketch.                                                                                                                                                                                                                                                           | 3×4 |
| 9. This section of the gravity dam has a vertical crack up to 10 m from base at a distance 20 m from toe (not shown in figure). Calculate (neglecting earthquake effects)                                                                                                                                                                                                            | 12  |
| a) The maximum vertical stresses at the heel and the toe of the dam.                                                                                                                                                                                                                                                                                                                 |     |
| b) The major principal stress at the toe of the dam.                                                                                                                                                                                                                                                                                                                                 |     |
| c) The intensity of shear stress on a horizontal plane near the toe.                                                                                                                                                                                                                                                                                                                 |     |



10. i) Derive the height of a low gravity dam from principal stress consideration. 2  
 ii) Derive and compare the two important expressions for base width of the elementary profile of a gravity dam. 7  
 iii) Describe chute blocks and baffle piers (no sketch needed)? 3
11. A section of a homogeneous earth dam is shown in figure. Determine phreatic line for this dam section and discharge passing through the dam. Coefficient of permeability of the dam body is  $5 \times 10^{-4}$  cm/sec. Calculate length of the discharge face both graphically (using graph paper) and analytically. 12



12. Describe with neat sketch any two seepage control features of earthen dam through embankment and through foundation. 3x4

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**JGEC/B.TECH/CIVIL/CE(PE)702A/2022-23**  
**2023**  
**PRESTRESSED CONCRETE**

Full Marks: 70

Times: 3 Hours

*The figures in the margin indicate full marks.*

*Candidates are instructed to write the answers in their own words as far as practicable.*

**GROUP-A**  
**[OBJECTIVE TYPE QUESTIONS]**

Answer **all** questions

5x2=10

1. Write two advantages of pre stressed concrete .
2. Write expression for upward uniformly distributed load for a parabolic tendon carrying a tension P.  
Take Central dip of cable h and span of the beam L
3. A prestressing force P is applied with a tendon having eccentricity e to a beam with rectangular cross section of section modulus Z and area A. What are the expressions for maximum and minimum stresses .
4. What is load balancing method ?
5. Why high strength concrete should be used in prestressed concrete ?

**GROUP-B**  
**[LONG ANSWER TYPE QUESTIONS]**

Answer any **five** questions

12x5 =60

6. i) Briefly explain pre tensioning and post tensioning method in prestressed concrete. 8  
ii) If prestressing force in a bent tendon is P for a beam of span L, find central dip h required to fully balance a concentrated load W applied at mid span. 4
7. i) A prestressed concrete beam 500mmX750mm in section has a span of 8m and is subjected to a uniformly distributed load of 17.5 kN/m including self weight of the beam. The prestressing tendons are located at the lower third point of the section and provide an effective prestressing force of 1500kN. Determine the extreme stresses 6  
ii) Determine the profile of a load balancing cable for a beam of span 8m carrying an all inclusive load of 40kN/m .The prestressing force in the tendon is 1250kN. The section of the beam is 450mmX600mm. Find also the stress in the beam section. 6
8. i) Briefly describe the losses that occur during tensioning process. 6  
ii) A pre-stressed concrete beam of 250mm wide and 400m deep has a span of 12m. The beam is pre-stressed by steel wires of area 350mm<sup>2</sup> provided at a uniform eccentricity of 50mm with an initial pre stressed of 1200N/mm<sup>2</sup>. Determine the percentage loss of stress if the beam is post tensioned beam 6  
Take E<sub>s</sub>=210KN/mm<sup>2</sup>, E<sub>c</sub>=35Kn/mm<sup>2</sup>, Ultimate creep strain= 23X10<sup>-6</sup>mm/mm per N/mm<sup>2</sup> for post tensioned beam  
Shrinkage of Concrete 220X10<sup>-6</sup> ,  
Relaxation of steel stress 4% of initial stress.  
Anchorage slip =1.40mm  
Friction coefficient for wave effect=0.00015
9. Design a pre-stressed concrete beam of **uniform rectangular cross section**. Span of the beam is 12m. The beam supports a total distributed load of 30 KN/m excluding self weight of the beam. The permissible stresses are 14N/mm<sup>2</sup> for concrete and 1050N/mm<sup>2</sup> for tendons 12  
Shear and Deflection checking not required. Assume standard data if required.

10. Design a pre-stressed concrete beam of uniform **I-section**. Span of the beam is 15m. The beam supports a total superimposed distributed load of 35 KN/m excluding self weight of the beam. Design with following requirements-  
Cube strength of concrete at 28 days is  $f_{ck} = 35\text{N/mm}^2$  and ultimate tensile stress in steel is  $1500\text{N/mm}^2$ . Safe stress in concrete at transfer of prestress  $f_t = 0.5f_{ck}$ . Safe stress in concrete due to final prestress  $f_c = 0.4f_{ck}$ , total loss of prestress=20%. Allowable tensile stress in concrete  $= 0.219\sqrt{f_{ck}}$   
Safe stress in steel = 60% of ultimate stress.  
Shear and Deflection checking not required. Assume standard data if required
11. A prestressed concrete beam of rectangular cross section is 120mmX250mm and has a span of 6m . The beam is provided with straight tendon at a uniform eccentricity of 45mm, the prestressing force being 200KN. live load on the beam is 4KN/m. Check the beam for **deflection** and compare with the permissible limits . Take creep coefficient 1.7 and  $E_c = 35\text{KN/m}^2$  . Loss of prestress 20%
12. A Post tensioned concrete beam of rectangular section 250mmX500mm has a span of 13m and carries a superimposed load of 9kN/m. The tendon is provided with parabolic profile with a central dip of 180mm and with no eccentricity at the ends. The effective prestressing force in the tendon is 750kN. Determine –  
i) The Principal stresses at supports  
ii) What will you do if principal tensile stress developed exceeds permissible limit ?

---

12

12

12

12

# JALPAIGURI GOVERNMENT ENGINEERING COLLEGE

[A GOVERNMENT AUTONOMOUS COLLEGE]

JGEC/B.TECH/CE/CE(PE)703A/2022-23

2022

## AIR AND NOISE POLLUTION AND CONTROL

Full Marks: 70

Time: 3 Hours

*The figures in the margin indicate full marks.*

*Candidates are instructed to write the answers in their own words as far as practicable.*

### GROUP-A [OBJECTIVE TYPE QUESTIONS]

Answer **all** questions

- |                                                                                  |        |
|----------------------------------------------------------------------------------|--------|
| 1. Write short notes on wet scrubber.                                            | 5x2=10 |
| 2. With the help of sketches show the 'Fumigating' and 'Trapping' plume pattern. | 2      |
| 3. What is plume rise? What are the primary forces responsible for plume rise?   | 2      |
| 4. Define the unit used to describe ozone layer.                                 | 2      |
| 5. What is Air Quality Index (AQI)?                                              | 2      |

### GROUP-B [LONG ANSWER TYPE QUESTIONS]

Answer any **four** questions

- |                                                                                                                      |           |
|----------------------------------------------------------------------------------------------------------------------|-----------|
| 6. i) Why air pollution models are required? What are the primary inputs of air quality dispersion model?            | 4x15 = 60 |
| ii) Write the complete code number of the following: (a) C2FH3Cl2, (b) CCIF3, (c) CHF2Br.                            | 1+3       |
| iii) What is the difference between criteria and standard?                                                           | 3         |
| iv) Traffic noise data are shown in the table below. Compute L <sub>eq</sub> , L <sub>90</sub> and L <sub>10</sub> . | 2         |
|                                                                                                                      | 6         |

Time (Sec)	10	20	30	40	50	60	70	80	90	100
Sound Level (dB)	71	75	70	78	80	84	76	74	75	74

- |                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 7. i) With the help of sketch show the co-ordinate system of Gaussian Dispersion Model.                                                                                                                                                                                                                                                                                                                                            | 4 |
| ii) Write down the salient features of last revision of NAAQS.                                                                                                                                                                                                                                                                                                                                                                     | 3 |
| iii) It is estimated that a burning solid waste dump emits 30 g/sec of oxides of nitrogen. What is the concentration of oxides of nitrogen from the source directly downwind at a distance of 3 km on an overcast night with wind speed of 7 m/sec? Assume this solid waste dump to be a point ground level source with no effective rise. Develop the relevant expression which is to be used from the general Gaussian Equation. | 6 |

Note:

The general form of Gaussian Dispersion Equation is as follows:

$$C(x,y,z;H) = \frac{Q}{2\pi\sigma_y\sigma_z u} \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \left[ \exp\left(-\frac{(H-Z)^2}{2\sigma_z^2}\right) + \exp\left(-\frac{(H+Z)^2}{2\sigma_z^2}\right) \right]$$

- |                                                                                                                                                                                                                                                                         |   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| a) All the notations have their usual meanings.<br>b) Vertical and horizontal dispersion co-efficient should be determined from given curves.<br>iv) Mention the noise standards as prescribed by CPCB for silence zone in L <sub>eq</sub> dB(A) in day and night time. | 2 |
| i) Why is pH of water bodies decreased due to acid rain and what are the effects of this decrease?<br>ii) Draw the combined absorption spectra and discuss briefly the salient features.                                                                                | 2 |

