

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 2nd Year 2nd Term Examination, 2022

ME 2221

(Computer Programming)

Time: 3 Hours

Full Marks: 210

- N.B.:** i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

- 1(a) What is meant by machine language and high-level language? How compilation differ from interpolation? 07
- 1(b) How many operators are used in C programming? Explain each with example. 13
- 1(c) You are given the weights of 120 second year mechanical engineering students. Write a program to calculate the average weight and standard deviation of their weights. Use the following formulas for 15

$$\text{average} = \bar{X} = \frac{\sum_{i=1}^n x_i}{n} \quad \text{and} \quad \text{standard deviation} = \sigma^2 = \frac{\sum_{i=1}^n (x_i - \bar{X})^2}{n}$$

where x_i = weight of student i , n = total number of students.

- 2(a) Explain the following terms with example: 09
(i) Keywords (ii) Statement (iii) Escape sequences.
- 2(b) Assume that every student of 2nd year mechanical takes five class tests on which score ranges from 0 - 25, and his final grade will be the average of the three highest test scores plus the term final marks which ranges from 0 - 75. Write a program which finds the final grades (marks) of 120 students. 16
- 2(c) Write a C program to calculate the roots of a quadratic equation $ax^2 + bx + c = 0$. 10
- 3(a) Explain the purpose of using 'goto', 'break', and 'continue' statement with example. How do break differ with exit () function? 10
- 3(b) Write a program to calculate the salaries of three employees A, B and C given that A worked for t_1 hours, B worked for t_2 hours and C worked for t_3 hours. Basic salary is TK 1000 for all employees, house rent is 50% of basic pay and medical allowance is TK 600 for all employees and A will get TK 10 bonus for every hour he worked more than B and B will get TK 5 bonus for every hour he worked more than C. Total salary is equal to sum of basic pay, house allowance, medical allowance and bonus. Assume $t_1 > t_2 > t_3$. 15
- 3(c) Write a program using switch statement to print one of the following messages: 10
(i) The hot water
(ii) The water is cold
(iii) The water is luke-warm
Assume any information you may require.
- 4(a) What is meant by array variable? When do we use array variable? What are its advantages and disadvantages? Explain. 08
- 4(b) Write a C program to find the largest element in a $(M \times M)$ matrix. 12
- 4(c) Consider an array of integers that may contains positive and negative numbers. Write a program that finds all the pairs of integers whose sum is equal to a given value. For example, suppose the set contains (2, 3, 4, 8, 9, 12,) and the sum is 12 then the pairs $3 + 9 = 12$ and $4 + 8 = 12$. 15

SECTION-B

- 5(a) What is meant by string? Write the purpose of the following string functions: 10
(i) strcpy() (ii) strcmp() (iii) strlen() (iv) strrev() (v) strlwr()
- 5(b) Write a program to scan an English sentence and calculate the number of 'a', 'e', 'i', 'o' and 'u' in the sentence. 10
- 5(c) Given the name of 120 second year mechanical engineering student. Write a program to sort them by name alphabetically. 15
- 6(a) Why user-defined function is necessary in C language? Discuss the categories of user-defined function based on argument and return value. 10
- 6(b) Write a function that can calculate the factorial of any given number. Now use this function in main() function to find out the sum of the following series: 15
- $$y = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \dots + \frac{x^n}{n!}$$
- 6(c) Write a program in C to print the first 150 natural numbers using recursion. 10
- 7(a) Explain the terms static memory allocation, dynamic memory allocation and global variable. 09
- 7(b) What is the basic difference between structure and union? How do you pass a structure to a function? 08
- 7(c) Write a C program using structure variable to create a data structure taking the following details of 60 students: (i) Roll number: integer, (ii) Name: string, (iii) Marks: float, and (iv) Grade: char. 18
- 8(a) What kind of information does a pointer variable represent? What are the advantages of using pointer variable? Explain. 08
- 8(b) Write a program to create and display a link list. 10
- 8(c) The age of 100 students stored in a data file called 'age.txt'. Write a program to read the data from the file and sort them in ascending order and then write them in an output file called 'sort.txt'. 17

