CE1746: Hydropower Engineering
Major Test

Time: Two Hours **Marks: 40**

Solve the following:
Assume any suitable data, if not given.

Q. 1 (a) Derive expression for specific speed of turbine. A hydro-electric installation is to develop 9100 KW. The head is 8 m and the speed of rotation is 150 r.p.m. The specific speed of turbine is not to exceed 48.5. What is the minimum number of units required. [3]

(b) Kaplan turbine of runner diameter 4.5 m running at 40 rpm. The guide blade angle at inlet (α) is 145^{0} and runner blade angle at outlet (ϕ) is 25^{0} to the direction of vane. The axial flow area of water through runner is 25 m^2. The runner blade angle at inlet is radial ($\theta = 90^{0}$), determine:
i. Hydraulic efficiency of turbine
ii. Discharge through turbine
iii. Power developed by the runner
iv. Specific speed of turbine [4]

Q. 2 (a) Explain the terms slip, % slip and negative slip of a reciprocating pump [2]

(b) A three stage centrifugal pump has three identical impellers, keyed to the same shaft. Each impeller is 40 cm in diameter and 2.5 cm wide at outlet. The vanes are curved back at outlet at 30^{0} and the thickness of vanes reduce the circumferential area by 15% at outlet. The manometric efficiency is 85% and overall efficiency is 75%. Determine the head generated by pump when running at 1200 rpm and delivering 60 lps. Find the shaft power also. [5]

Q. 3 (a) What is an air vessel? Describe the function of air vessel for reciprocating pumps. [2]

(b) A cylinder of a single acting reciprocating pump is 125 mm in diameter and 250 mm in stroke. The pump is running at 40 rpm and discharge water to a height of 15 m. the diameter and length of delivery pipe are 100 mm and 30 m, respectively. If an air vessel is fitted in delivery pipe at a distance of 1.5 m from the centre of the pump and coefficient of friction f for delivery pipeline is 0.04 in the formula $h_f = fl.V^2/(2gd)$, find the pressure head in the cylinder :
(i) at the beginning of the delivery stroke
(ii) in the middle of delivery stroke. [4]

Q.4 (a) Derive the continuity equation describing water hammer phenomenon taking into consideration the compressibility of water and the elasticity of the pipe material. [4]

(b) Derive the expression for variation of water level in simple surge tank due to sudden closure of valve. Neglect frictional resistance in the pipeline and obtain the expressions for maximum upsurge and period of oscillation. [4]

Q.5 (a) Derive the expression for time of flow establishment in a pipe when the valve at downstream end is opened suddenly. [3]

(b) A 150 mm dia, 1500 m long pipe leads from a large reservoir to an outlet which is 20 m below the water level in the reservoir. If a valve at the pipe outlet is suddenly opened, estimate the time required to reach the 50% of steady state flow velocity. Neglect the frictional losses. [3]

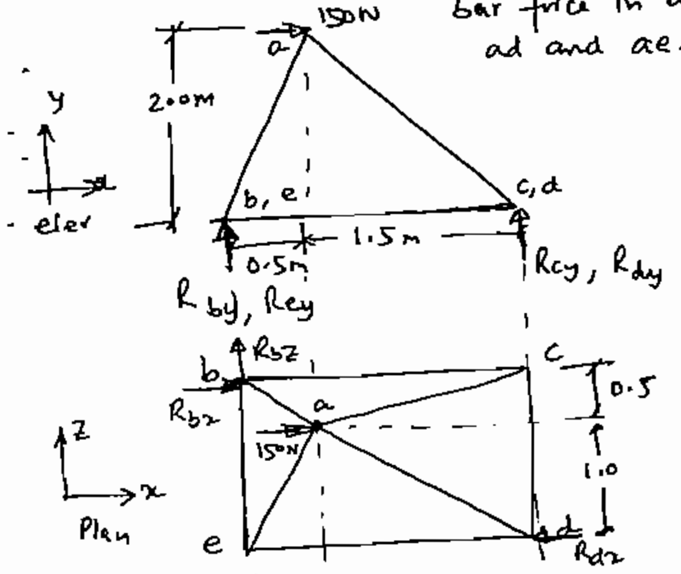
Q.6 (a) Write down purpose and design considerations for surge tanks. [2]

(b) Explain the phenomenon of rupture of water column due to water hammer. [2]

(c) Draw time history of water hammer pressure wave at the valve, centre of pipeline and at reservoir. [2]

CEL 231 STRUCTURAL ANALYSIS-I
MAJOR TEST

Q1 Compute the Reactions and bar force in ab, ac, ad and ae.