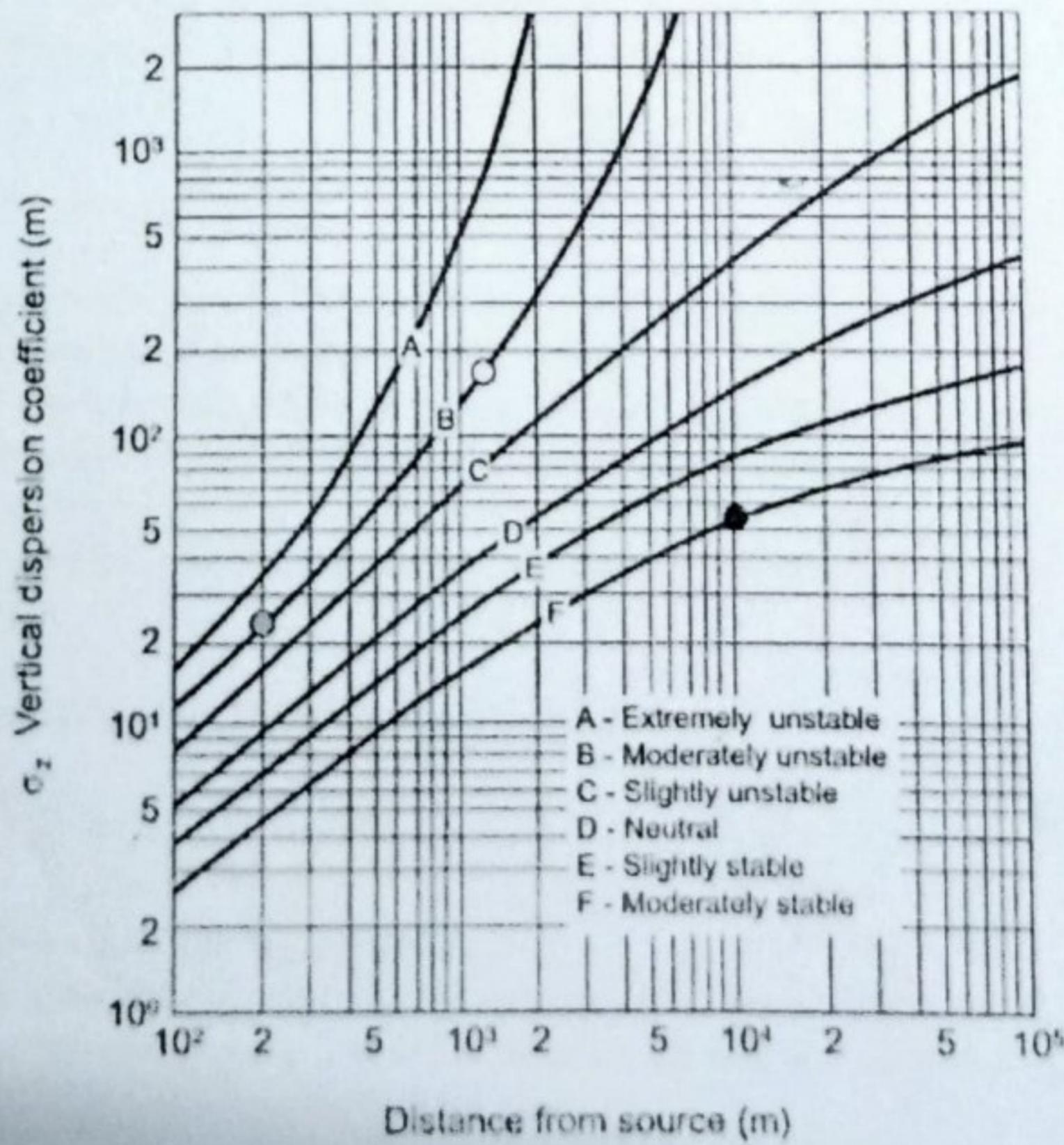
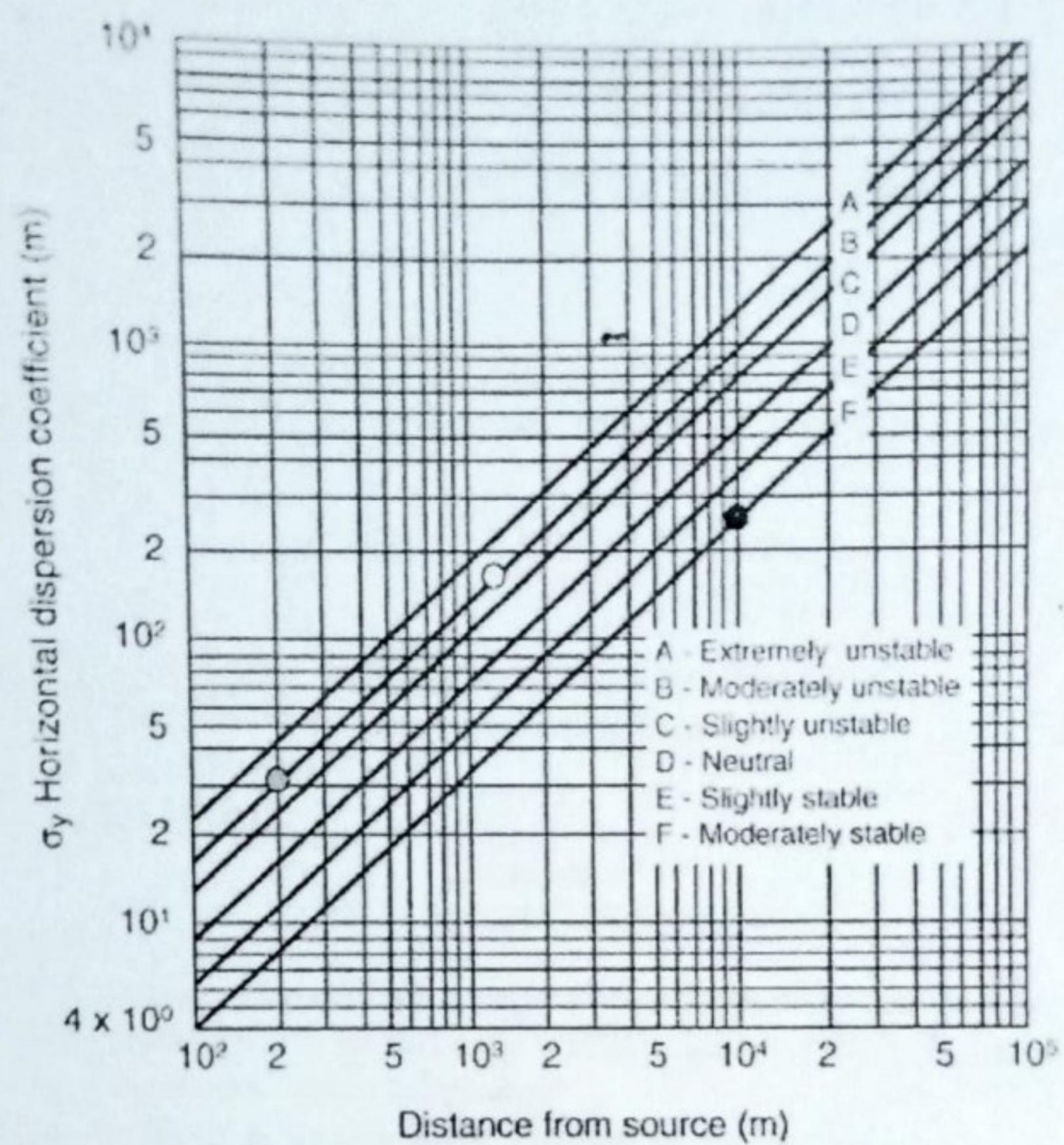
- iii) A stack of a copper smelter is 380 m high and has an internal diameter at the top of 5 m. The exit velocity of the stack gases is estimated as 20 m/sec, at a temperature of  $130^{\circ}\text{C}$ . Ambient temperature is  $20^{\circ}\text{C}$  and wind speed at stack height are estimated to be 8 m/sec. estimate the effective height of stack if
- The atmosphere stable with the temperature increasing @  $2^{\circ}\text{C/Km}$  (negative lapse rate).
  - The atmosphere is slightly unstable (stability category- C).

