

Personal Information

1. Name of Applicant : _____

2. Date of Birth (DD/MM/YYYY) : _____

3. Category (Highlight/Tick one) : General / SC / ST / OBC-NC

4. Financial Category : (a) Self sponsored
(b) Industry sponsored (Cyient employees)

5. Interested M.Tech specialization : (a) _____

(b) _____

(c) _____

6. Educational Background (10th Class (or equivalent) level and above)

S.No.	Certificate / Degree	Branch	Institute /College	University	Year	%, CGPA ...

Was the Bachelors degree obtained through correspondence course / in distance education mode? Yes / No

7. Years of experience:

[Signature of the student]

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total

Instructions:

1. Solve the problems in the space provided below each question.
 2. If additional space is required, you may continue the same on the *additional page* in the end.
 3. Questions 1 to 4 are compulsory. You may choose any four amongst questions 5 to 16.
 4. Each question carries 10 marks. The paper is for 80 marks.
 5. Clearly explain all the steps involved including illustrations where necessary.
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Q1) (a) If $(x + a)(x + b) = x^2 + 15x + 50$, then find a and b .

(b) If $(x + 2)^5$ is written as a polynomial, what is the coefficient of x^2 ?

Q2) (a) If $\vec{a} = 3\hat{i} + 4\hat{j}$ and $\vec{b} = 4\hat{i} - 3\hat{j}$, then find

i) $\vec{a} \cdot \vec{b}$

ii) $\vec{a} \times \vec{b}$

(b) If $f = x^2 + 3x + 5y^2 + z$, then find the gradient ∇f at the point $(2, 1, 0)$.

Q3) a) Find the maximum and minimum of a function $f(x) = 2\cos(2x)$ for $x \in [0, \pi/2]$.

b) If $f = x^2 + 3x + 5$, then find the extremum point (maximum/minimum) of the function. Is it a maximum or minimum value of the function?

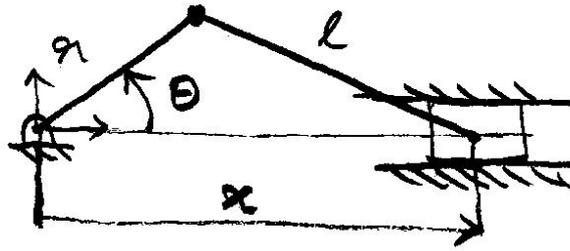
Q4) (a) Find the total differentiation of the following functions

i) $f = x^2 + 3x + 5y^2 + z.$

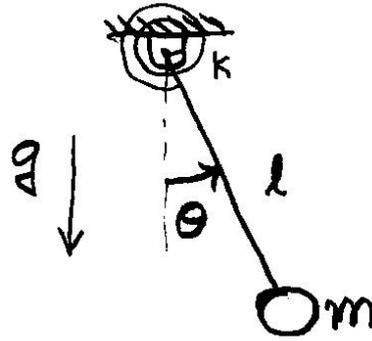
ii) $f = \frac{\sin(x)\cos(y)}{z}$

(b) Find the solution of a differential equation $\frac{dy}{dx} = -\frac{x}{y}$. What is the name of the curve the solution represents?

Q5) Find the position, velocity, and acceleration of the slider as functions of angular displacement, velocity, and acceleration of crank.

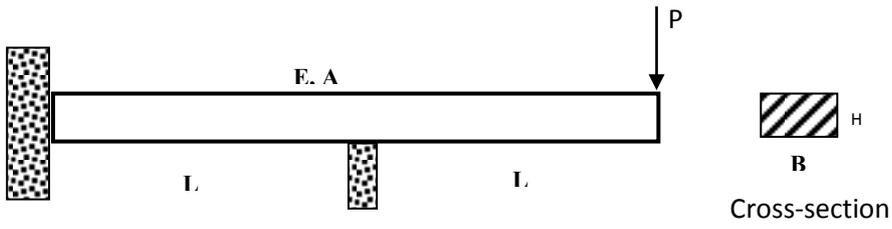


Q6) Derive the equation of motion for the system shown below for small amplitude oscillations about the equilibrium position. What is the natural frequency of the system? (Note: $\theta=0$ is the equilibrium position for rotational spring at the pivot.)



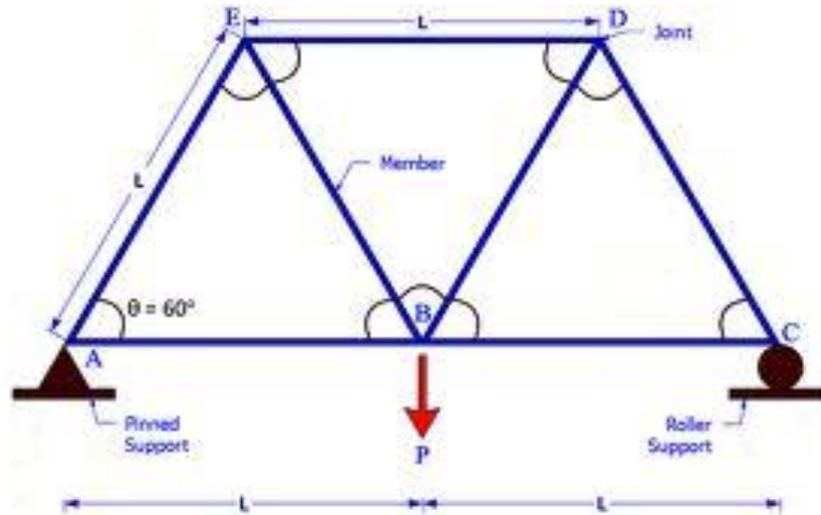
Q7) Consider the overhanging beam shown below, where $P=100\text{kN}$, $B=H=10\text{mm}$, $L=1000\text{mm}$, $E=70\text{GPa}$.

