Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2019

Programme Name: B. Tech. Civil Engineering **Semester : VI**
Course Name : Design of Formwork **Time : 03 hrs**
Course Code : CEEG 318 **Max. Marks : 100**
Nos. of page(s) : 5

INSTRUCTIONS: ALL QUESTIONS ARE COMPULSORY

SECTION A

ALL QUESTIONS ARE COMPULSORY AND EACH QUESTION CARRIES 4 MARKS

<table>
<tr><th>S. No.</th><th></th><th>Marks</th><th>CO</th></tr>
<tr><td>Q 1</td><td>State True/ False for the following statements:
a. Some of the special structures are: shells, domes, folded plates, cooling towers, tunnels, etc.
b. Traditional slab and beam formwork is characterized by less labor and time efficient operation.
c. Various factors in achieving economy in column formwork are-location, orientation, shape, size, varying percentage of steel, and avoiding projections.
d. The term flying formwork is used because forms are assembled at the ground.</td><td>4</td><td>CO</td></tr>
<tr><td>Q 2</td><td>Match the following:
<table>
<tr><th>S. NO.</th><th>COLUMN A</th><th>S. NO.</th><th>COLUMN B</th></tr>
<tr><td>1</td><td>Long span bridges</td><td>A</td><td>Silos, bins, shafts, cores, bridge piers, caissons, etc.</td></tr>
<tr><td>2</td><td>Vertical slipform is used for</td><td>B</td><td>Girder and slab arrangements</td></tr>
<tr><td>3</td><td>Large area wall form</td><td>C</td><td>Inside shutter is fixed, aligned correctly and supported by suitable props. Curb reinforcement is fixed and a starter bar is welded with the cutting edge.</td></tr>
<tr><td>4</td><td>Curb</td><td>D</td><td>Gang form, prefabricated panels joined together to form a large shutter panel.</td></tr>
</table></td><td>4</td><td>CO</td></tr>
<tr><td>Q 3</td><td>What is tunnel form system? State the two advantages of tunnel form system.</td><td>2+2 =4</td><td>CO</td></tr>
<tr><td>Q 4</td><td>What is flying form system? State the two disadvantages of flying form system.</td><td>2+2 = 4</td><td>CO</td></tr>
<tr><td>Q 5</td><td>What is slipform? What are the main components of vertical slip form? For which structures vertical slipform is used.</td><td>1+2+1 =4</td><td></td></tr>
</table>