Some of the following equation may be required (notations have their usual meanings)

$$\Delta h = 2.6 \left( \frac{F}{U_h S} \right)^{1/3} \quad F = gr^2 v_s \left( \frac{T_s - T_a}{T_s} \right) \quad \Delta h = \frac{1.6 F^{1/3} (x_e)^{2/3}}{U_h} \quad S = \frac{g}{T_a} \left( \frac{\Delta T_a}{\Delta Z} + 0.01 \right)$$

$$X_f = 120 F^{0.4} \text{ if } F \geq 55 \text{ m}^4/\text{s}^3; X_f = 50 F^{5/8} \text{ if } F < 55 \text{ m}^4/\text{s}^3$$

9. i) What are the mechanical devices used to control particulate pollutants and the common technology used to control gaseous pollutant in industries? 5
- ii) Write the equation of NO-NO<sub>2</sub>-O<sub>3</sub> photochemical reaction sequence. 3
- iii) What is waste minimization? How we can relate waste minimization with sustainable development? 3
- iv) Define noise pollution and discuss it's the health effects in detail. 4
10. i) Why minimization at source is a good option for SO<sub>2</sub>? 3
- ii) What is enhanced greenhouse effect? How we can minimize it? 2+2
- iii) Process change is the best option for minimization of NO<sub>x</sub>- explain with example. 3
- iv) With the help of a sketch discuss the assumption related with reflection at the ground and show the steps to calculate X<sub>e</sub> ( $\sigma_z = 0.47H$ ). given H is the effective height of emission 5
11. i) The noise spectrum of a cutter equipment at a distance of 5 feet is analyzed and producing results are given below: 8
- | Centre Frequency (Hz)     | 63  | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---------------------------|-----|-----|-----|-----|------|------|------|------|
| Sound Pressure Level (dB) | 62  | 71  | 72  | 77  | 92   | 79   | 77   | 63   |
| A correction (dB)         | -26 | -16 | -9  | -3  | 0    | +1   | +1   | -1   |
- a) What are the total sound pressure level (L<sub>PT</sub>) and total sound level (L<sub>PAT</sub>) generated by the equipment?
- b) What are total sound pressure generated at a given distance?
- c) What are the corresponding total sound power and intensity level?
- ii) Find the Cartesian (x, y, z) of the following points: 5
- a) The stack tip (0, 0, 0)
- b) The point representing ground level source with negligible height (0, 0, 0)
- c) Any point on plume centreline (0, y, 0)
- d) Any point on the ground just beneath the plume centreline
- e) The point at which the plume touches the ground
- iii) Why CO regarded as criteria pollutant, but CO<sub>2</sub> is not? 2
12. i) What are the natural self-cleansing properties of environment? 2
- ii) The sound level is 86 dB at 31m from the source. What is the sound level in dB at 85m from the source? 2
- iii) What are the assumption of Gaussian dispersion equation? 4
- iv) Draw the global energy balance sketch and show the balance for the space and atmosphere. 7



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COE/B.TECH./CE/ CE(PE)703B/2022-23

2022

PHYSICO-CHEMICAL PROCESS FOR WATER AND WASTEWATER TREATMENT

Full Marks: 70

Times: 3 Hours

*The figures in the margin indicate full marks.*

*Candidates are requested to write their answers in their own words as far as practicable.*

*All the notations have their usual meanings unless specifically mentioned.*

**NOTE: Please supply two (2) regular (millimeter) graph paper with the answer script.**

**GROUP-A**  
**[OBJECTIVE TYPE QUESTIONS]**

Answer all questions

5x2=10

1. Write down the objective of aeration process.
2. Two activated carbon A and B having surface area  $1500 \text{ m}^2/\text{gm}$  and  $500 \text{ m}^2/\text{gm}$  respectively and pore volume  $0.4 \text{ ml/gm}$  and  $1.2 \text{ ml/gm}$ . Compare these activated carbons in regard with adsorption efficiency.
3. Differentiate between strong acid cation exchange resin and weak acid cation exchange resin with example.
4. Why is *Delta* formed at the confluence of the river? Explain this in light of coagulation theory.
5. Mention the merits and demerits of chlorine to be used as disinfectant compared to UV ray.

**GROUP-B**  
**[LONG ANSWER TYPE QUESTIONS]**

Answer any Four of the following

4x15=60

6. (i) A suspension of sand like particles in water is flowing into a settling tank at  $0.10 \text{ m}^3/\text{s}$ . Assume  $g = 9.81 \text{ m/s}^2$ , specific gravity of particles = 2.65, and kinematic viscosity of water =  $1.0105 \times 10^{-2} \text{ cm}^2/\text{s}$ . Determine the minimum surface area (in  $\text{m}^2$ ) required for this settling tank to remove particles of size 0.06 mm with 100% efficiency. (6)

- (ii) A settling column is run on a type-1 suspension. The settling column is 2 m tall, and the initial concentration is of the well mixed sample is 650 mg/L. Results of the analysis are shown below.

Time, min	0	58	77	91	114	154	250
Conc. remaining, mg/L	650	560	415	325	215	130	52

What is the theoretical efficiency of the settling basins that receive the suspension if the loading rate is  $2.4 \times 10^{-2} \text{ m/min}$ ? (9)

7. (i) Why alkalinity must be present for effective coagulation? (2)
- (ii) Suppose you are dealing with two kind of water (a) Low Turbidity- High alkalinity (b) Low alkalinity- Low turbidity. In which type do you observe better coagulation? Which type of coagulation will be effective for each of the above water? What will you need to do to make it more effective? (6)
- (iii) Discuss the disinfection process with chlorine and its compounds. Mention the predominance of ions with respect to pH. (4)
- (iv) Why ammonia is often added externally (if not present) in water before disinfection with chlorine? (3)
8. (i) A rapid sand filter has a bed depth of 0.7 m. It is composed of sand grains that have a specific gravity of 2.65 and shape factor of 0.82. The porosity of the bed is 0.45 throughout. The kinematic viscosity of water may be assumed to be  $1.002 \times 10^{-3}$  kgm/s. The sieve analysis of the sand is shown below. (10)

Av. Particle size, mm	Mass retained, %
1	0.87
0.71	8.63
0.54	21.30
0.46	28.10
0.38	23.64
0.42	7.09
0.27	3.19
0.23	2.16
0.18	1.02

Determine the loss of head through the bed if the flow rate is 5 m/s.

- (ii) Compare rapid sand filter and slow sand filter w.r.t. five important parameters. (5)
9. (i) Derive the expression for Langmuir isotherm state the necessary assumption. (5)
- (ii) Langmuir adsorption isotherm is expressed as  $q = Q_b C / (1 + bC)$ . Single solute monochlorophenol (mcp) isotherm were determined separately for two different activated carbons, A and B. The parameters were as follows:
- Activated carbon A :  $Q_A = 200$  mg mcp/gm of activated carbon;  $b_A = 0.2$  L/mg
- Activated carbon B :  $Q_B = 300$  mg mcp/gm of activated carbon;  $b_B = 0.3$  L/mg
- a) In 1 liter of solution containing 50 mg mcp. 200 mg activated carbon A is added. What will be the equilibrium mcp concentration in solution? (5)
- b) At the end of step (i), you added 200 mg of activated carbon B in the same solution. What will be equilibrium concentration? (5)

10. (i) Construct an ion-exchange isotherm for chloride nitrate on Duolite ES-368 and compute average separation factor ( $\alpha_{\text{NO}_3^-}$ ) for the following data (please take a mm graph paper and put your signature thereon). Plot  $y_{\text{Cl}^-}$  vs  $x_{\text{Cl}^-}$ . (9)

gm of resin added in 100 ml solution	$[\text{NO}_3^-]$ meq/L	$[\text{Cl}^-]$ meq/L
0.02	4.1	0.9
0.04	3.5	1.5
0.10	2.2	2.8
0.20	1.2	3.8
0.40	0.5	4.5
1.20	0.2	4.8

Resin originally in chloride form. Chloride capacity of resin = 4 meq/gm.

- (ii) Show the nature of the curve for the following isotherm (Don't use graph paper) (6)

- a) Sulphate-nitrate (total concentration: 0.002 N, 0.004 N and 0.008 N). Plot  $X_{\text{SO}_4^-}$  vs  $Y_{\text{SO}_4^-}$   
 b) Chloride-nitrate (Concentration as state above). Plot  $X_{\text{Cl}^-}$  vs  $Y_{\text{Cl}^-}$

11. (i) What is the objective of chemical precipitation? Explain this process with an example. (3)

- (ii) A water has the following ionic constituents (mequiv/L): (12)

$$\text{Dissolved CO}_2 = 0.6$$

$$\text{Ca}^{2+} = 4.7$$

$$\text{Mg}^{2+} = 1.0$$

$$\text{Na}^+ = 2.2$$

$$\text{HCO}_3^- = 2.5$$

$$\text{SO}_4^- = 2.9$$

$$\text{Cl}^- = 2.5$$

- a) Calculate the chemical requirement (mequiv/L) required to remove as much of the calcium as possible. (No  $\text{Mg}^{2+}$  removal is required).  
 b) Draw a bar diagram of the finished water.  
 c) Calculate the daily quantity (kg/day) of lime and soda ash (assume a purity of 92% for the lime and 90% for the soda ash) to treat 17500 m<sup>3</sup>/d of this water.  
 d) Determine the mass (kg/day) of the sludge produced.

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JALPAIGURI GOVERNMENT ENGINEERING COLLEGE

[A GOVERNMENT AUTONOMOUS COLLEGE]

B.TECH./CIVIL ENGINEERING/CE(PE)704A/2022-2023

2022

PAPER NAME – Structural Dynamics

Full Marks: 70

Time: 3 Hours

*The figures in the margin indicate full marks.*

*Candidates are requested to write their answers in their own words as far as practicable.*

*Assume any reasonable data, if required.*

**GROUP-A**  
**|OBJECTIVE TYPE QUESTIONS|**

Answer **all** questions

5x2=10

1. What are the possible modes of vibration of a mass-less vertical cantilever column [L, A, E, G, I, J] with a mass at top and write the corresponding stiffness with dimension.
2. Mention the major causes of damping in a structure.
3. Explain D'Alembert's Principle.  
A mass [M] hangs vertically downwards from a pin connected spring [K] and the spring[K] is again hinged to
4. the free end of a mass-less horizontal cantilever beam [L, A, E, G, I, J]. Determine the resultant stiffness for the structure.
5. Represent pictorially at least two dynamic disturbances caused by natural phenomena.