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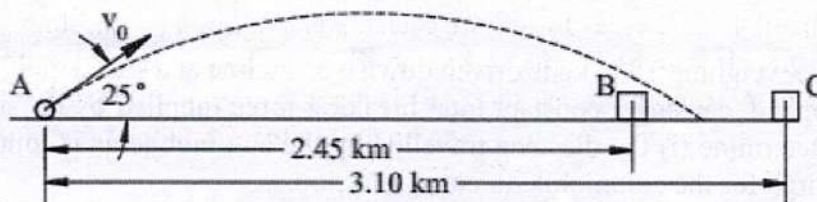
- N.B.:** i) Answer any THREE questions from each section in separate scripts.
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SECTION-A

- 1(a) A mass is suspended by a spring. The vertical motion of mass A is defined by the relation $y = 11 \sin 2t + 16 \cos 2t + 112$, where y and t are expressed in mm and seconds, respectively. Determine (i) the position, velocity and acceleration of A when $t = 1.75$ sec, (ii) the maximum velocity and acceleration of A. 10



- 1(b) Car B is travelling a distance d ahead of car A. Both cars are travelling at 60 m/s when the driver of B suddenly applies the breaks, causing his car to decelerate at 12 m/s^2 . It takes 0.75 sec to the driver of car A to react (this is the normal reaction time for drivers) when he applies his brakes, he decelerates at 15 m/s^2 . Determine the minimum distance d between cars so as to avoid a collision. 12
- 1(c) A projectile is fired with an initial velocity v_0 at an angle of 25° with horizontal. Determine the required value of v_0 if the projectile is to hit (i) point B, (ii) point C, (iii) what maximum altitude the projectile will reach? 13



- 2(a) Block B starts from rest and moves downward with a constant acceleration. Knowing that after slider A has moved 12 cm, its velocity is 60 cm/sec, determine (i) the acceleration of A and B, (ii) the velocity and change in position of B after 2.5 sec. 18

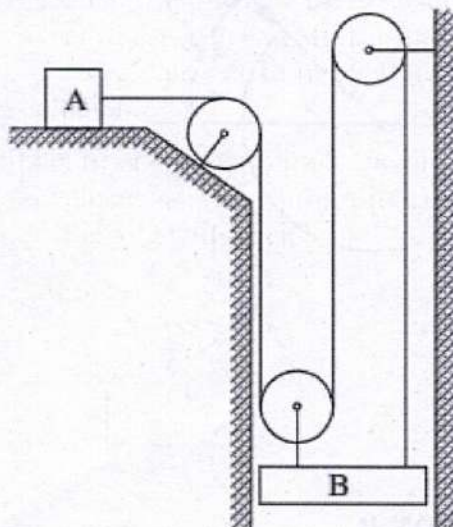


Fig. Q2(a)

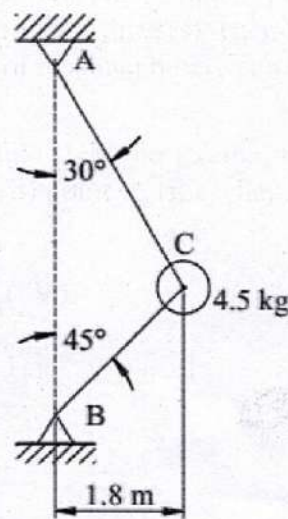
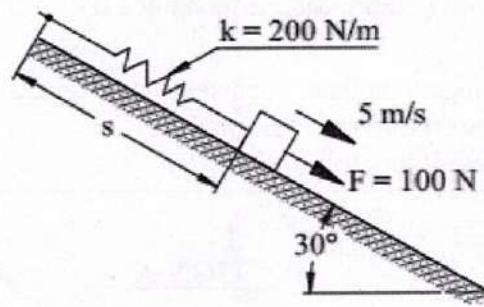