SECTION B

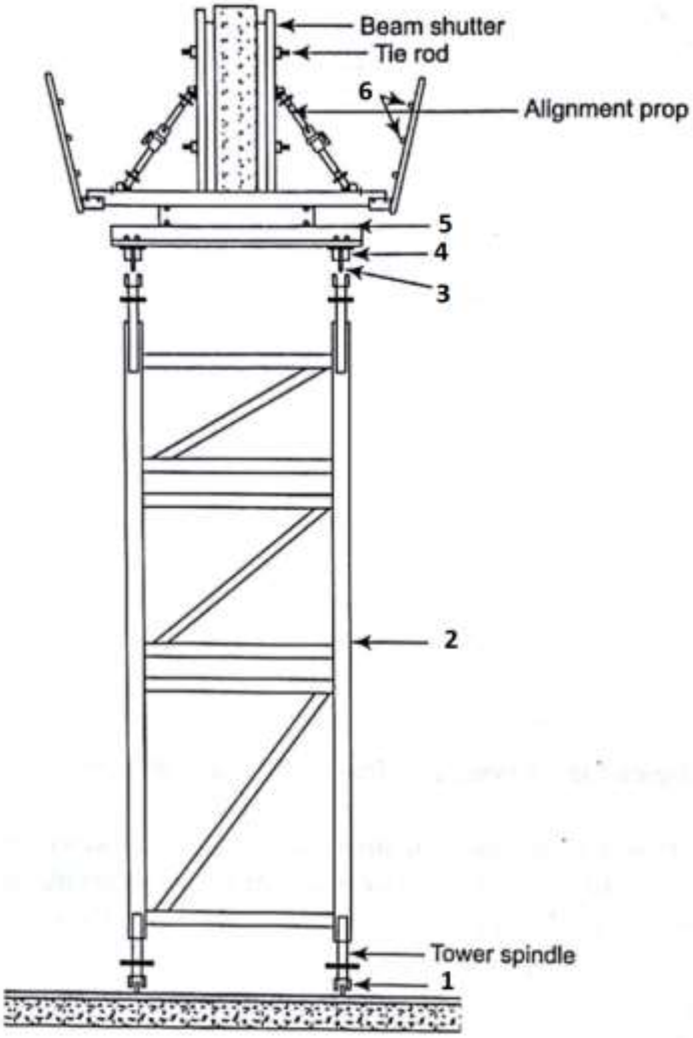
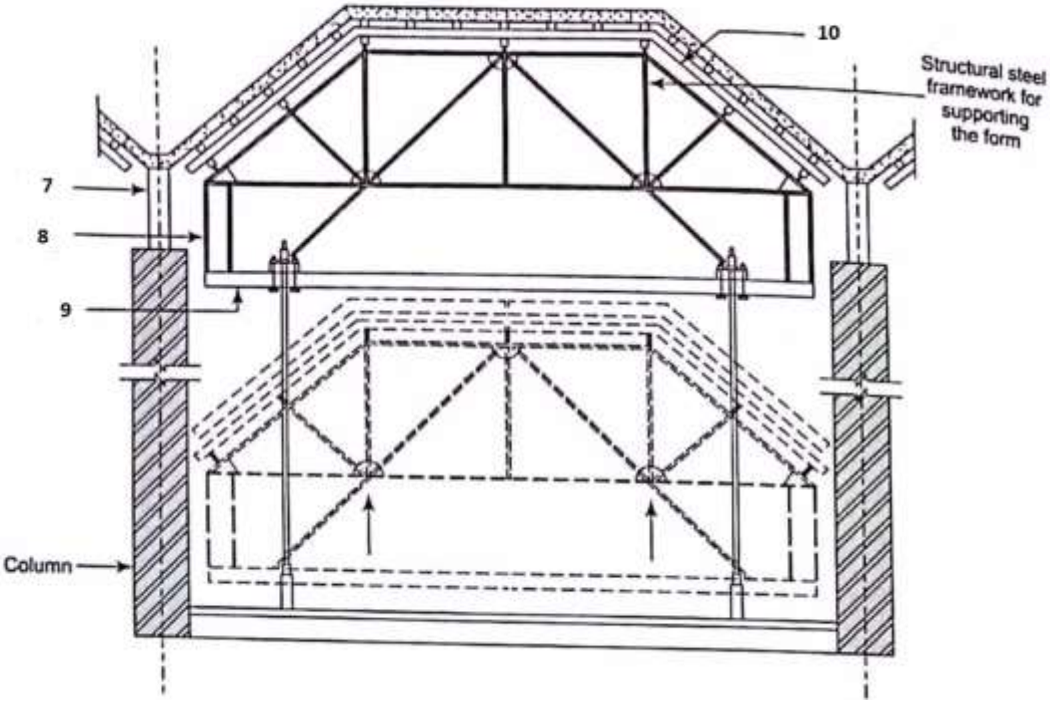
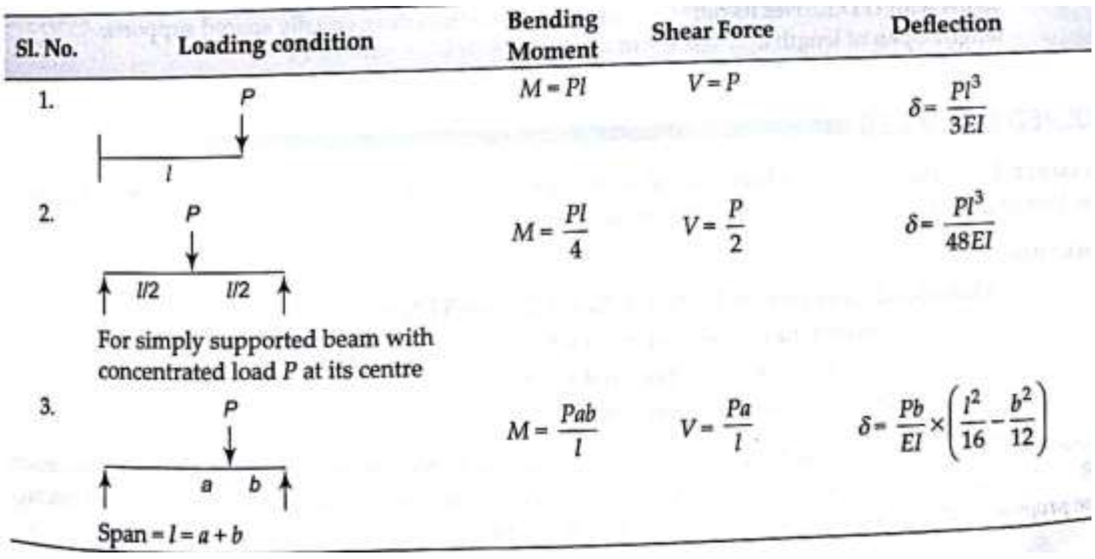
<table>
<tr><th colspan="4">ALL QUESTIONS ARE COMPULSORY AND EACH QUESTION CARRIES 10 MARKS</th></tr>
<tr><td>Q 6</td><td>Draw a qualitative diagram for the conventional wall formwork. Also, name all components.</td><td>6+4 =10</td><td>CO</td></tr>
<tr><td>Q 7</td><td>Name the components:


