4-2

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 2nd Semester

Course Title: Project Planning and Management | Course Code: CE 401
Time: 3 hours | Credit Hour: 3.00 | Full Marks: 150

Answer all the questions

QUESTION 1 [30 MARKS]

a. "CPM networks are often referred to as **activity oriented** and useful for **construction projects**". Provide sufficient justification to validate the above quoted statement. **[10]**

b. The network of a construction project is shown in **Figure 1**, along with the duration of each activity. Apply network analysis technique to determine the Earliest and Latest Event Time of each event. **[20]**

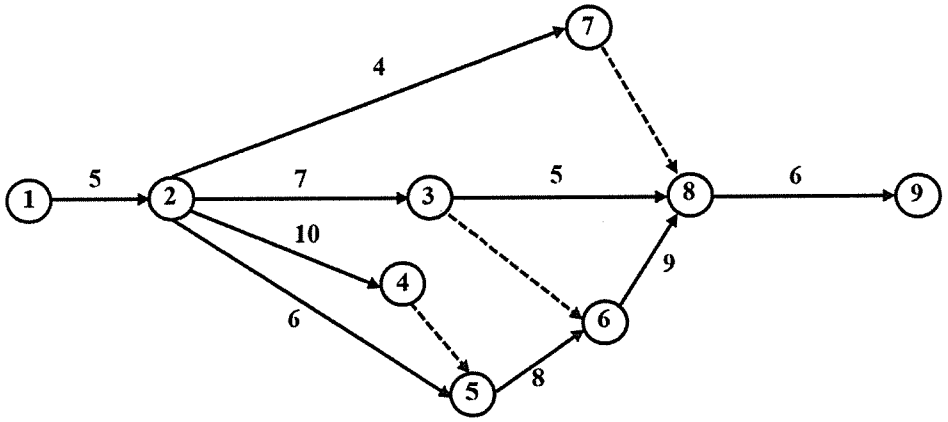

Figure 1. Network diagram along with activity duration

QUESTION 2 [25 MARKS]

Apply CPM technique to the network shown in **Figure 1** to determine the followings:

a. Activity Time (EST, EFT, LST, LFT) of each activity. **[15]**

b. Total Float of each activity. **[05]**

c. The Critical Path. **Show the Critical Path on the Network.** **[05]**

QUESTION 3 [20 MARKS]

BuildMax Logistics, a construction and warehousing company, is considering expanding its existing warehouse facility. The expansion requires an initial investment of $1,200,000. Projected net cash inflows from the expanded facility is shown in **Table 1**:

Table 1. Projected net cash inflows obtained by financial analysts

Year	1	2	3	4	5
Cash Inflow ($)	350,000	400,000	450,000	500,000	300,000

a. Calculate the Internal Rate of Return (IRR) for the warehouse expansion project. **[15]**

b. Evaluate the calculated IRR and determine if the project is financially viable if BuildMax Logistics has a required rate of return of 12%. **[05]**

QUESTION 4 [20 MARKS]

a. Demonstrate how the Public Procurement Act (PPA) ensures Value for Money for the benefit of public interest during the implementation of Government funded projects. **[07]**

b. Riverfront City is considering a flood control project to protect its downtown area. The initial cost of the project is estimated to be $2,000,000. This project is expected to generate the following benefits over its 5-year lifespan:

- Reduced property damage from flooding, resulting in an estimated annual benefit of $300,000.
- Decreased emergency response costs during flood events, leading to annual savings of $150,000.
- Increased economic activity due to reduced flood risk, resulting in an estimated annual benefit of $100,000.

Riverfront City uses a discount rate of 8%.

i. Construct a benefit-cost ratio analysis to assess the economic viability of the project. **[10]**

ii. Justify your decision by explaining the significance of the benefit-cost ratio in this context. **[03]**

QUESTION 5 [20 MARKS]

A construction company is planning to build two types of roads: Highway Roads and Residential Roads. The project must be completed within a given budget, land availability, and working hours. Required information is provided in **Table 2.**

Table 2. Information about Highway and Residential Roads

Road Type	Cost per km ($)	Land Required per km (m^2)	Working Hours per km (hrs.)	Maximum Speed Limit (km/h)
Highway	800,000	5000	300	100
Residential	300,000	3000	150	50

Project Constraints:

- Budget Limitation: The total budget is $25,000,000.
- Land Availability: A total of 200,000 m^2 of land is available.
- Labor Constraints: The total available working hours is 10,000 hours.
- Mandatory Construction Requirement: Both types of Roads (Highway Roads and Residential Roads) must be built.