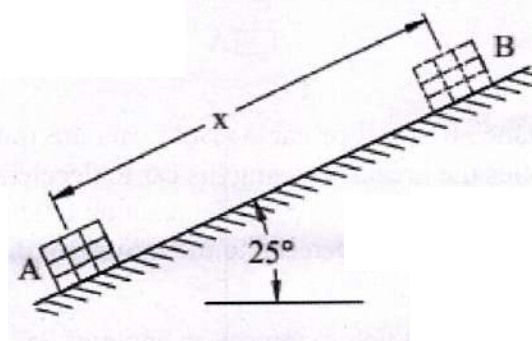
Fig. Q2(b)

- 2(b) Two wires AC and BC are tied at C to a sphere which rotates at a constant speed v in the horizontal circle as shown. Determine the range of the allowable values of v , if both wires are to remain taut and if the tension in either of the wires is not to exceed 105 N. 17

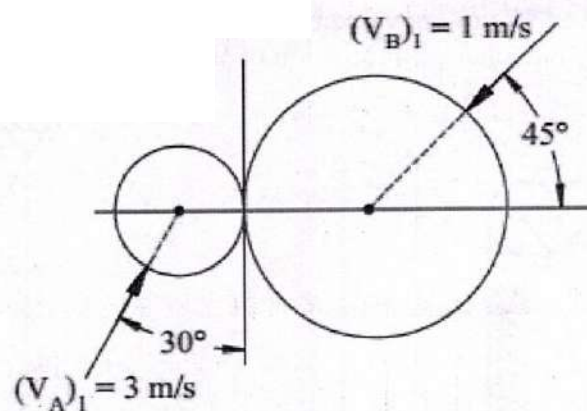
- 3(a) When $s = 0.6$ m, the spring is unstretched and the 10 kg block has a speed of 5 m/s down the smooth plane. Determine the distance s when block stops. Also, determine maximum velocity of the block. 17



- 3(b) A 10 kg package is projected up a 25° incline with an initial velocity of 7.5 m/sec. Knowing that the coefficient of kinetic friction between the package and the incline is 0.20, determine (i) the maximum distance x that the package will move up the incline, (ii) the velocity of the package as it returns to its original position, (iii) the total amount of energy dissipated due to friction. 18



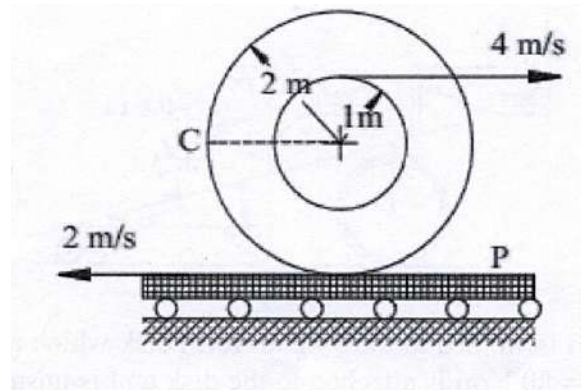
- 4(a) An automobile weighing 1800 kg is driven down a 6° incline at a speed of 90 km/hr when the brakes are applied, causing a constant total braking force (applied by the road on the tires) of 6300 N. Determine (i) the distance travelled by the automobile as it comes to a stop, (ii) the time required for the automobile to come to a stop. 17
- 4(b) Two smooth disks A and B, having a mass of 1 kg and 2 kg, respectively, collide with the velocities shown in figure. If $e = 0.75$, determine velocity component of each disks after collision. 18



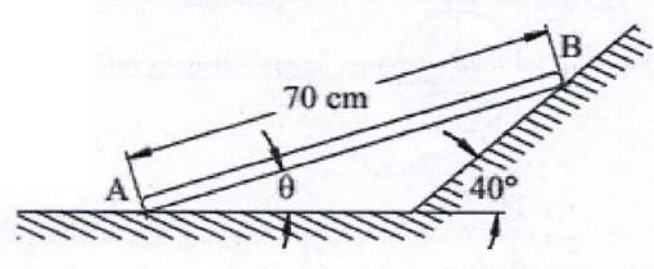
SECTION-B

- 5(a) The propeller of a small airplane rotates at a constant rate of 1800 rpm in a clockwise sense when viewed by the pilot. Knowing that the airplane is turning left along a horizontal circular path of radius 1200 m, and that the speed of the airplane is 270 km/hr, determine the angular acceleration of the propeller at the instant the airplane is moving on west. 12