Figure 1. Typical formwork for heavy beam</td><td>1x 10= 10</td><td></td></tr>
</table>

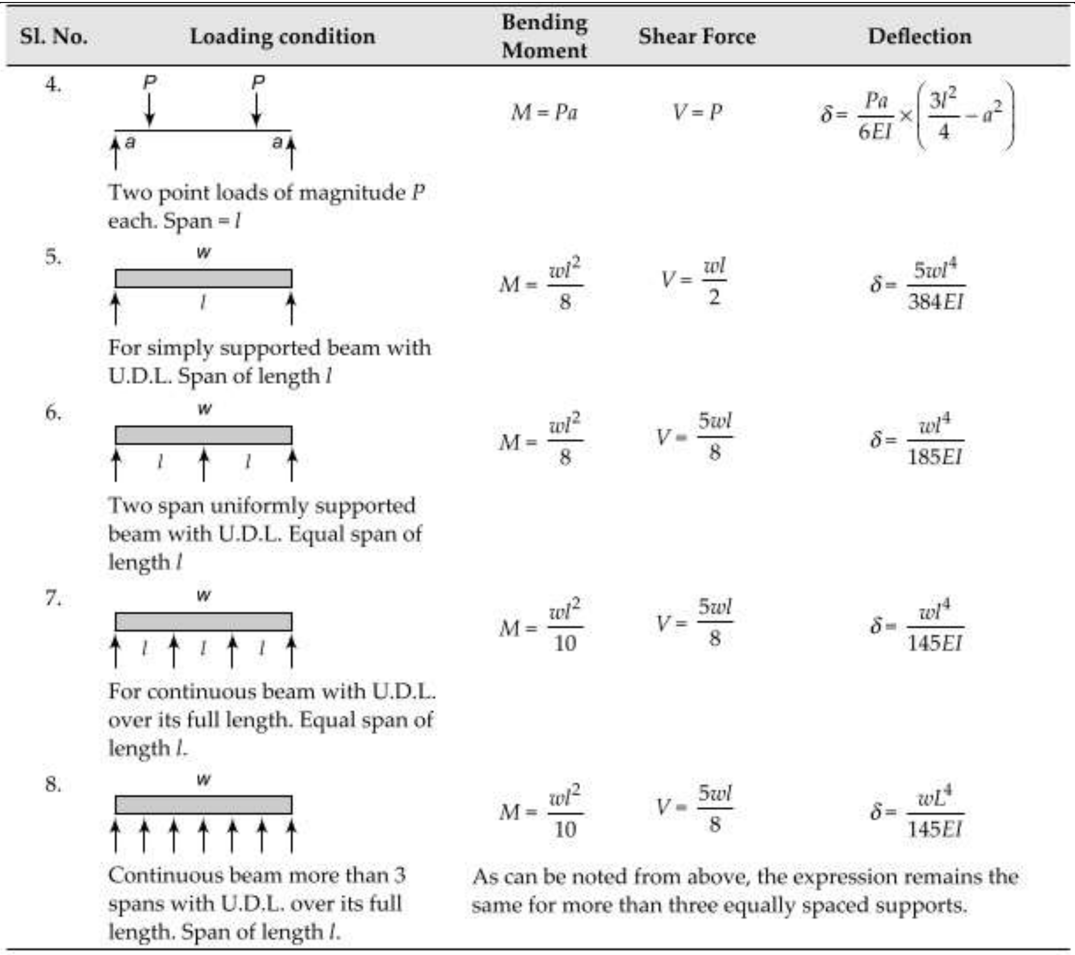
	 Figure 2. Folded plate formwork		
Q 8	List out the various recommendations as per OSHA, ACI for safety in formwork. **OR** List out the various reasons for formwork failure.	**10**	**CO**
Q 9	Sequence the following: a) determine the height of the column. b) select appropriate permissible stress and section properties. c) determine the material available for sheathing, yokes, and batten. d) estimate the load. e) compute the lateral pressure. f) determine the largest cross-sectional dimension of the column. g) select the sheathing material. h) determine the stud spacing. Discuss the reasons for case study of failure of cantilever portion of pier cap and deck slab failure.	**6+4 =10**	
SECTION-C **ATTEMPT ANY TWO QUESTIONS AND EACH QUESTION CARRIES 20 MARKS**			
Q 10	Check the adequacy of wall formwork for the following details and data: 12 mm thick plywood is used, H-16 beam @ 210 mm c/c distance has been used as studs, ISMC 100 double walers back to back with 50 mm gap has been used @ 1000 mm c/c distance, and 16 mm tie rod @ 1000 mm c/c with yield stress 250 MPa has been used.	**20**	**CO**