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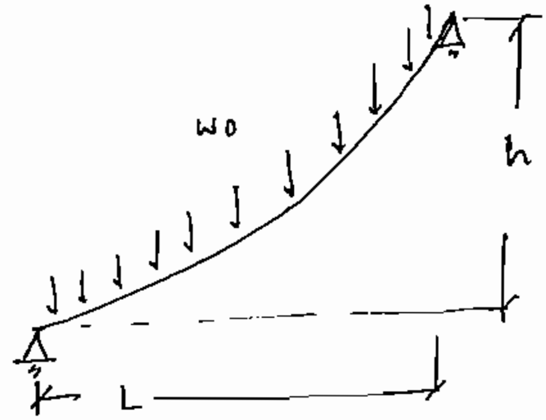
Q2 Derive the expression for maximum tension in the cable.



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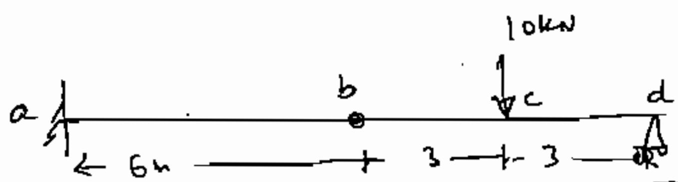
Q3 Using conjugate beam method determine the displacement at point 'c'. EI is constant.



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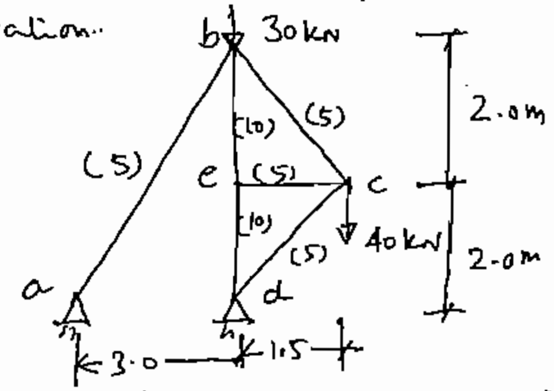
Q4 (i) Compute the vertical deflection of joint 'c' due to loads shown.
(ii) How much would the length of member 'ab' have to be changed by adjusting a turnbuckle, to return joint c to its undeflected vertical elevation.



$E = 207 \times 10^6$ KPa, Area is shown in paranthesis (cm^2)

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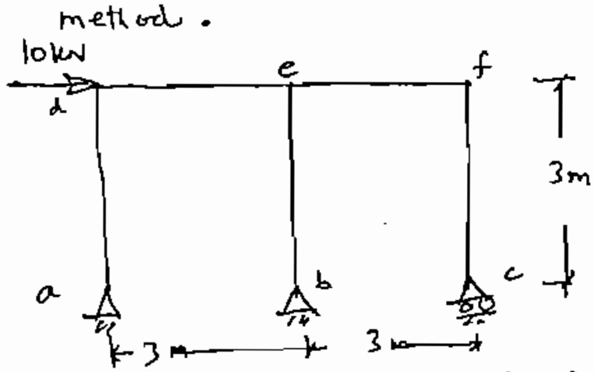
Q5 (i) Draw BM diagram using force method.



(ii) Support 'b' settles down by 0.05m.
$EI = 10 \text{ kNm}^2$

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(6) Use portal method to find support moments and moments in beam bd.