**GROUP-B**  
**|LONG ANSWER TYPE QUESTIONS|**

Answer any **five/four** questions

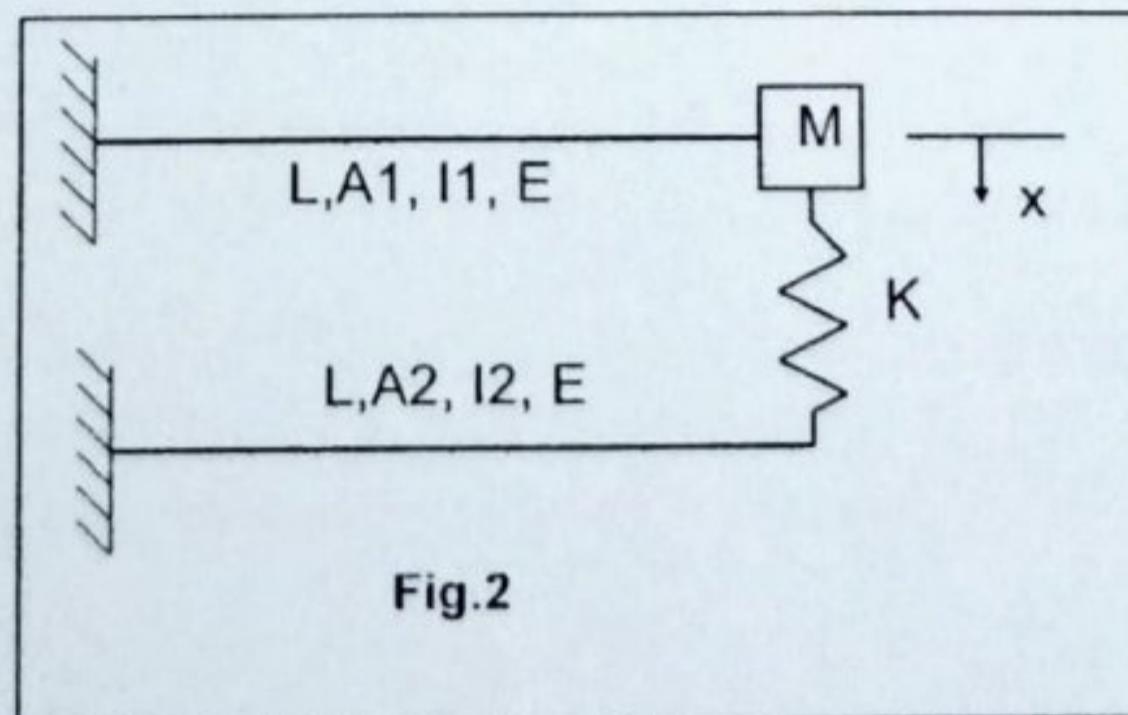
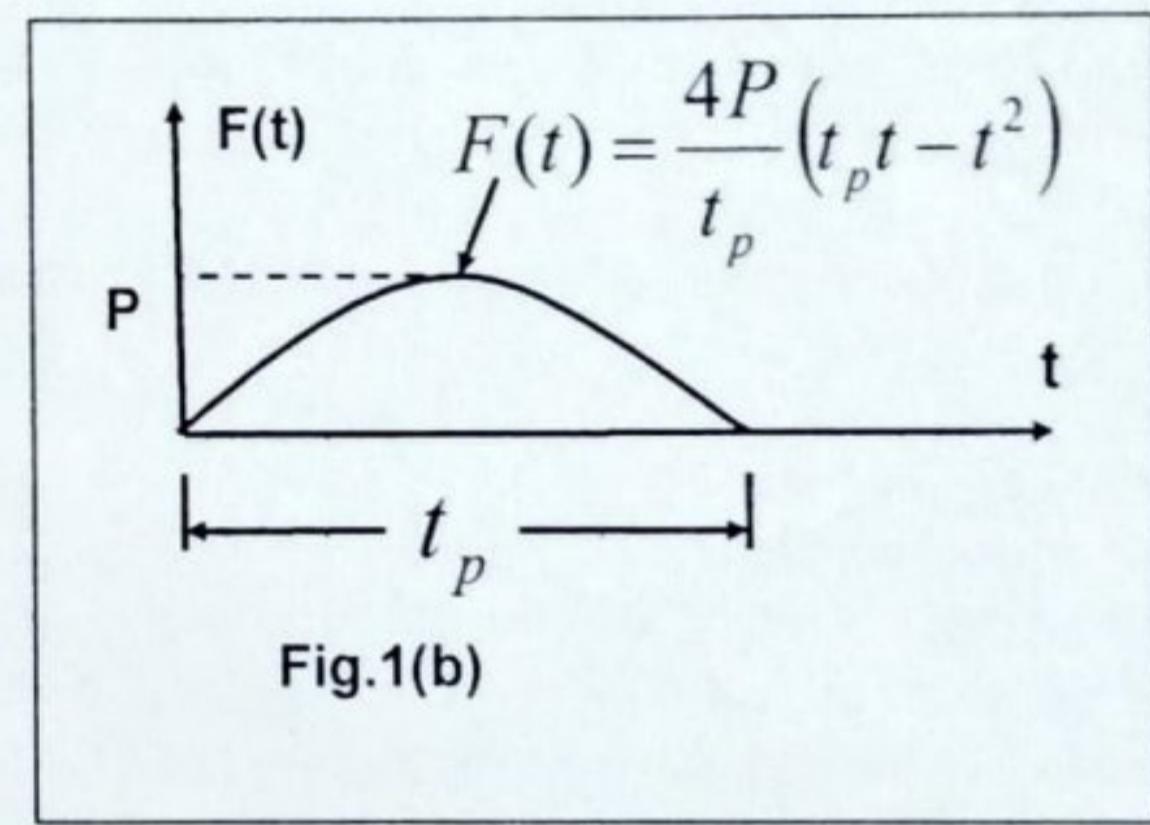
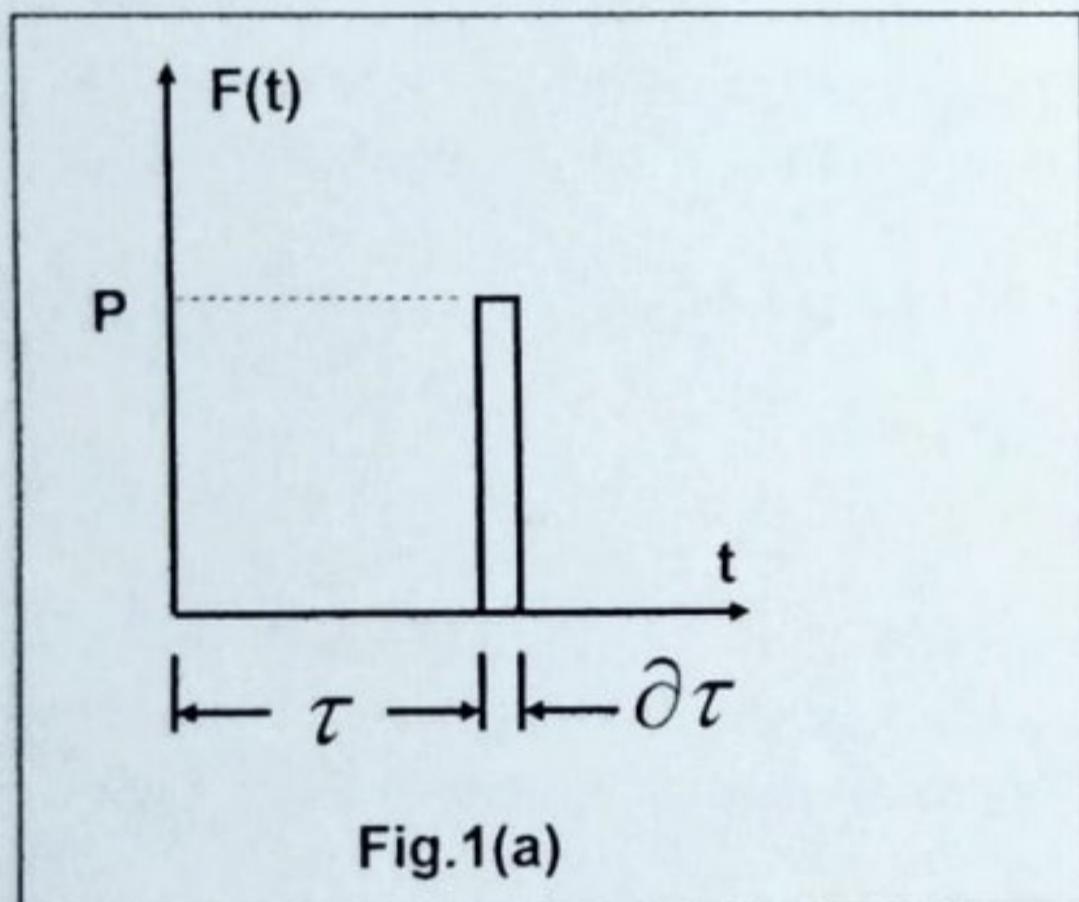
4x15 = 60