The following data is also available:

1. For concrete pressure by using CIRIA method
    a. D, weight density of concrete = 26 kN/m^3
    b. R, rate of rise = 1 m/h
    c. Temperature of concrete = 25 °C
    d. H, vertical form height = 8.3 m
    e. h, vertical pour height = 8 m
    f. Shape constant = 1
    g. Concrete constituent factor = 0.45
2. For 12 mm plywood
    a. Allowable moment carrying capacity = 0.2 kNm/ m
    b. Allowable shear = 6.2 kN/ m
    c. Permissible EI = 1.1 kNm^2/ m
    d. Permissible deflection = 0.8 mm
3. For H-16 beam
    a. Depth of H-16 beam = 160 mm
    b. Flange of H-16 beam = 65 mm
    c. Allowable moment carrying capacity = 3 kNm
    d. Allowable shear = 6 kN
    e. Permissible EI = 145 kNm^2
    f. Permissible deflection = 3.33 mm
4. For ISMC 100 see details from IS 800:2007



Sl. No.	Loading condition	Bending Moment	Shear Force	Deflection
1.	P l	$M = Pl$	$V = P$	$\delta = \frac{Pl^3}{3EI}$
2.	P l/2 l/2 For simply supported beam with concentrated load P at its centre	$M = \frac{Pl}{4}$	$V = \frac{P}{2}$	$\delta = \frac{Pl^3}{48EI}$
3.	P a b Span = $l = a + b$	$M = \frac{Pab}{l}$	$V = \frac{Pa}{l}$	$\delta = \frac{Pb}{EI} \times \left(\frac{l^2}{16} - \frac{b^2}{12}\right)$



Sl. No.	Loading condition	Bending Moment	Shear Force	Deflection
4.	Two point loads of magnitude P each. Span = l	$M = Pa$	$V = P$	$\delta = \frac{Pa}{6EI} \times \left(\frac{3l^2}{4} - a^2\right)$
5.	For simply supported beam with U.D.L. Span of length l	$M = \frac{wl^2}{8}$	$V = \frac{wl}{2}$	$\delta = \frac{5wl^4}{384EI}$
6.	Two span uniformly supported beam with U.D.L. Equal span of length l	$M = \frac{wl^2}{8}$	$V = \frac{5wl}{8}$	$\delta = \frac{wl^4}{185EI}$
7.	For continuous beam with U.D.L. over its full length. Equal span of length l.	$M = \frac{wl^2}{10}$	$V = \frac{5wl}{8}$	$\delta = \frac{wl^4}{145EI}$
8.	Continuous beam more than 3 spans with U.D.L. over its full length. Span of length l.	$M = \frac{wl^2}{10}$	$V = \frac{5wl}{8}$	$\delta = \frac{wL^4}{145EI}$

As can be noted from above, the expression remains the same for more than three equally spaced supports.