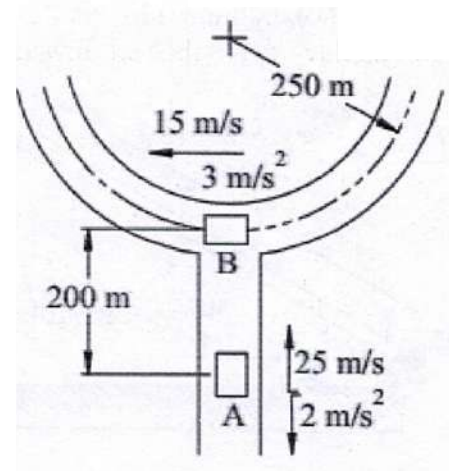
5(b) Determine the velocity of point C of the spool shown. Assume the spool does not slip on the platform P. 10



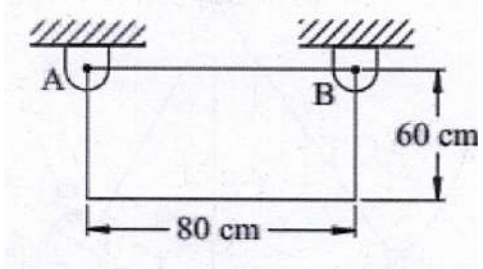
5(c) Rod AB is 70 cm long and slides with its ends in contact with the floor and the inclined plane. End A moves with a constant velocity of 63 cm/sec to the right. At the instant when $\theta = 25^\circ$, determine (i) the angular velocity of the rod, (ii) the velocity of end B. 13



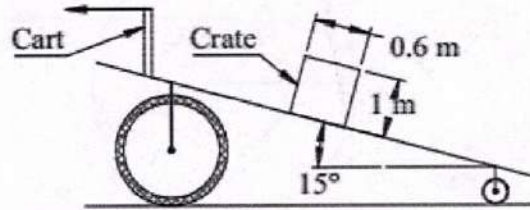
6(a) At the instant shown, car A travels with a speed of 25 m/s, which is decreasing at a constant rate of 2 m/s^2 while car B travels with speed 15 m/s, which is increasing at a constant rate of 3 m/s^2 . Determine the velocity and acceleration of car A with respect to car B. Also determine the velocity and acceleration of B with respect to car A. 17



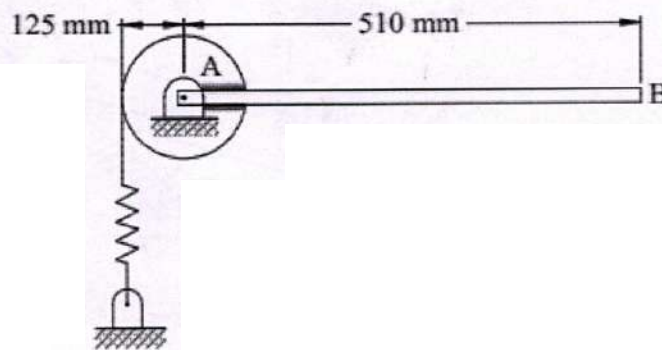
6(b) A $60 \text{ cm} \times 80 \text{ cm}$ rectangular plate weighing 35 kg is suspended from two pins A and B. If the pin B is suddenly removed, determine (i) the angular acceleration of the plate and (ii) the component of reaction at pin A, immediately after pin B is removed. 18