- Find the reaction forces of the supports (shown as shaded blocks, on left and center)
- Draw the Shear force diagram
- Draw the bending moment diagram



Q8) Shown below is a truss with all members of length L , and $P=1\text{kN}$, $L=2\text{m}$, $E=200\text{Mpa}$, $A=10\text{mm}^2$

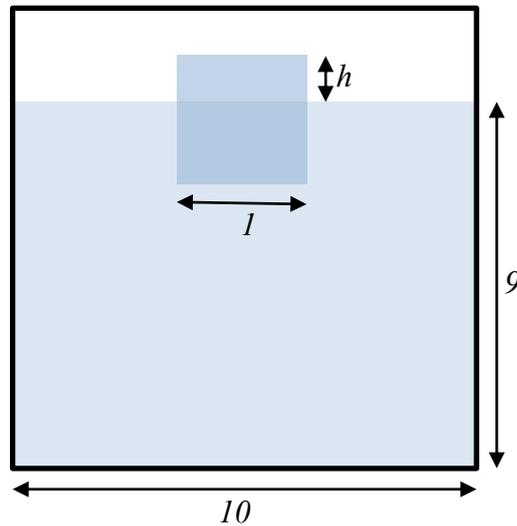
- Find the reaction forces
- Find the forces in all the truss members



Q9) Consider a large cubic container of size 10m x 10m x 10m filled with water at room temperature and with an ice block of size 1m x 1m x 1m floating over it. The initial water level along with the ice block is 9m and the 1m space above the water is filled with air at atmospheric pressure P_0 with some space being taken up by the ice floating above the water level. Determine

- The height, h , of the ice block floating above the water level.
- The final water level of water after the ice melts

Assume that water has a density of 1000 kg/m^3 and ice has a specific gravity of 0.92.

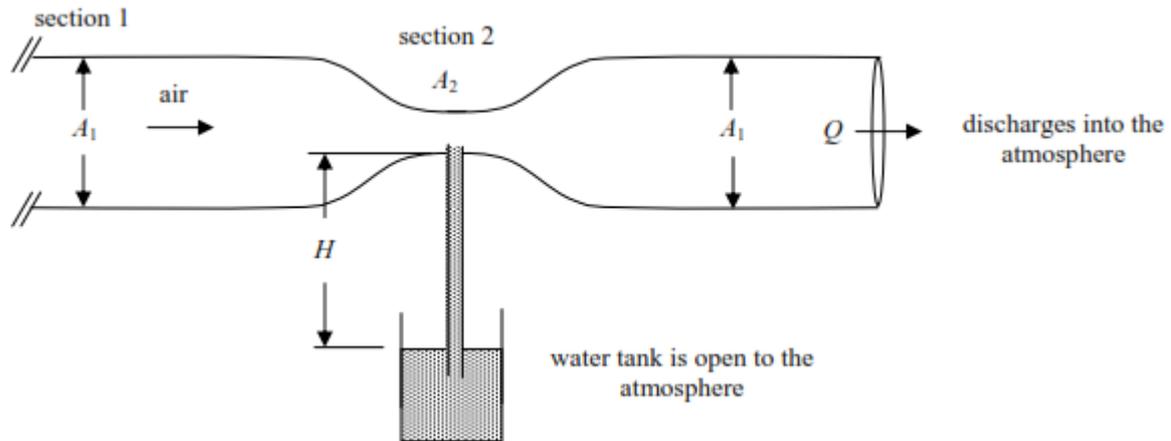


(Not to scale)

Q10) A diesel engine develops a brake power of 4.5 kW. It's indicated thermal efficiency is 30% and the mechanical efficiency is 85%. Take the calorific value of fuel as 40000 kJ/kg and calculate (a) the fuel consumption in kg/hr and (b) the indicated specific fuel consumption in kg/kW-hr.

Q11) Two fluids, A and B exchange heat in a **counter-flow** heat exchanger. Fluid A enters at 420°C and has mass flow rate of 1 kg/s . Fluid B enters at 20°C and also has mass flow rate of 1 kg/s . Effectiveness of heat exchanger is 75% . Determine the heat transfer rate and exit temperature of fluid B, given that specific heat of Fluid A = 1kJ/kg-K and that of Fluid B = 4kJ/kg-K .

Q12) Air flows through the Venturi tube that discharges to the atmosphere as shown in the figure. If the flow rate is large enough, the pressure in the constriction will be low enough to draw the water up into the tube. Determine the flow rate, Q , needed to just draw the water into the tube. What is the pressure at section 1? Assume the air flow is frictionless.



Q13) A cutter tip is initially at $X=10\text{mm}$, $Y=20\text{mm}$. In a rapid motion, using G00 code, it moves to $X=160\text{mm}$, $Y=120\text{mm}$. The X and Y axes has a maximum speed of $10,000\text{mm/min}$ and $5,000\text{mm/min}$ respectively. Operating at maximum speed, what the time it took to reach the destination?

Q14) A 15mm diameter threaded screw with a pitch of 1.25mm is to be made using a lathe machine. (a) Calculate the feed rate required to manufacture the screw, if the spindle speed is 10rpm. (b) What will be the feed rate if a two-start threaded screw is required instead?

Q15) Let $n = 0.6$ and $C = 90$ in the Taylor equation for tool wear. What is the percent increase in number of work pieces that can be plain turned if the cutting speed is reduced by 50% without changing the tool feed rate.

Q16) A 100x200x150 mm block of cast iron with a through hole of 80 mm diameter on the 200x150 face is to be casted. Calculate the volume of wooden pattern for casting of the block assuming zero shrinkage.