Apply linear programming techniques to:

a. Construct the objective function and constraint equations to represent the problem mathematically. **[05]**

b. Analyze and determine the optimal number of kilometers of Highway Roads and Residential Roads that should be constructed to maximize the total road length while staying within the constraints. **[15]**

QUESTION 6 [35 MARKS]

a. Illustrate the variation of Holding, Ordering and Total Cost with Order Quantity. **[10]**

b. A construction company is responsible for maintaining an optimal inventory of high-quality concrete mix required for various infrastructure projects. The company places an order every two months for 30,000 bags of concrete mix, with a unit cost of $75 per bag. The holding cost is 18% of the acquisition cost, and the order placement cost is $50 per order.

Using the given data, apply the EOQ model to determine the followings:

i. Economic Order Quantity (EOQ) that minimizes total inventory costs. **[10]**

ii. Number of orders per year required to maintain the inventory efficiently. **[05]**

iii. Total annual inventory cost considering both ordering and holding costs. **[10]**

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University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 2nd Semester

Course Title: Environmental Engineering IV | Course Code: CE 433
Time: 2 hours | Credit Hour: 2.00 | Full Marks: 100

You must answer all the FIVE questions. [24 + 13 + 13 + 25 + 25]

QUESTION 1 [24 MARKS]

a. As part of an environmental impact study, you are evaluating the potential hazards associated with the establishment of a nitric acid storage and transfer facility in a region. ***Identify*** the key pollutants that may be emitted from such a facility. ***Discuss*** how these pollutants interact with the atmosphere to create harmful environmental and health effects, including secondary pollutant formation such as ozone or acid rain. **[4+10]**

b. *The London Smog* of 1952 demonstrated the deadly impact of SO_x on human health, with thousands of deaths attributed to exposure during a period of intense air pollution. Discuss how SO_x contributed to such health risks, particularly in high concentrations. In your answer, ***explain*** the physiological mechanisms affected by SO_x exposure elaborating why certain populations are more vulnerable. **[10]**

QUESTION 2 [13 MARKS]

a. A **settling chamber** is designed under the following conditions to remove pollutants from gas emission from an industry. **[5+2]**

- **Air:**
  - Horizontal velocity: 0.22 m/s
  - Temperature: 80°F
  - Viscosity of air: 1.67×10^{-5} kg/m.s
- **Particle:** Specific Gravity = 2.0
- **Chamber:** Length = 10 m, Height = 2 m

i. *Calculate* the **minimum size of particle** that will be removed with 100% theoretical efficiency from a settling chamber

ii. *Justify* whether this settling chamber will be suitable for the removal of PM_{10} or not.

b. *Show* the graphical representation of the plume behavior under the following conditions. **[2+2+2]**

i. Ambient lapse rate is greater than adiabatic lapse rate

ii. The height of the inversion layer is 20 m and the height of smokestack is 25 m.

iii. The atmosphere is adiabatic.

QUESTION 3 [13 MARKS]

a. A small village has been formed around a river. It was the only water source and the people used the river water for drinking and household purposes. After a few years, the people of that village were frequently infected by various diseases. Besides, there were plenty of dead fish seen on the water surface. Therefore, some tests were performed on the river water and the results showed very high BOD and Fecal Coliforms (FC). **[8+5]**

i. ***Analyze*** the situation to explain the effects of the increase in BOD and FC in the river water.

ii. ***Discuss*** the factors affecting the self-purification capacity of the river in case of organic wastes and pathogens.