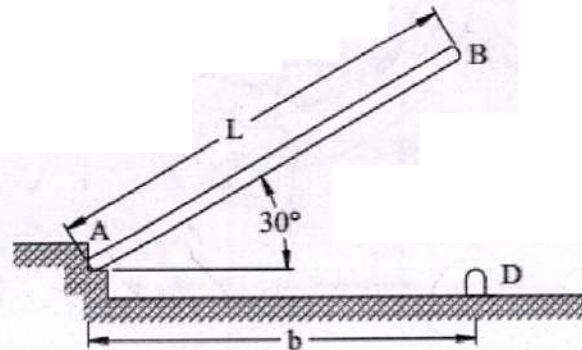
- 7(a) The uniform crate has a mass of 50 kg and rest on the cart having an inclined surface. Determine the smallest acceleration that will cause the crate slip or turn over relative to the cart. Assume $\mu_s = 0.5$. 17



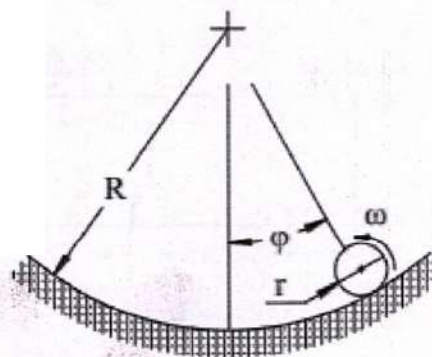
- 7(b) The 6 kg slender rod AB is welded to the 3 kg uniform disk which rotates about a pivot at A. A spring of constant $k = 80 \text{ N/m}$ is attached to the disk and is unstretched when the rod AB is horizontal. Knowing that the assembly is released from rest in the position shown, determine its angular velocity after it has rotated through 90° . 18



- 8(a) Show that speed of a sphere in an inclined surface is independent of its mass and radius. Assume no slipping occur during this travel. 10
- 8(b) A slender rod of mass m and length L is released from rest in the position shown and hits the edge D. Assuming perfectly elastic impact ($e = 1$) at D, determine the distance b for which the rod will rebound with no angular velocity. 15



- 8(c) The disk of mass m and radius r rolls without slipping on the circular path. Determine the normal force which the path exerts on the disk has an angular velocity ω . 12



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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 2nd Year 2nd Term Examination, 2022

Math 2205
(Mathematics IV)

Time: 3 Hours

Full Marks: 210

- N.B.:** i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any is missing.

SECTION-A

- 1(a) Define Laplace transform. Find the Laplace transform of the periodic function 10

$$f(t) = \begin{cases} \sin 2t, & 2\pi < t < 4\pi \\ 0, & \text{otherwise} \end{cases}$$

- 1(b) State the convolution theorem for the inverse Laplace transform. Evaluate the following using this theorem 12

$$L^{-1} \left\{ \frac{s^2}{(s^2 + a^2)(s^2 + b^2)} \right\}$$

- 1(c) Solve the following differential equation using Laplace transform $Y'' + 9Y = \cos 2t$; $Y(0) = 1, Y\left(\frac{\pi}{2}\right) = -1$ 13

- 2(a) Construct the partial differential equation by eliminating a, b, c from 09

$$z = a(x + 4) + b(x - 4) + abt + c$$

- 2(b) Form a partial differential equation by eliminating the arbitrary function φ from 10

$$\varphi(x + y + z, x^2 + y^2 - z^2) = 0$$

- 2(c) Find the solution of partial differential equation $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$, given that, $x > 0, t > 0, u(0, t) = 1, u(x, 0) = 0$ using Laplace transform. 16

- 3(a) Write down the Dirichlet's condition for Fourier series expansion. Obtain Fourier series for the expansion of the function $f(x) = x \sin x$ in the interval $-\pi < x < \pi$, hence deduce that, 22

$$\frac{\pi}{4} = \frac{1}{2} + \frac{1}{1.3} - \frac{1}{3.5} + \frac{1}{5.7} - \dots$$

- 3(b) Find the Fourier integral of the function $f(x) = 0, \frac{1}{2}, e^{-x}$ for $x < 0, x = 0, x > 0$, respectively. 13

- 4(a) Define odd and even function. If $f(t) = t^2, 0 \leq t \leq 1$, find half range Fourier sine series. 12