Q 11	Design the formwork for a column of cross section 400 mm X 400 mm, and a height of 3 m. A plywood of 12 mm thickness is available (take the permissible values same as question 10). Timber of cross sections 50 mm X 100 mm, 100 mm X 100 mm, 100 mm X 150 mm, and 150 mm X 150 mm is available. Permissible bending stress for timber = 7 N/mm^2, permissible shear stress for timber = 0.8 N/mm^2, E = 7700 N/mm^2. Mild steel tie rod of 16 mm diameter is available. Dead load of concrete = 26 kN/m^3, R = 2.5 m/h, T = 15°C, $C_w X C_c$ = 1.2 (use ACI formula). Also draw a neat diagram for final design with proper detailing.	**18+2 = 20**	
Q 12	Design a slab formwork using 12 mm plywood, H-16 beams (see properties from question 10) and CT410- props (having capacity of 14 kN) as a staging for a slab thickness of 150 mm. H-16 beams are to be used as the secondary and primary beams. The live load on the formwork is 2.0 kN/m^2 with 25 % additional for impact (w.r.t live load). The formwork load is 0.3 kN/m^2. Also draw a neat diagram for final design with proper detailing.	**18+2 = 20**	

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<tr><td>Q 1</td><td>State True/ False for the following statements:
a. The four distinct components of tunnel are: curb, invert, wall, and arch.
b. Traditional slab and beam formwork is characterized by labor intensive and time consuming operation.