6. A two storey building has following details:  
Lumped mass of roof =700000kg and Lumped mass of first floor is 950000 kg. Storey stiffness of both stories may be taken as 2.0E+09N/m and 1.6E+09N/m for ground storey and first storey respectively. Write the equation of motion for free vibration from first principle. Also, evaluate natural frequencies and modal vectors of all modes of vibration.
7. A three storey building has following details:  
Lumped mass of first floor, second floor and roof are M<sub>1</sub>(first floor) = 135000kg, M<sub>2</sub>(second floor) = 175000 kg and M<sub>3</sub>(roof) = 125000kg respectively. The fundamental natural frequency is 25rad/sec. The fundamental modal vector is {U<sub>rooft</sub>, 1 = 1.0, U<sub>2nd floor</sub>, 1 = 0.785, U<sub>1st floor</sub> = 0.425}. Given, Seismic Zone Factor (Z) =0.36; Importance Factor (I) = 1.2; Response Reduction Factor (R) = 5 and Average Response Acceleration Coefficient (Sa/g) = 2.5 for 5% damping for all time periods. Determine the seismic floor forces as well as floor displacements by Modal analysis and Response Spectrum method.
8. A m/c weighing 200kg is supported on four springs having stiffness of 750kg/cm each. The operating frequency is 1500rpm. Given  $\beta = 0.2$ . Determine the amplitude of motion, transmissibility and transmitted force. Also, determine the value of K if only 10% of the shaking force of the unit is to be transmitted to the foundation.
9. Determine the response at any time 't' of a single degree undamped spring(k)-mass(m) system, which is at rest, due to an impulsive force of magnitude 'P' over a very short duration  $\partial\tau$  at time  $t = \tau$  [Fig.1(a)]. Using the above result, determine the response of a single degree undamped spring (k)-mass(m) system, which is at rest, due to the following disturbing force[Fig. 1(b)], at any time 't': (i) $t < t_p$  and (ii)  $t > t_p$ .
10. a) A Determine the fundamental natural frequency of a vibrating horizontal simply supported flexural beam having length = L, constant flexural rigidity = EI, uniform distributed mass per unit length = m and a lumped mass 'M' at mid-point of the beam; using Rayleigh's method. 10

b) Derive the equivalent stiffness and write the free vibration equation of motion of the single degree of freedom system as shown in Fig. 2. 5

II. a) Determine the torsional stiffness of a single storey R.C.C. beam-column framed building with following details: (i) Center-line dimension:  $6.0M \times 5.0M$  rectangular on plan; (ii) No. and size of column: Four equal column of size  $400mm \times 400mm$  located at the corners; (iii) Floor height =  $3.5M$ ; and (iv) Assume, the columns are tied by in-plane rigid floor diaphragm. 9

b) A foundation block of mass  $M$  kg rests on elastic foundation. The block is  $h$  meter high,  $2a$  meter long and  $2b$  meter wide. The foundation has sub-grade modulus  $q$   $N/m^2/m$ . Write the equation of motion for free vibration in rocking mode in the plane parallel to the length and determine the natural frequency (rocking mode) in terms of given data. 6



**JALPAIGURI GOVERNMENT ENGINEERING COLLEGE**  
**[A GOVERNMENT AUTONOMOUS COLLEGE]**  
**JGEC/B.TECH/CE/CE(PE)705B/2022-23**  
**2022**  
**PAVEMENT DESIGN**

Full Marks: 70

Time: 3 Hours

*The figures in the margin indicate full marks. Assume any reasonable data, if required.  
 Candidates are instructed to write the answers in their own words as far as practicable.*

**GROUP-A**  
**[OBJECTIVE TYPE QUESTIONS]**

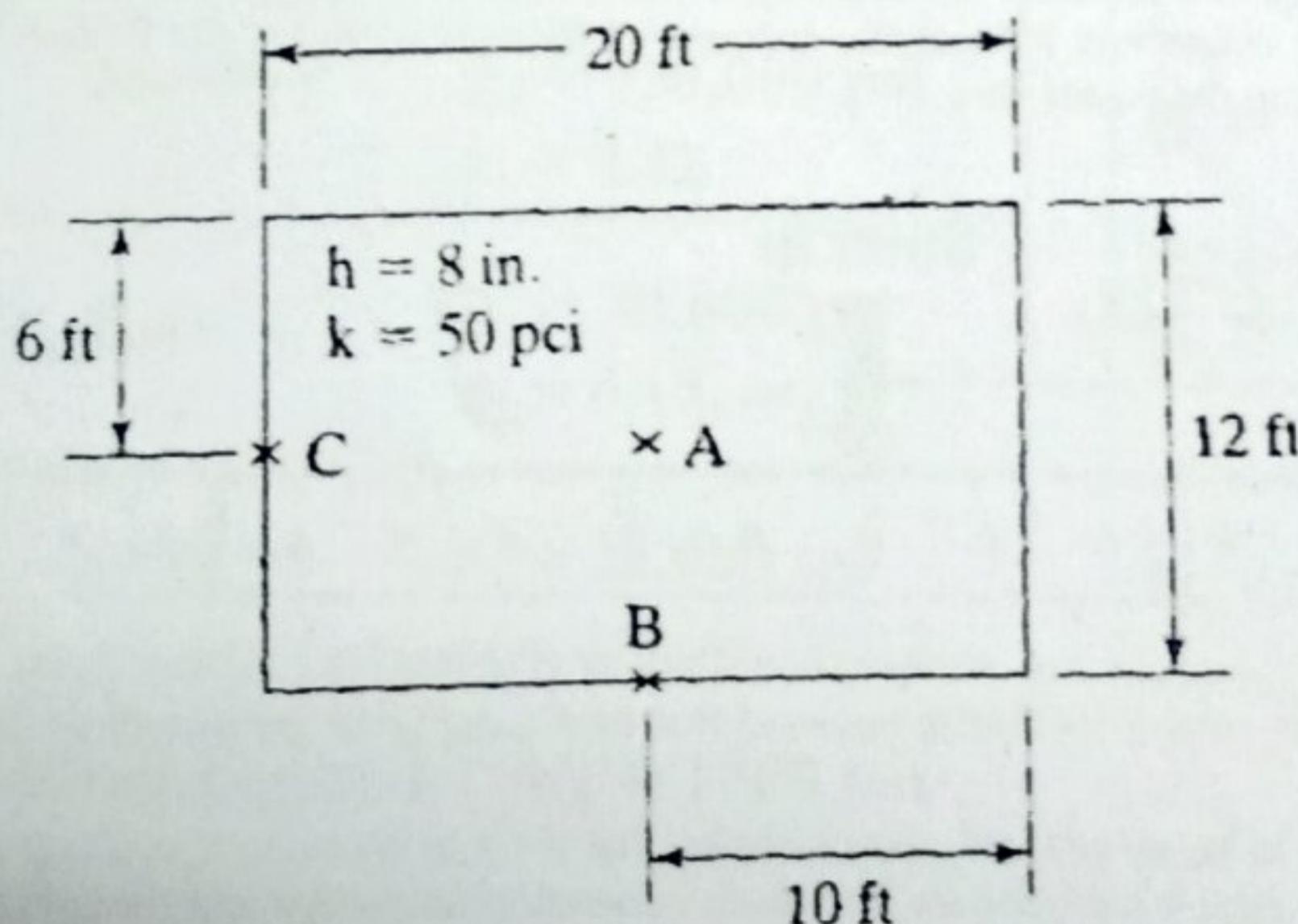
Answer all questions

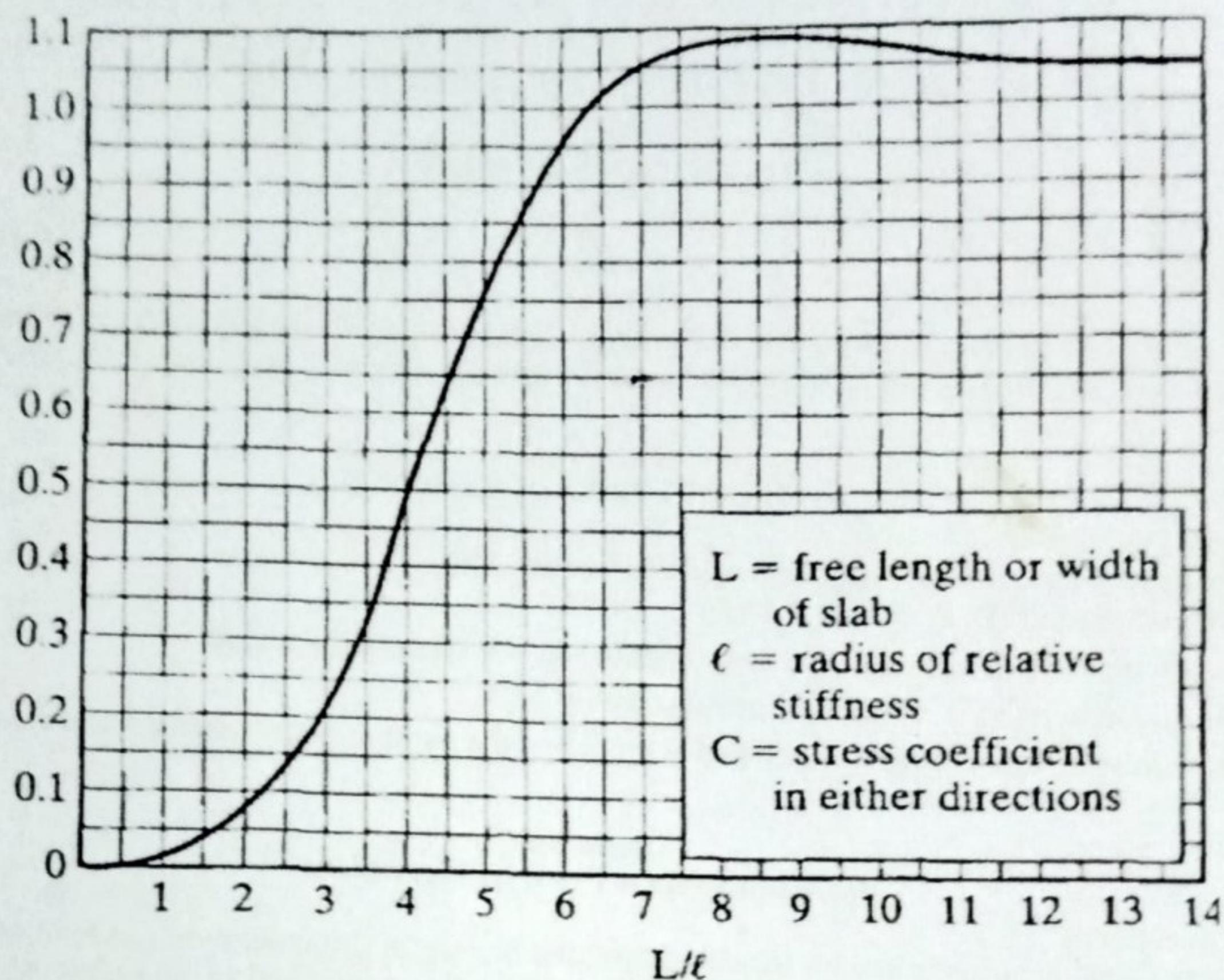
- |                                                                                                                   |   |
|-------------------------------------------------------------------------------------------------------------------|---|
| 1. What is the purpose of providing reinforcement in rigid pavement?                                              | 2 |
| 2. How load is transferred in JPCP without dowel?                                                                 | 2 |
| 3. Why high-quality material is used in upper layer of pavement? Explain with a figure.                           | 2 |
| 4. Determine Resilient modulus of a subgrade having CBR = 7.5%.                                                   | 2 |
| 5. Which stress (tension/compression) is developed at the top of the pavement due to temperature during day time? | 2 |
| Explain.                                                                                                          | 2 |