- 4(b) Write parseval's identity corresponding to the Fourier series of the function 13

$$f(x) = \begin{cases} x, & 0 < x < 2 \\ -x, & -2 < x < 0 \end{cases}$$

- 4(c) Find the Fourier cosine transform of $f(x) = \frac{1}{(1+x^2)}$ and hence derive the Fourier sine transform of $\varphi(x) = \frac{x}{(1+x^2)}$. 10

SECTION-B

5(a) To show that $P_n(x)$ is the coefficient of z^n in the expansion of $(1 - 2xz + z^2)^{-1/2}$ in ascending power of z . 15

5(b) Express $f(x) = x^4 + 3x^3 - x^2 + 5x - 2$ in terms of Legendre polynomial. 10

5(c) Prove that, 10

$$\int_{-1}^1 (x^2 - 1) P_{n+1}(x) P_n'(x) dx = \frac{2n(n+1)}{(2n+1)(2n+3)}$$

6(a) Define Bessel's function of 1st kind and 2nd kind. 08

6(b) Verify that $J_0(x) = \frac{1}{\pi} \int_0^\pi \sin(x \cos \theta) d\theta$ is one solution of Bessel's differential equation $x^2 y'' + xy' + x^2 y = 0$. 11

6(c) Prove that, 16

$$(i) \int_0^1 \frac{t J_0(xt)}{\sqrt{1-t^2}} dt \quad (ii) \int_0^{\pi/2} \sqrt{\pi x} J_{1/2}(2x) dx = 1$$

7(a) A bar of 30 cm length has its ends kept at 20° and 80° , respectively, until steady state conditions prevail. The temperature at each end is then suddenly reduce to 0° and maintained thereafter. Find the temperature in bar. 17

7(b) A tightly stretched string with fixed end points $x = 0$ and $x = 5$ cm is initially at rest in it's equilibrium position. If each of it's points is given a velocity $u_t(x, 0) = 2x(1 - x)$, find the displacement of the string at any distance x from one end at any time t . 18

8(a) A rectangular plate is bounded $0 < x < a$, $0 < y < b$. The sides of the plate $u(0, y)$, $u(a, y)$, $u(x, b)$ are kept at zero degree temperature. The temperature of the side $u(x, 0) = \sin \frac{n\pi x}{a}$. Determine the temperature at any point of the plate in the steady-state. 17

8(b) Determine the steady state temperature distribution $u(r, \theta)$ in a semi-circular plate of radius 'b' cm with insulated faces. The boundary diameter is kept at 0°C and the temperature on the circumference is prescribed by $u(b, \theta) = k\theta(\pi - \theta)$ when $0 \leq \theta \leq \pi$. 18

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 2nd Year 2nd Term Examination, 2022

ME 2211

(Mechanics of Solid)