c. Various factors in achieving economy in column formwork are number of repetition and steel formwork.
d. Table form is a part of flying formwork.</td><td>4</td><td>CO</td></tr>
<tr><td>Q 2</td><td>Match the following:
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<tr><td>S. NO.</td><td>COLUMN A</td><td>S. NO.</td><td>COLUMN B</td></tr>
<tr><td>1</td><td>Cutting edge</td><td>A</td><td>Used for high rise structure: jump form</td></tr>
<tr><td>2</td><td>Climbing formwork</td><td>B</td><td>Assists the caisson in sinking below the ground or river bottom</td></tr>
<tr><td>3</td><td>Short span bridges</td><td>C</td><td>Canal lining, tunnel inverts, highway projects, etc.</td></tr>
<tr><td>4</td><td>Horizontal slipform is used for</td><td>D</td><td>Simple slab arrangements</td></tr>
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<tr><td>Q 6</td><td>Draw a qualitative diagram for the conventional slab formwork. Also, name all components.</td><td>6+4 = 10</td><td>CO</td></tr>
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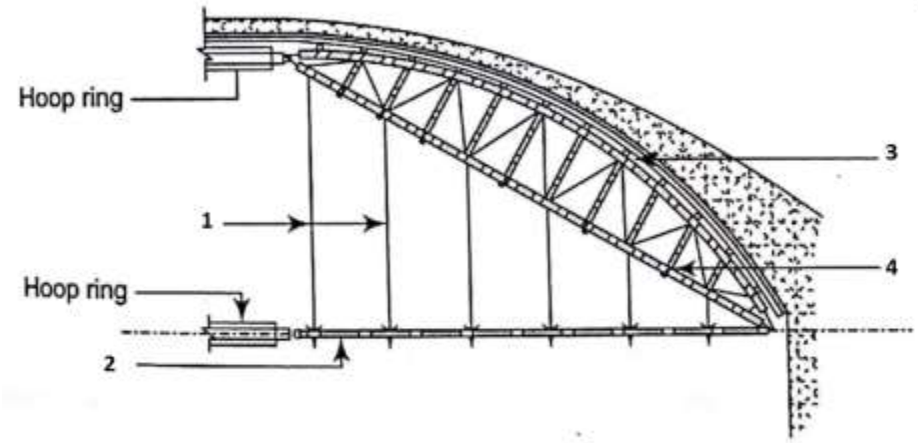
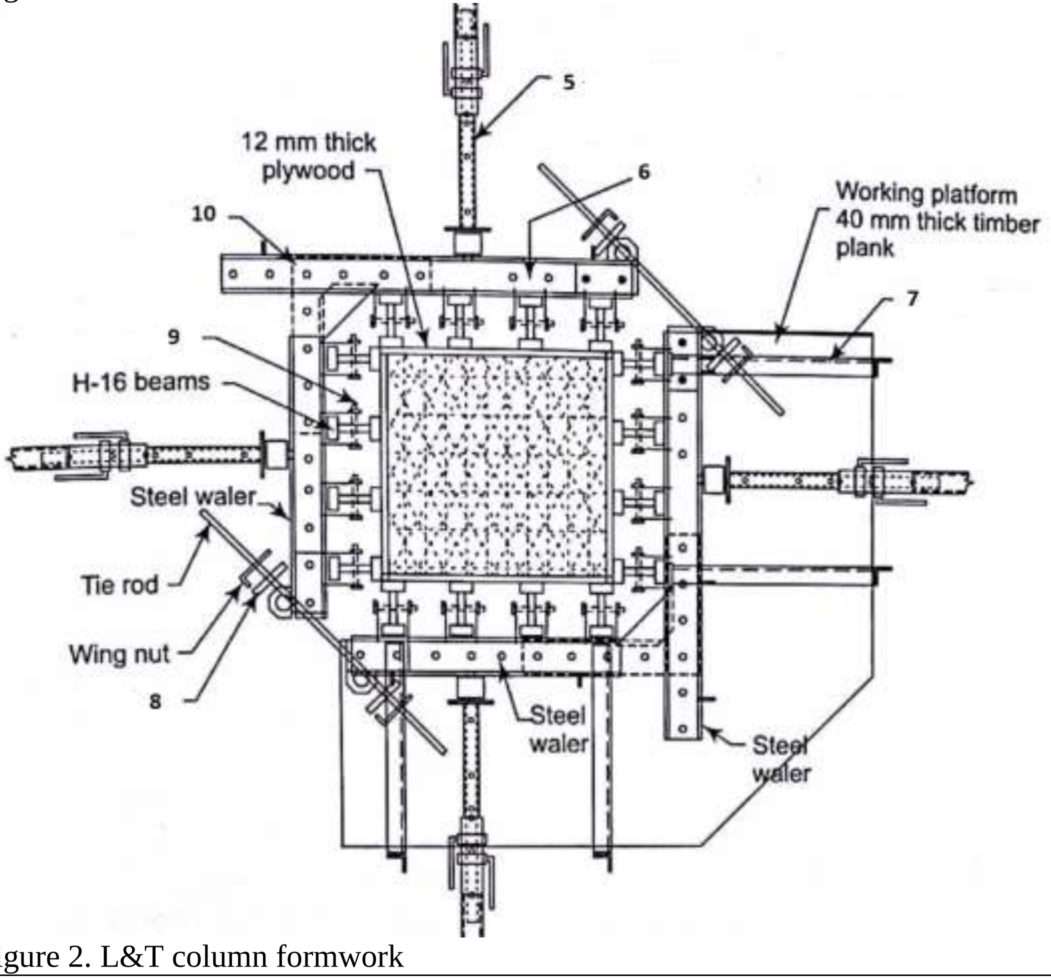
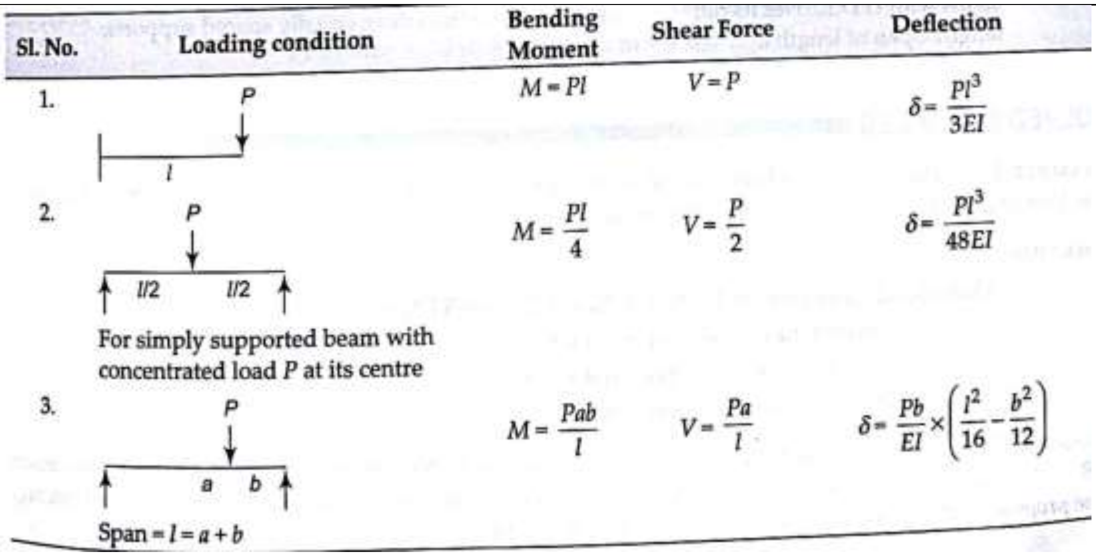
Q 7	Name the components:  Figure 1. Elevation of dome formwork  Figure 2. L&T column formwork	**10**	
Q 8	List out the various recommendations as per OSHA, ACI for safety in formwork. **OR**	**10**	**CO**