**GROUP-B**  
**[LONG ANSWER TYPE QUESTIONS]**

Answer any four questions

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 6. a. Determine the curling stresses in an 8-in. slab during the day under a temperature gradient of $3^{\circ}\text{F}$ per inch of slab for the following two cases: (a) at an interior point of an infinite slab, and (b) at points A, and C in a finite slab, as shown in Figure below. The modulus of subgrade reaction is assumed to be 50 pci. modulus of elasticity of concrete = $4 \times 10^6$ psi, Poisson ratio of concrete = 0.15, coefficient of thermal expansion of concrete = $5 \times 10^{-6}$ in./in./ $^{\circ}\text{F}$ . Chart given below may be used. | 6 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|

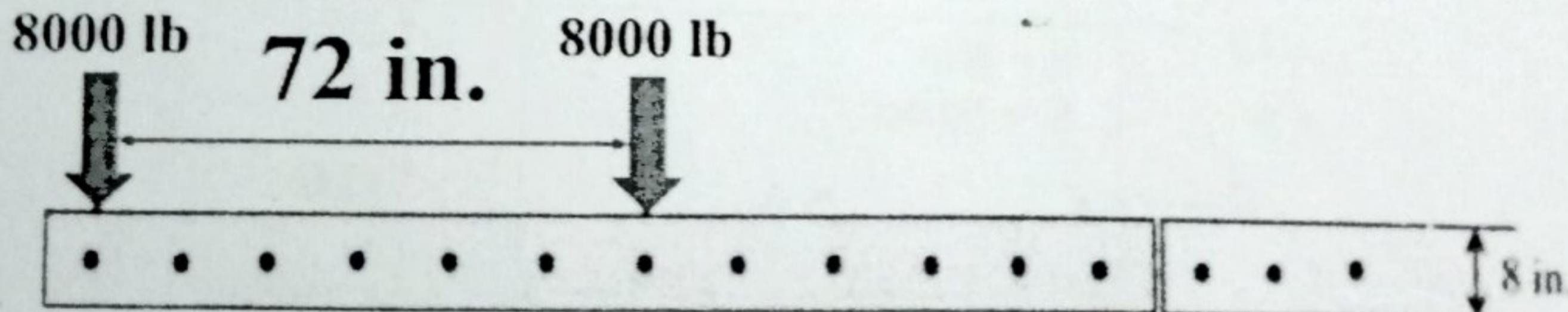




b. Describe construction of WBM.

c. What is pumping and blow-up distress of pavement?

7. a. A set of 1 in.-diameter dowel bars are placed 12 in. on center in a 12-ft-wide concrete slab, as shown in figure below. Two loads (8,000 lb each) are applied as shown. Assume the 90% efficiency of the dowel bars. The modulus of subgrade reaction is 100 pci; the concrete modulus is 3,000 ksi and Poisson's ratio is 0.15. Determine the force distribution in the dowel bars.



b. Can the concrete handle the stress developed in problem 7a? Given: joint opening of 0.75 in., a modulus of dowel support of 800,000 pci, modulus of elasticity of the dowel of 20,000 ksi, and Concrete M 30.

c. A concrete slab is to be placed with the condition that the maximum joint opening allowable is 0.9 mm. The pavement may experience a temperature difference between construction and the coldest winter month of 40°C. The coefficient of thermal expansion and contraction of the concrete slab is  $9.5 \times 10^{-6}$  per degree Celsius. The drying shrinkage coefficient of concrete is  $1.55 \times 10^{-4}$ . Assume the adjustment factor due to the slab-subbase friction is 0.65. Compute the maximum feasible slab length.

8. a. A set of dual tires has a total load  $2P_d$  of 46kN, a contact radius  $a$  of 115 mm, and a center-to-center tire spacing  $S_d$  of 350mm. Determine the ESWL by Boyd and Foster's method at 60mm and 500mm depth.

b. A common full-size car has two single axles with 3-kip load on each. A Class 9 truck has two tandem axles and one single axle. The tandem axles carry 50-kip load on each axle. The single axle of the Class 9 truck carries 15 kip. If  $SN = 5$ ,  $p = 2.5$ , how many full-sized cars produce the equivalent damage of a Class 9 truck? Table given below may be used.

5  
4  
6

3

3

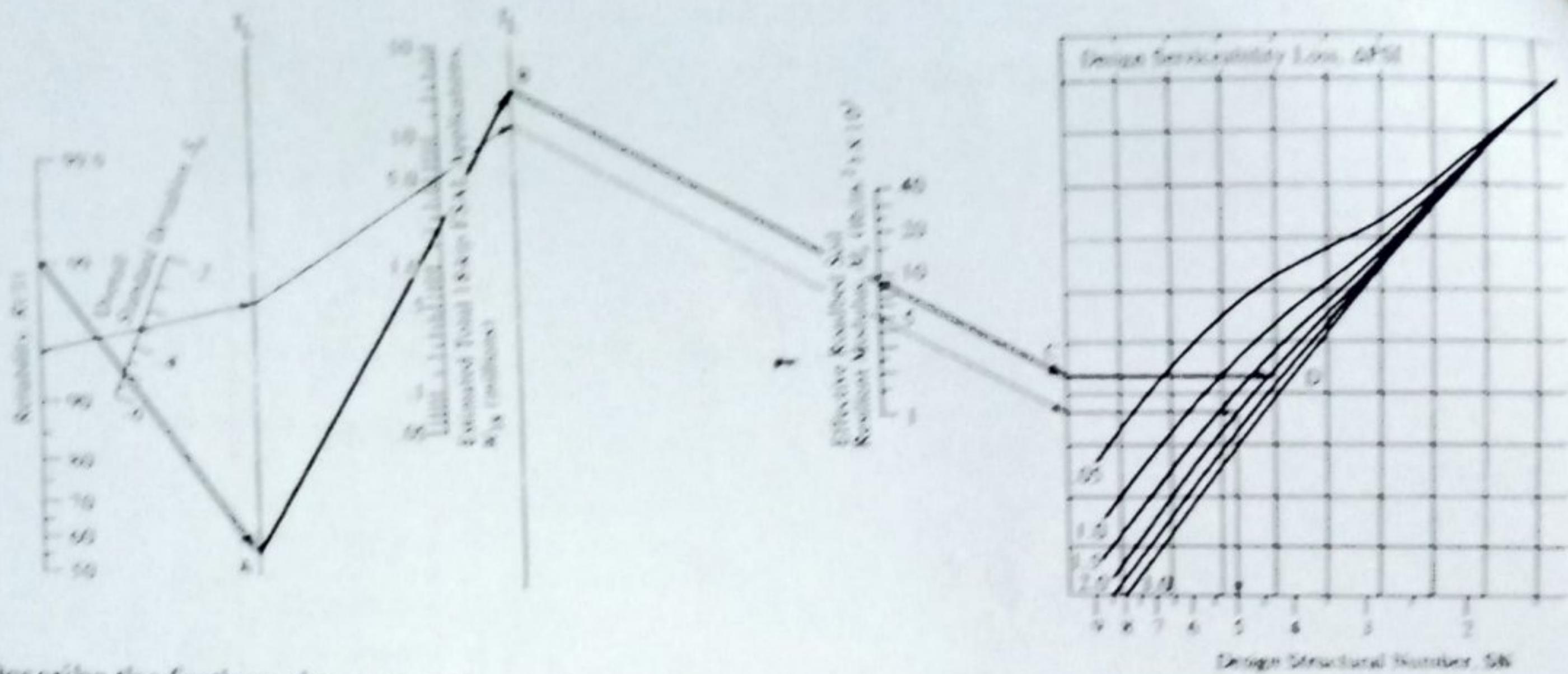
Load Equivalency Factors for Flexible Pavement (SN = 5,  $p_f = 2.5$ )