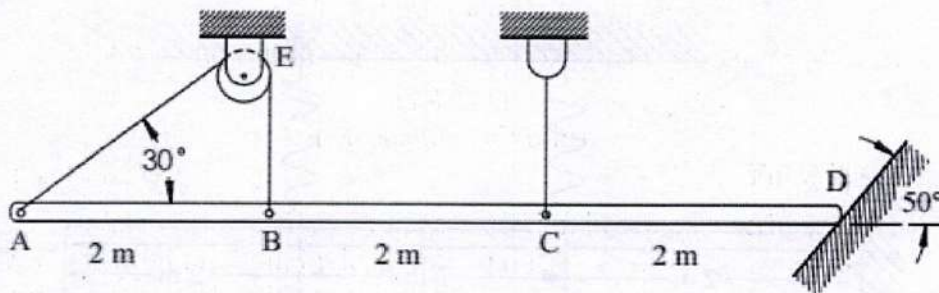
Time: 3 Hours

Full Marks: 210

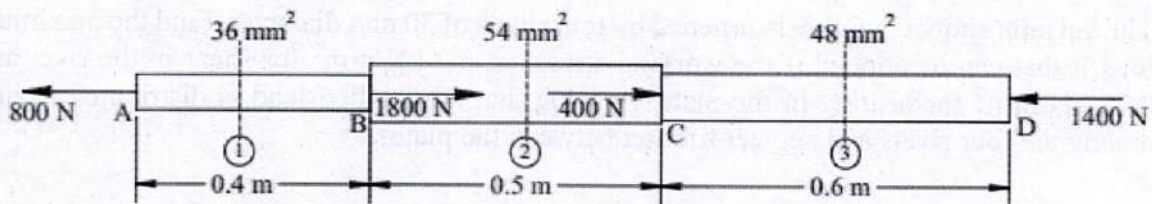
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SECTION-A

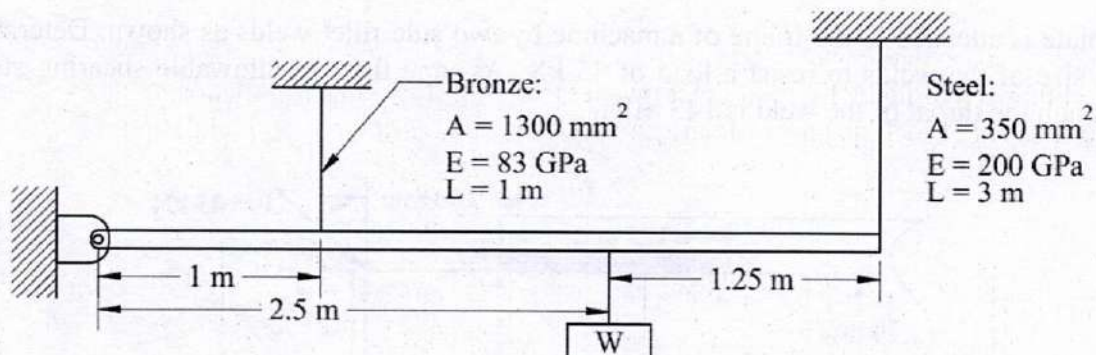
- 1(a) The homogeneous bar ABCD shown is supported by a cable that runs from A to B through a pulley E, a vertical cable at C and a smooth inclined surface at D. Determine the mass (M) of the heaviest bar that can be supported if the stress in each cable is limited to 100 MPa. The area of cable AB is 250 mm² and that of the cable at C is 300 mm². 17



- 1(b) The bar ABCD consists of three cylindrical steel segments with different lengths and cross-sectional areas. Calculate the normal stress in each segment for the applied loads as shown. 18

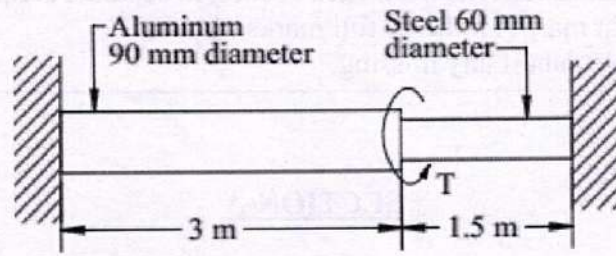


- 2(a) A rigid beam with negligible weight shown is pinned at one end and attached to two vertical rods. The beam was initially horizontal before the load $W = 225$ kN was applied. Find the vertical movement of W. 18