QUESTION 4 [25 MARKS]

a. A municipal wastewater treatment plant discharges treated effluent into the nearby stream. The characteristics of the wastewater effluent and stream have been shown in **Figure 1** below. Assume that the mixing of the effluent is complete and instantaneous into the stream. ***Calculate*** the following using **Streeter-Phelps model.** **[20+5]**

i. The **critical time downstream** at which dissolved oxygen is minimum.
[Given, the deoxygenation rate constant is 0.18 /day at 20°C.]

ii. The **minimum dissolved oxygen.**

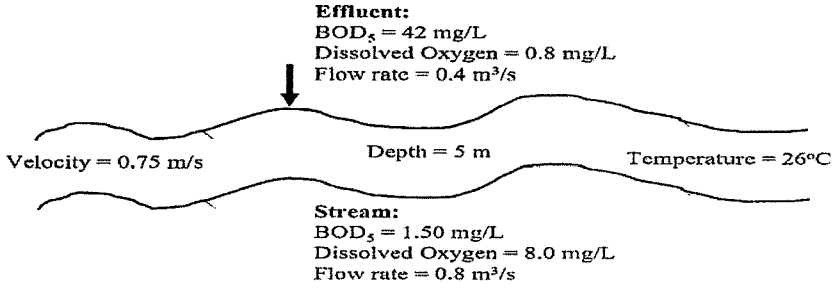


Figure 1. Waste discharge into a stream

QUESTION 5 [25 MARKS]

a. You are an environmental engineer evaluating the SO_2 pollution potential from a smokestack located in a suburban area. The stack releases pollutants from a height of 85 m. The factory burns 300 tons of coal per day containing 8% sulfur, and 10% of the sulfur is emitted as SO_2. The surface wind speed measured at 10 m height is 3.5 m/s. It is a clear summer day with the sun nearly overhead, and the maximum surface temperature is 30°C. **[5+8+12]**

i. ***Calculate*** the emission rate of SO_2 in g/s.

ii. Using the **Gaussian Plume Model**, ***calculate*** the SO_2 concentration at a point 1.4 km downwind, on the plume centerline (crosswind distance = 0), at a height of 10 m.

iii. Keeping all other variables constant (including emission rate and meteorological conditions), ***compute*** the maximum ground-level SO_2 concentrations for stack heights of 100 m, 200 m, and 300 m.
Present your findings graphically (concentration vs. distance) and ***analyze*** how stack height affects pollutant dispersion and ground-level concentration. Which height results in safer air quality at ground level? ***Justify*** your answer. ***[Attach the necessary chart with the answer script.]***

Necessary equations and Tables

1. $DO_{Sat} = 14.62 - 0.394T + 0.007714T^2 - 0.0000646T^3$

2. $t_c = \frac{1}{k_r - k_d} ln\left\{\frac{k_r}{k_d}\left[1 - \frac{D_o(k_r - k_d)}{k_d L_o}\right]\right\}$

3. $D_c = \frac{k_d}{k_r} L_o e^{-k_d t_c}$

4. $c(x,y,z) = \frac{Q}{2\pi\sigma_y\sigma_z u} \exp\left(\frac{-y^2}{2\sigma_y^2}\right)\left(\exp\left(\frac{-(z-h)^2}{2\sigma_z^2}\right) + \exp\left(\frac{-(z+h)^2}{2\sigma_z^2}\right)\right)$

5. $c(x,y,z) = \frac{Q}{2\pi\sigma_y\sigma_z u} \exp\left(\frac{-y^2}{2\sigma_y^2}\right)\left(\exp\left(\frac{-(z-h)^2}{2\sigma_z^2}\right)\right)$

6. $\bar{u}(z) = \bar{u}_o\ (z/z_o)^p$

7. $\sigma_y = a.x^{0.894}$

8. $\sigma_z = c.\ x^d + f$

9. $d_p = \left(\frac{18\mu v_h H}{g\rho_p L}\right)^{1/2}$

TABLE 7.8 ATMOSPHERIC STABILITY CLASSIFICATIONS

Surface wind speed[a] (m/s)	Day solar insolation			Night cloudiness[e]	
	Strong[b]	Moderate[c]	Slight[d]	Cloudy (≥4/8)	Clear (≤3/8)
<2	A	A–B[f]	B	E	F
2–3	A–B	B	C	E	F
3–5	B	B–C	C	D	E
5–6	C	C–D	D	D	D
>6	C	D	D	D	D