Gross axle load KN	lb	Load equivalency factors	
		Single axles	Tandem axles
8.9	2,000	0.00018	
17.8	4,000	0.00209	
66.7	15,000	0.478	0.0360
200.0	45,000	34.00	3.27
222.4	50,000	52.88	4.86

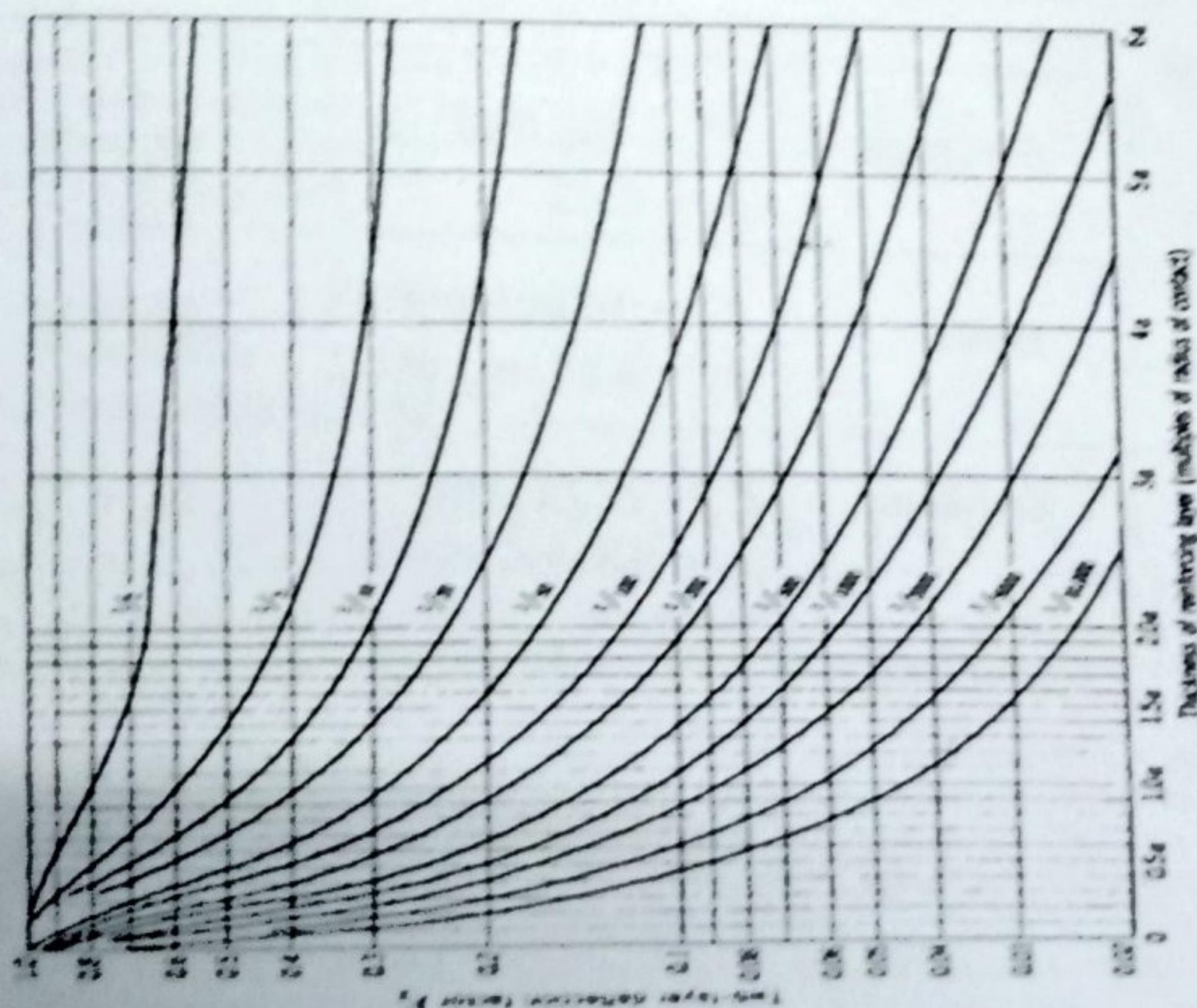
c. Determine cumulative number of standard axles from the following data: Four lane divided carriageway, Initial traffic in the year of completion of construction = 6000 cvpd (two-way), Traffic growth rate per annum = 6.0 per cent, Design life period = 20 years, Vehicle damage factor = 5.2 and Lateral Distribution factor = 0.75 (for each direction). 3

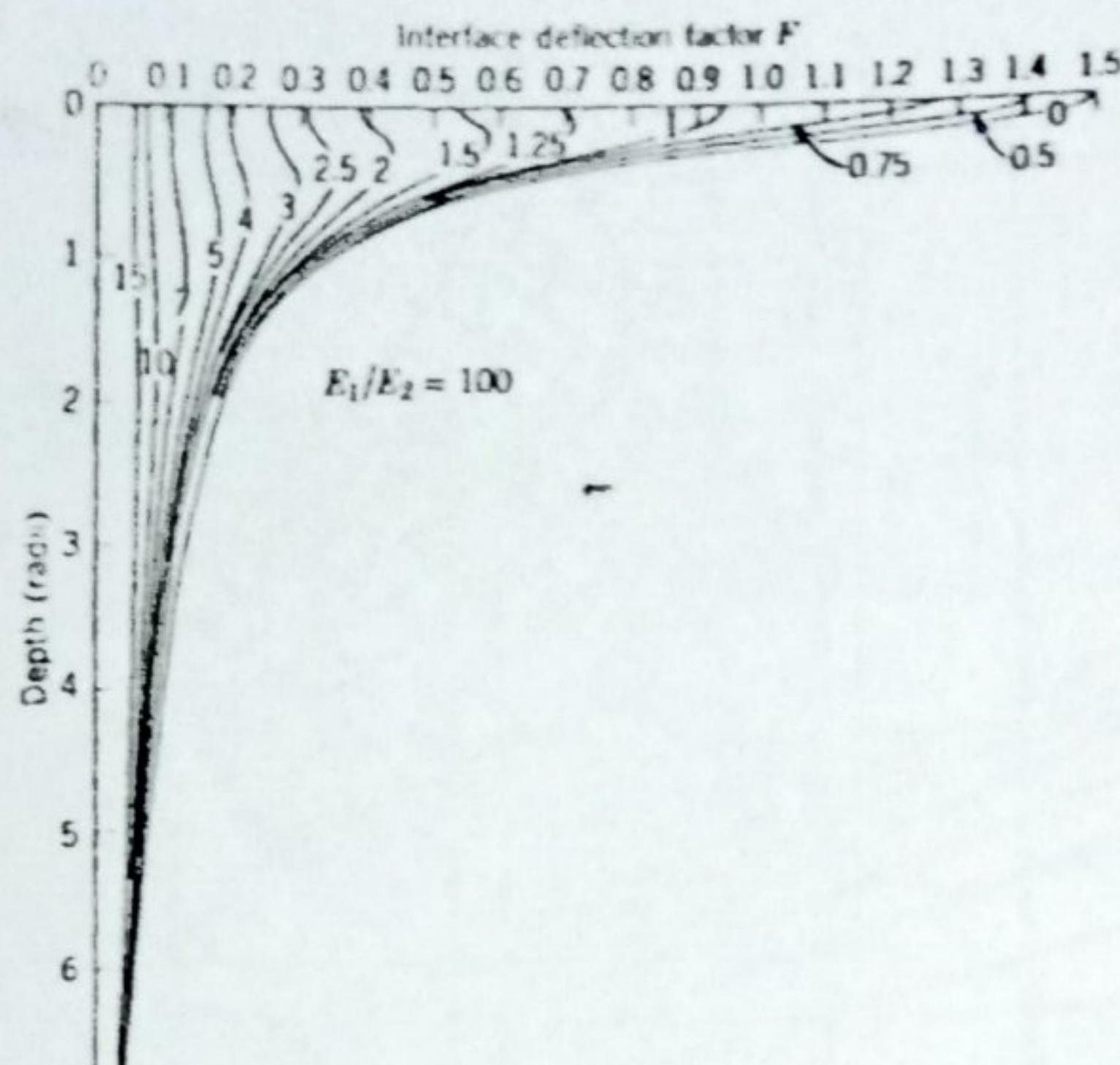
d. A pavement section with the layer coefficients and moduli of surface, base, and subbase layers is shown in figure below. The predicted design ESAL is 10 million and the standard deviation is 0.35. The expected terminal serviceability for this pavement is 2.5. For these conditions, determine the layers' thicknesses at 99% reliability. Round off the thicknesses to 0.50 in. Nomograph given below may be used. 6

<b>Surface</b>	$E_1 = 450,000 \text{ psi}$ $a_1 = 0.42$	$D_1 = ?$
<b>Base</b>	$E_2 = 30,000 \text{ psi}$ $a_2 = 0.15, m_2 = 1.2$	$D_2 = ?$
<b>Subbase</b>	$E_3 = 20,000 \text{ psi}$ $a_3 = 0.1, m_3 = 1.2$	$D_3 = ?$
<b>Road bed soil</b> $M_R = 1000 \text{ psi}$		