	List out the various reasons for formwork failure.		
Q 9	What measures should be adopted to achieve economy in column formwork construction? Discuss the reasons for case study of toppling of prestressed girder during construction at a major bridge on Banganga River.	**6+4 =10**	
SECTION-C ATTEMPT ANY TWO QUESTIONS AND EACH QUESTION CARRIES 20 MARKS			
Q 10	Check the adequacy of wall formwork for the following details and data: 12 mm thick plywood is used, H-16 beam @ 250 mm c/c distance has been used as studs, ISMC 100 double walers back to back with 50 mm gap has been used @ 1200 mm c/c distance, and 16 mm tie rod @ 1200 mm c/c with yield stress 250 MPa has been used. The following data is also available: 5. For concrete pressure by using CIRIA method h. D, weight density of concrete = 25 kN/m^3 i. R, rate of rise = 1 m/h j. Temperature of concrete = 25 °C k. H, vertical form height = 6.15 m l. H, vertical pour height = 6 m m. Shape constant = 1 n. Concrete constituent factor = 0.3 6. For 12 mm plywood e. Allowable moment carrying capacity = 0.2 kNm/ m f. Allowable shear = 6.2 kN/ m g. Permissible EI = 1.1 kNm^2/ m h. Permissible deflection = 0.8 mm 7. For H-16 beam g. Depth of H-16 beam = 160 mm h. Flange of H-16 beam = 65 mm i. Allowable moment carrying capacity = 3 kNm j. Allowable shear = 6 kN k. Permissible EI = 145 kNm^2 l. Permissible deflection = 3.33 mm 8. For ISMC 100 see details from IS 800:2007	**20**	**CO**