[a] Surface wind speed is measured at 10 m above the ground
[b] Corresponds to clear summer day with sun higher than 60° above the horizon
[c] Corresponds to a summer day with a few broken clouds, of a clear day with sun 35-60° above horizon
[d] Corresponds to a fall afternoon, or a cloudy summer day, or a clear summer day with sun 15-35° above horizon
[e] Cloudiness is defined as the fraction of sky covered by clouds
[f] For A-B, B-C, or C-D conditions, average the values obtained for each

Source: Turner (1970)

[You must submit this page with your answer script]

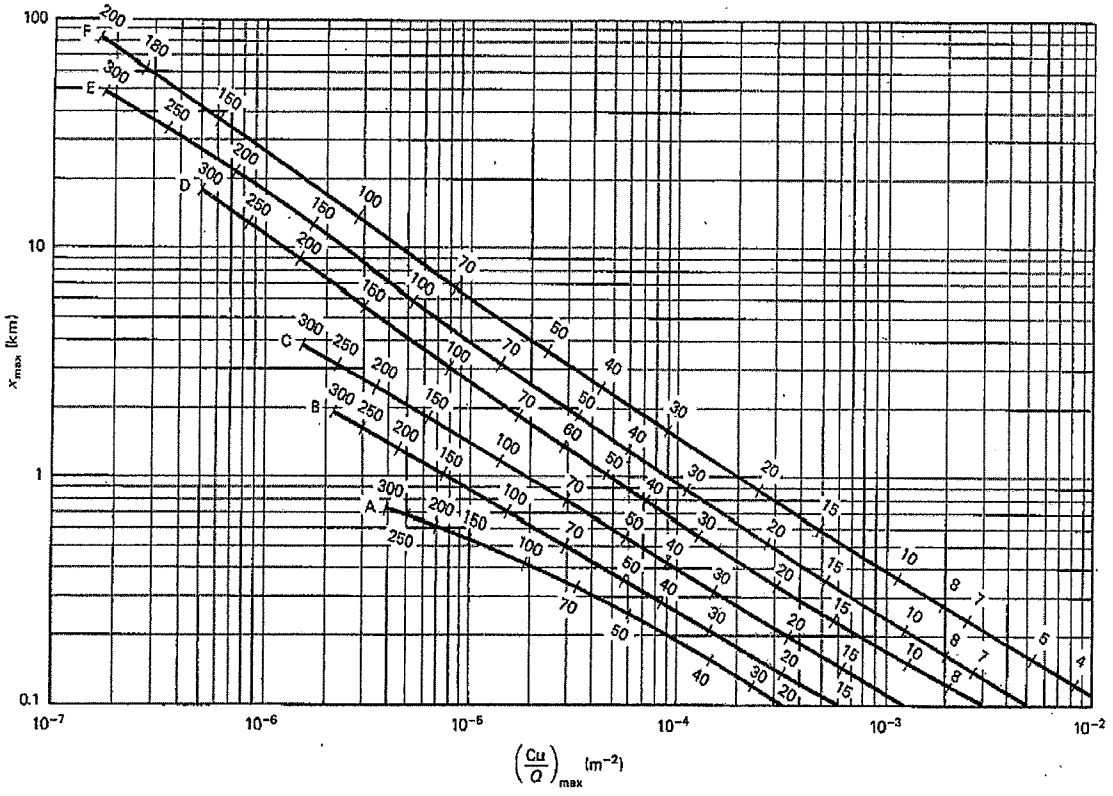
TABLE 7.7 WIND PROFILE EXPONENT p FOR ROUGH TERRAIN[a]

Stability class	Description	Exponent, p
A	Very unstable	0.15
B	Moderately unstable	0.15
C	Slightly unstable	0.20
D	Neutral	0.25
E	Slightly stable	0.40
F	Stable	0.60

[a] For smooth terrain, multiply p by 0.6; see Table 7.8 for further descriptions of the stability classifications used here.