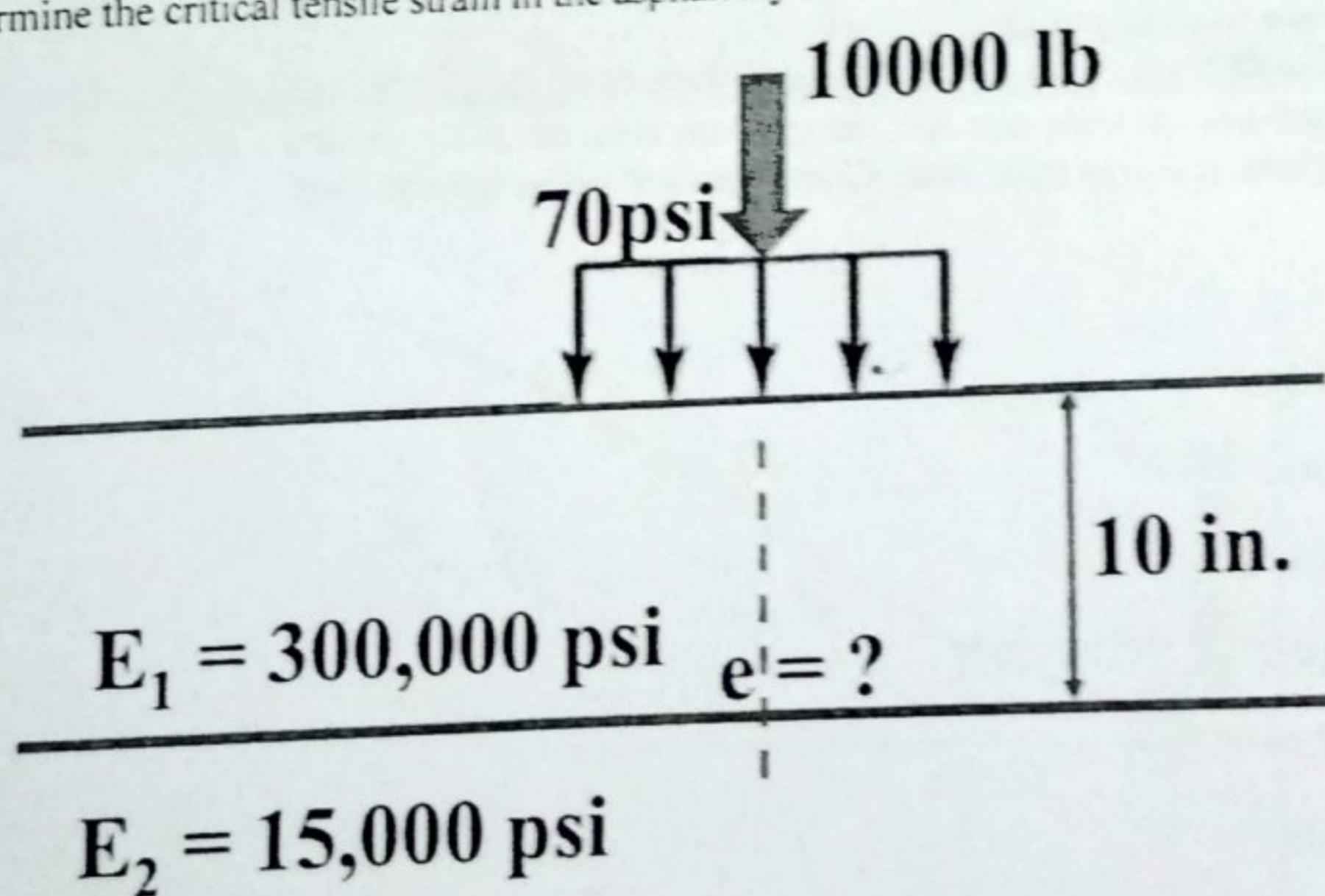
9. a. Describe the feather edge type and trench type construction of gravel road in brief. 4  
 b. What is Resilient modulus? How Resilient modulus can be determined in from any of laboratory test?  
 c. Write short note on: Rutting, Hydroplaning, Raveling and Bleeding. 3
10. a. Calculate the surface deflection  $\Delta_s$  under the center of a tire ( $a = 6.5$  in.  $p = 90$  psi) for a 12-inch pavement having a 1000000-psi modulus and subgrade modulus of 10,000 psi from two-layer theory. Also calculate the interface deflection  $\Delta_i$  and the deflection that takes place within the pavement layer  $\Delta_p$ . Charts given below may be used. 8

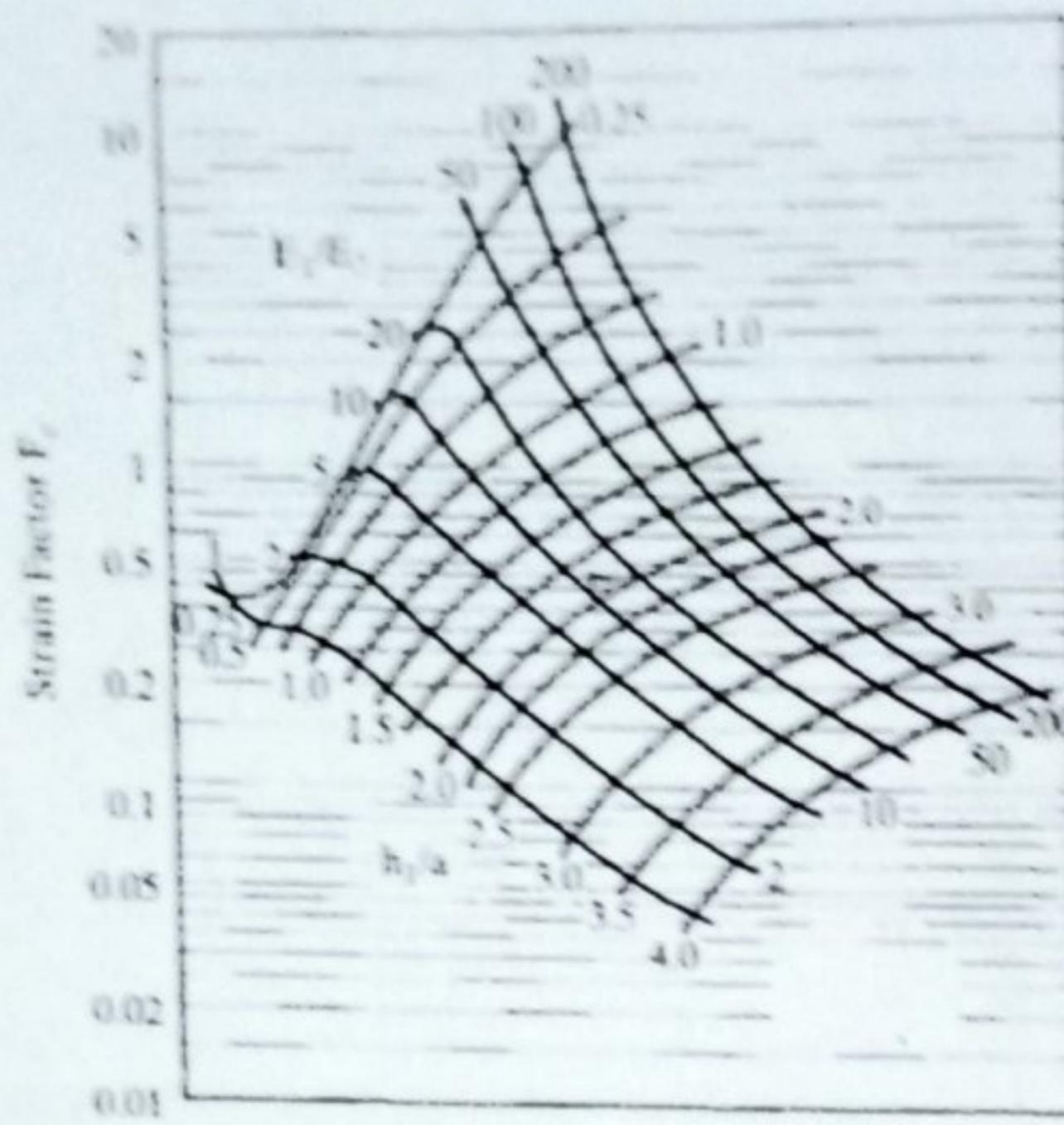




b. Figure shows a full-depth asphalt pavement 10 in. thick subjected to a single-wheel load of 10000 lb having contact pressure 70 psi. If the elastic modulus of the asphalt layer is 300,000 psi and that of the subgrade is 15,000 psi , determine the critical tensile strain in the asphalt layer. Chart given below may be used.

5





c. Establish relation between the radial strain and vertical strain of a flexible pavement when the Poisson ratio is 0.5. 3

11. a. Describe slipform paving method of construction of rigid pavement. 7

b. Write a short note of curing of rigid pavement. 3

c. Design a highway for a wheel load of 4500kg with a tire pressure of 5.2kg/cm<sup>2</sup> by McLeod method. The plate bearing test carried out on subgrade soil using 30cm diameter plate yielded a pressure of 2.6 kg/cm<sup>2</sup> after 10 repetitions of the load at 0.5cm deflection. Charts attached below may be used. 5