Sl. No.	Loading condition	Bending Moment	Shear Force	Deflection
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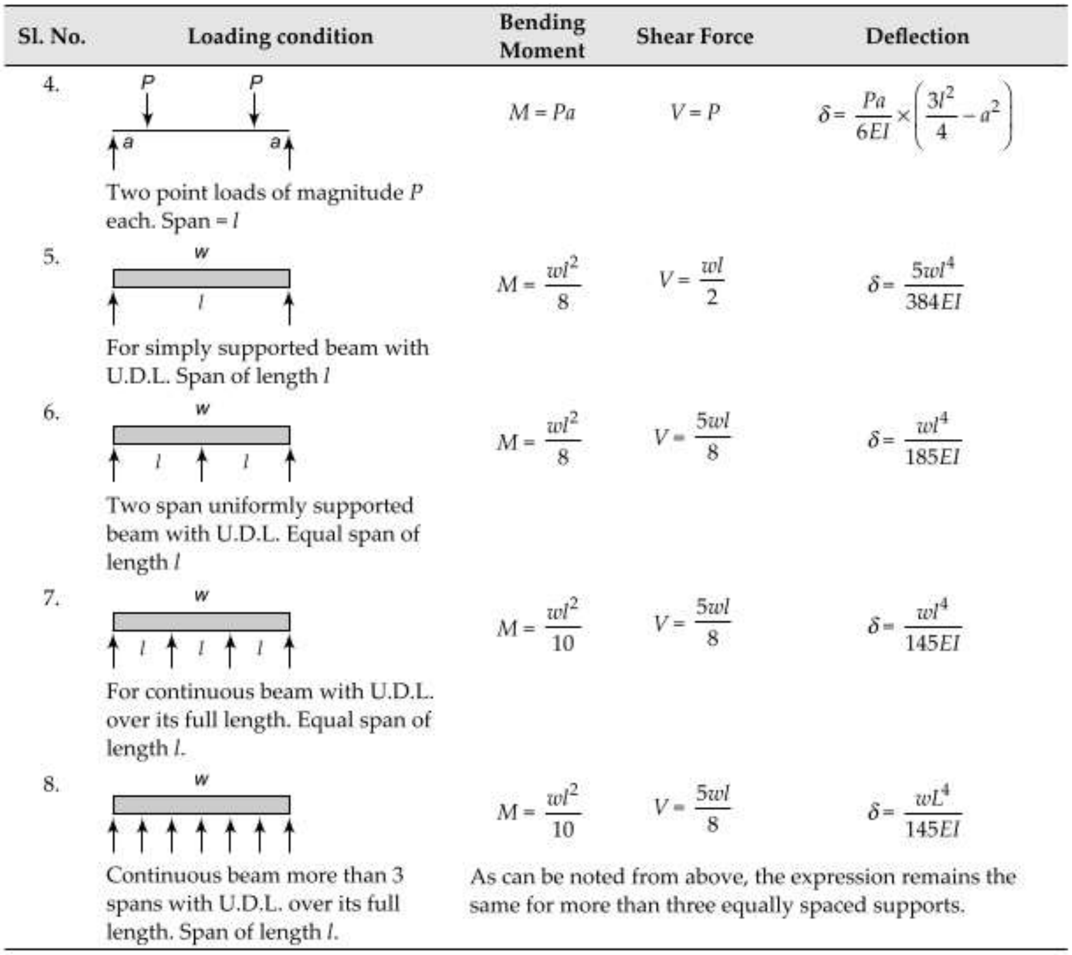
2.	For simply supported beam with concentrated load *P* at its centre	$M = \frac{Pl}{4}$	$V = \frac{P}{2}$	$\delta = \frac{Pl^3}{48EI}$
3.	Span = $l = a + b$	$M = \frac{Pab}{l}$	$V = \frac{Pa}{l}$	$\delta = \frac{Pb}{EI} \times \left(\frac{l^2}{16} - \frac{b^2}{12}\right)$



Sl. No.	Loading condition	Bending Moment	Shear Force	Deflection
4.	Two point loads of magnitude *P* each. Span = *l*	$M = Pa$	$V = P$	$\delta = \frac{Pa}{6EI} \times \left(\frac{3l^2}{4} - a^2\right)$
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8.	Continuous beam more than 3 spans with U.D.L. over its full length. Span of length *l*.	$M = \frac{wl^2}{10}$	$V = \frac{5wl}{8}$	$\delta = \frac{wL^4}{145EI}$

As can be noted from above, the expression remains the same for more than three equally spaced supports.

Q 11	Design the formwork for a column of cross section 350 mm X 350 mm, and a height of 3 m. A plywood of 12 mm thickness is available (take the permissible values same	**18+2 = 20**	

	as question 10). Timber of cross sections 50 mm X 100 mm, 100 mm X 100 mm, 100 mm X 150 mm, and 150 mm X 150 mm is available. Permissible bending stress for timber = 7 N/mm^2, permissible shear stress for timber = 0.8 N/mm^2, E = 7700 N/mm^2. Mild steel tie rod of 16 mm diameter is available. Dead load of concrete = 26 kN/m^3, R = 2m/h, T = 15°C, $C_w X C_c$ = 1 (use ACI formula). Also draw a neat diagram for final design with proper detailing.		
Q 12	Design a slab formwork using 12 mm plywood, H-16 beams (see properties from question 10) and CT410- props (having capacity of 16 kN) as a staging for a slab thickness of 150 mm. H-16 beams are to be used as the secondary and primary beams. The live load on the formwork is 2.0 kN/m^2 with 35 % additional for impact (w.r.t live load). The formwork load is 0.4 kN/m^2. Also draw a neat diagram for final design with proper detailing.	**18+2 = 20**	