Table 4. Constants in empirical relationships for σ_y and σ_z

		$x \leq 1$ km			$x \geq 1$ km		
Stability class	a	c	d	f	c	d	f
A	213	440.8	1.941	9.27	459.7	2.094	-9.6
B	156	106.6	1.149	3.3	108.2	1.098	2.0
C	104	61	0.911	0	61	0.911	0
D	68	33.2	0.725	-1.7	44.5	0.516	-13.0
E	50.5	22.8	0.678	-1.3	55.4	0.305	-34.0
F	34	14.35	0.740	0.35	62.6	0.180	-48.6



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Department of Civil Engineering
Final Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 2nd Semester

Course Title: Environmental Engineering V | Course Code: CE 435
Time: 2 hours | Credit Hour: 2.00 | Full Marks: 60

Answer all the questions

QUESTION 1 [10 MARKS]

a. Discuss how environmental priorities can shift over time in response to socio-economic changes. Use examples from Bangladesh's development trajectory. [5]

b. Define a development project. What are the typical studies conducted at different phases of a development project? [2+3]

QUESTION 2 [20 MARKS]

a. Explain the process of legislation and policy preparation regarding resettlement. [10]

b. Write a short note on: [5+5]
   i. Environmental Impact Assessment (EIA)
   ii. EQS in Bangladesh

QUESTION 3 [30 MARKS]

Case Study: *Meghna River Development Corridor*

The government has launched the Meghna River Development Corridor Project, aimed at transforming 600 acres of lowland near the Meghna River into a mixed-use development zone. The plan includes:

An industrial cluster (textile, plastics, and food processing)
A logistics hub and port facilities
Residential and commercial zones
Construction of a 12 km access highway and rail link

The area currently supports seasonal wetlands, floodplain agriculture, and fishing communities. An initial assessment has flagged serious concerns, including air and water pollution, groundwater depletion, ecological disturbance, and lack of enforcement of environmental quality standards. However, the project promises significant economic gains and job creation.

a. As an environmental planner for the Meghna project, evaluate how the characteristics of an environmentally sound, sustainable development project can be integrated into this corridor.

Your answer should highlight:

Site selection and design considerations
Pollution control infrastructure
Stakeholder inclusion [15]

b. Critically assess the economic aspects of environmental quality control that should be implemented in the Meghna project. Discuss:

The cost implications of compliance with environmental quality standards
The use of pollution taxes or subsidies
The feasibility and enforcement of regulations in large-scale infrastructure project [15]

Part A

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 2nd Semester

Course Title: Environmental Engineering VIII | Course Code: CE 531
Time: 1 hour | Credit Hour: 2.00 | Full Marks: 50

Answer all the questions

QUESTION 1 [50 MARKS]

a. i) Identify four characteristics of Geographic Information System. [4+4+2=10]
ii) Name three generalization techniques
iii) Outline the characteristics of conformal projection type.

b. Given dataset are: [5x8=40]
Bangladesh district shapefile, Bangladesh health facilities shape file,
Bangladesh education facilities shapefile and, Bangladesh roadway shapefile.

Analyze the dataset in QGIS to answer the following questions.

i. How can you find the area of any polygon? What is the total area of the district Sylhet?
ii. How many health facilities are in Sylhet according to the data?
iii. How many education facilities are in Sylhet according to the data?
iv. Identify an area where a few health and education facilities are concentrated. Is the area near western or eastern boundary of Sylhet?
v. Find out the numbers of health and education facilities in the concentrated area.
vi. How can you filter a data in attribute table? How many universities are available in the concentrated area according to the data?
vii. What is the total length of national highway in Sylhet?
viii. What are the features in print layout excluding the map?

Part B

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 2nd Semester

Course Title: Environmental Engineering VIII | Course Code: CE 531
Time: 1 hour | Credit Hour: 2.00 | Full Marks: 50

Answer all the questions

QUESTION 1 [25 MARKS]

a. Discuss why ocean-observing satellite systems are important? [5]

b. Explain the key factors that have contributed to the long-term success of the Landsat. [5]

c. Give the examples of various types of sensors used in the Landsat satellites and explain their applications. [10]

d. Clarify the basic working principle of radar technology to detect and measure the distance of the objects. [5]

QUESTION 2 [25 MARKS]

a. Detect two unique properties of laser light. [5]

b. Differentiate between full waveform and discrete LiDAR systems. [5]

c. Identify the distance to an object if a LiDAR system sends out a laser pulse, and the pulse takes 10 nanoseconds (ns) to return after hitting that object. [5]

d. Document how Remote Sensing (RS) and GPS technologies are integrated with Geographic Information Systems (GIS) and provide an example describing its practical application. [10]