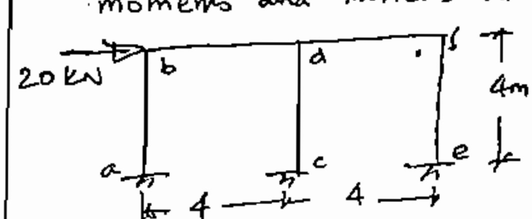

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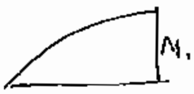
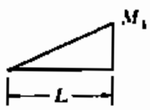
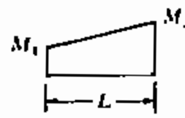
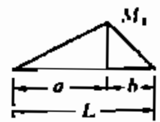
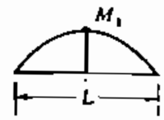
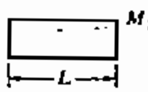
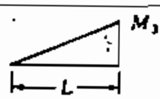
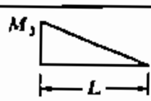
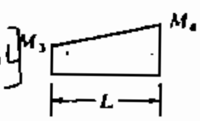
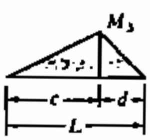
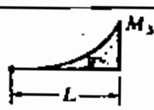
Table 10-1 Values of product integrals $\int_0^L M_L M_L \, dx$



	M_L / M_L				
$\frac{2}{3} M_1 M_3 L$		$\frac{L}{2} M_1 M_3$	$\frac{L}{2}(M_1 + M_2)M_3$	$\frac{L}{2} M_1 M_3$	$\frac{2L}{3} M_1 M_3$
$\frac{5}{12} M_1 M_2 L$		$\frac{L}{3} M_1 M_3$	$\frac{L}{6}(M_1 + 2M_2)M_3$	$\frac{L}{6}\left(1 + \frac{a}{L}\right) M_1 M_3$	$\frac{L}{3} M_1 M_3$
$\frac{1}{4} M_1 M_2 L$		$\frac{L}{6} M_1 M_3$	$\frac{L}{6}(2M_1 + M_2)M_3$	$\frac{L}{6}\left(1 + \frac{b}{L}\right) M_1 M_3$	$\frac{L}{3} M_1 M_3$
$\frac{1}{12}\left[M_1(3M_3 + 5M_4)\right]L$		$\frac{L}{6} M_1(M_3 + 2M_4)$	$\frac{L}{6} M_1(2M_3 + M_4) + \frac{L}{6} M_2(M_3 + 2M_4)$	$\frac{L}{6}\left(1 + \frac{b}{L}\right) M_1 M_3 + \frac{L}{6}\left(1 + \frac{a}{L}\right) M_1 M_4$	$\frac{L}{3} M_1(M_3 + M_4)$
[illegible]		$\frac{L}{6}\left(1 + \frac{c}{L}\right) M_1 M_3$	$\frac{L}{6}\left(1 + \frac{d}{L}\right) M_1 M_3 + \frac{L}{6}\left(1 + \frac{c}{L}\right) M_2 M_3$	For $c \le a$: $\frac{L}{3} M_1 M_3 - \frac{L(a-c)^2}{6ad} M_1 M_3$	$\frac{L}{3}\left(1 + \frac{cd}{L^2}\right) M_1 M_3$
$\frac{1}{12}\left[M_1 M_3\left(3 - \frac{3c}{L} + \frac{c^2}{L^2}\right)\right]L$		$\frac{L}{3} M_1 M_3$	$\frac{L}{3}(M_1 + M_2)M_3$	$\frac{L}{3}\left(1 + \frac{ab}{L^2}\right) M_1 M_3$	$\frac{8L}{15} M_1 M_3$
		$\frac{L}{4} M_1 M_3$	$\frac{L}{12}(M_1 + 3M_2)M_3$	$\frac{L}{12}\left(1 + \frac{a}{L} + \frac{a^2}{L^2}\right) M_1 M_3$	$\frac{L}{5} M_1 M_3$

Note: All curves are second-degree parabolas with vertices shown by heavy dots.