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4th Year 2nd Semester

Course Title: Structural Engineering VI | Course Code: CE 417
Time: 2 hours | Credit Hour: 2.00 | Full Marks: 100

Answer all the questions

QUESTION 1 [15 MARKS]

By following the elastic vector method, compute the service load capacity P for the welded bracket connection shown in **Figure 1**. The fillet weld size is 3/4 inch, and **E50XX** electrode is used for the welding. Use the **AISC-ASD** method for the calculation, and assume the plate thickness does not affect the result. [15]

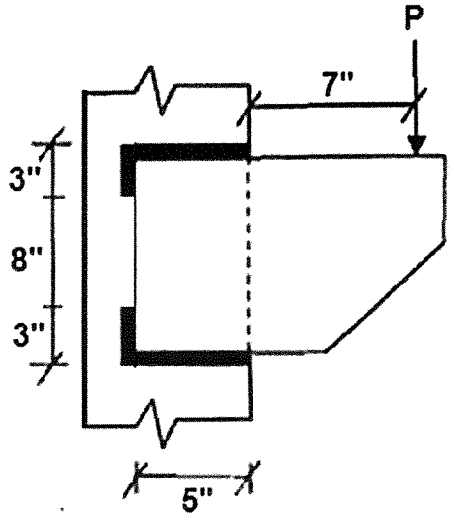


Figure 1

QUESTION 2 [20 MARKS]

Select the lightest W section (from **Table 1**) to carry a service superimposed concentrated service dead load of 10 kips and a service live load of 15 kips working at the middle point of a simply supported beam. The length of the beam is 25 ft, and adequate lateral support is provided. Use A572 Grade 70 steel, and follow the **AISC-LRFD** approach.

Note: Beam self-weight is not negligible and hence it must be accounted for.

[20]

Table 1

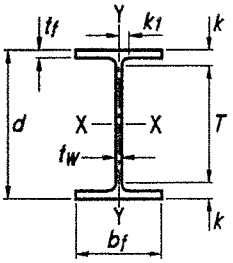
Shape	b_f (in)	t_f (in)	I_x (in^4)	I_y (in^4)	Z_x (in^3)	Z_y (in^3)
W12×26	6.49	0.380	204	17.3	37.2	8.17
W16×36	6.99	0.430	448	24.5	64.0	10.8
W16×26	5.50	0.345	301	9.59	44.2	5.48
W12×45	8.05	0.575	348	50.0	64.2	19.0
W14×30	6.73	0.385	291	19.6	47.3	8.99
W16×45	7.04	0.565	586	32.8	82.3	14.5
W18×60	7.56	0.695	984	50.1	123	20.6

QUESTION 3 [25 MARKS]

Determine the allowable moment capacity of W14×120 section of A572 Grade 70 steel for the beam shown in **Figure 2.** The beam has no lateral bracings in between support points A and D. Use the **AISC-ASD** method. If intermediate lateral supports are provided at points B and C, determine the allowable moment capacity of the beam. [15+5+5]
Assume $C_b = 1$.

Section properties of W14×120:

D (in)	t_w (in)	b_f (in)	t_f (in)	S_x (in^3)	Z_x (in^3)	r_x (in)	r_y (in)	r_{ts} (in)	h_o (in)	T (in)	J (in^4)
14.3	0.525	14.6	0.86	173	192	6.22	3.73	4.17	13.4	10	7.12



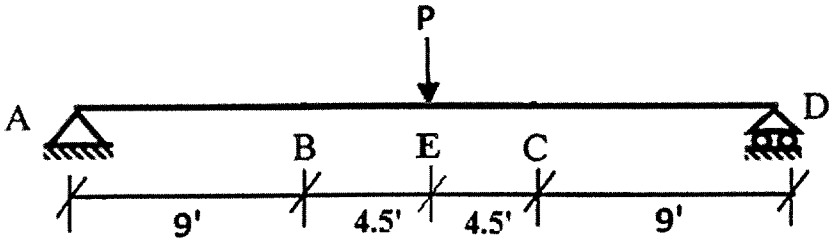


Figure 2

QUESTION 4 [15 MARKS]

From the following table, select the lightest W section of A572 Grade 50 steel to serve as a main member 28 ft long to carry an axial compression service load of 150 kips dead load and 220 kips live load in a braced structure, as shown in **Figure 3**. Assume the member fixed at the top and hinged at the bottom for buckling in either principal direction. Use the **AISC-LRFD** method. [15]

Shape	A_g (in^2)	b_f (in)	t_f (in)	T (in)	h_0 (in)	t_w (in)	r_x (in)	r_y (in)
W14×99	26.5	14.5	0.710	10.0	13.3	0.440	6.14	3.70
W12×65	19.1	12.0	0.605	9.125	11.5	0.390	5.28	3.02
W14×74	21.8	10.1	0.785	10.875	13.4	0.450	6.04	2.48
W21×62	18.3	8.24	0.615	18.375	20.4	0.400	8.54	1.77
W12×79	23.2	12.1	0.753	9.125	11.7	0.470	5.34	3.05
W14×90	29.1	14.6	0.780	10.0	13.4	0.485	6.17	3.71

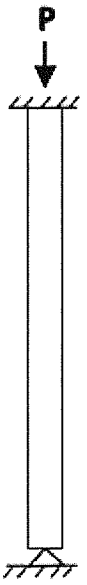


Figure 3

QUESTION 5 [25 MARKS]

(i) Explain porosity and undercutting of welding. [6]

(ii) Plastic neutral axis divides the cross section into two equal areas. Explain briefly. [7]

(iii) With a neat sketch, explain the mechanism of lateral torsional buckling. Explain the effect of the lateral torsional buckling on the flexural strength of steel member [8+4]

Table: Minimum size of fillet welds

Material Thickness of Thinner Part Joined, in. (mm)	Minimum Size of Fillet Weld, [a] in. (mm)
To 1/4 (6) inclusive	1/8 (3)
Over 1/4 (6) to 1/2 (13)	3/16 (5)
Over 1/2 (13) to 3/4 (19)	1/4 (6)
Over 3/4 (19)	5/16 (8)

FORMULA

$$F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right] F_y \quad \text{For } \frac{KL}{r} \le 4.71\sqrt{\frac{E}{F_y}} \qquad F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$$

$$F_{cr} = 0.877 F_e \qquad \text{For } \frac{KL}{r} > 4.71\sqrt{\frac{E}{F_y}} \qquad P_n = F_{cr} A_g$$

$$C_b = \frac{12.5 M_{max}}{2.5 M_{max} + 3M_A + 4M_B + 3M_C} R_m \le 3.0 \qquad L_p = 1.76 r_y \sqrt{\frac{E}{F_y}}$$

$$L_r = 1.95 r_{ts} \frac{E}{0.7F_y} \sqrt{\frac{Jc}{S_x h_o}} \sqrt{1 + \sqrt{1 + 6.76\left(\frac{0.7F_y S_x h_o}{E \quad Jc}\right)^2}}$$

$$M_n = C_b \left[M_p - (M_p - 0.7F_y S_x)\left(\frac{L_b - L_p}{L_r - L_p}\right)\right] \le M_p$$

$$M_n = M_p - (M_p - 0.7F_y S_x)\left(\frac{\lambda - \lambda_p}{\lambda_r - \lambda_p}\right) \qquad F_{cr} = \frac{C_b \pi^2 E}{\left(\frac{L_b}{r_{ts}}\right)^2} \sqrt{1 + 0.078 \frac{Jc}{S_x h_o}\left(\frac{L_b}{r_{ts}}\right)^2}$$

$$k_c = \frac{4}{\sqrt{h/t_w}}, \text{ where } 0.35 \le k_c \le 0.763 \qquad M_n = F_{cr} S_x \le M_p$$

$$\lambda_r = 0.56\sqrt{\frac{E}{F_y}} \qquad \lambda_r = 1.49\sqrt{\frac{E}{F_y}} \qquad \lambda_{pf} = 0.38\sqrt{\frac{E}{F_y}} \qquad \lambda_{rf} = 1.0\sqrt{\frac{E}{F_y}}$$

$$f'_x = \frac{P_x}{A} \qquad f'_y = \frac{P_y}{A} \qquad M_n = \frac{0.9 E k_c S_x}{\lambda^2}$$

$$f''_x = \frac{Ty}{I_p} \qquad f''_y = \frac{Tx}{I_p}$$