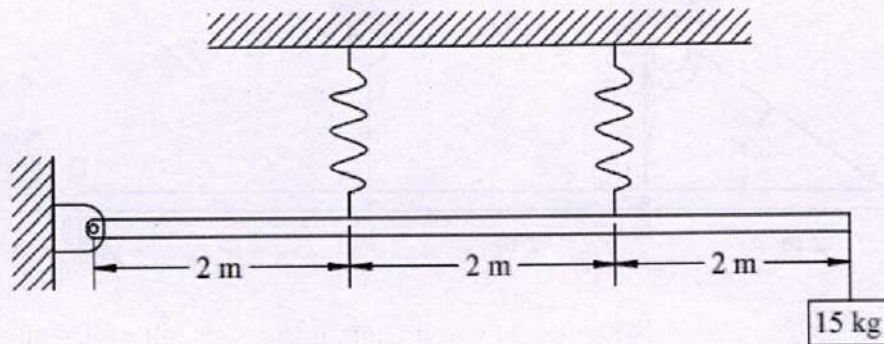


- 2(b) A solid aluminum shaft of 80 mm diameter fit concentrically in a hollow steel tube. Compute the minimum internal diameter of the steel tube so that no contact pressure exists when the aluminum shaft carries an axial compressive load of 400 kN. Assume $\nu = 1/3$, $E_{Al} = 70$ GPa. 17

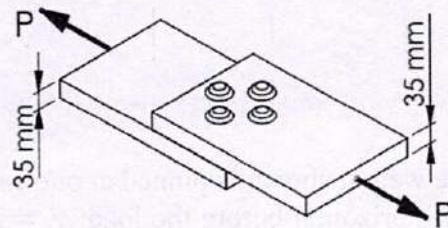
- 3(a) The shaft in the figure consists of a 90 mm diameter aluminum segment that is rigidly joined to a 60 mm diameter steel segment. The ends of the shaft are attached to rigid supports. Calculate the maximum shear stress developed in each segment when the torque $T = 80 \text{ N.m}$ is applied. Use $G = 28 \text{ GPa}$ for aluminum and $G = 80 \text{ GPa}$ for steel.



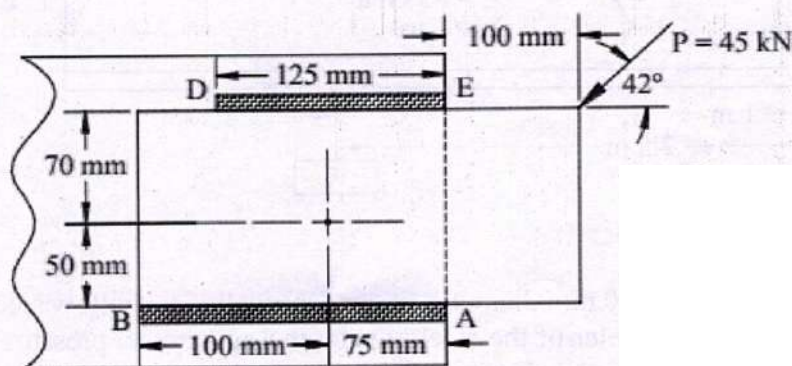
- 3(b) A rigid bar, hinged at one end, is supported by two identical springs as shown. Each spring consists of 20 turns of 12 mm wire having a mean diameter of 200 mm. Compute the maximum shearing stress in the spring. Neglect the mass of the rigid bar.



- 4(a) The lap joint shown in figure is fastened by four rivets of 30 mm diameter. Find the maximum load P that can be applied if the working stress are 0.2 kN/mm^2 for shear in the rivet and 0.25 kN/mm^2 for bearing in the plate. Assume that the applied load is distributed evenly among the four rivets and neglect friction between the plates.

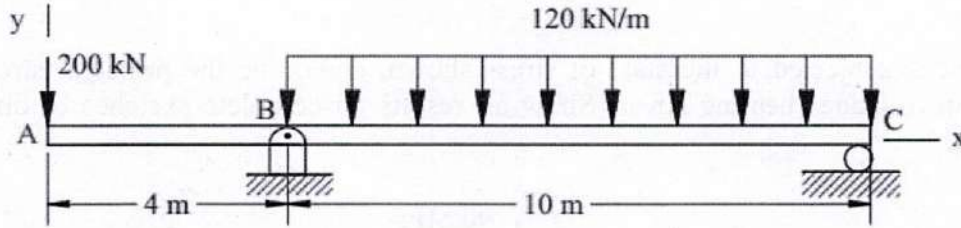


- 4(b) A plate is attached to the frame of a machine by two side fillet welds as shown. Determine the size of the welds to resist a load of 45 kN. Assume that the allowable shearing stress through the throat of the weld is 145 MPa.

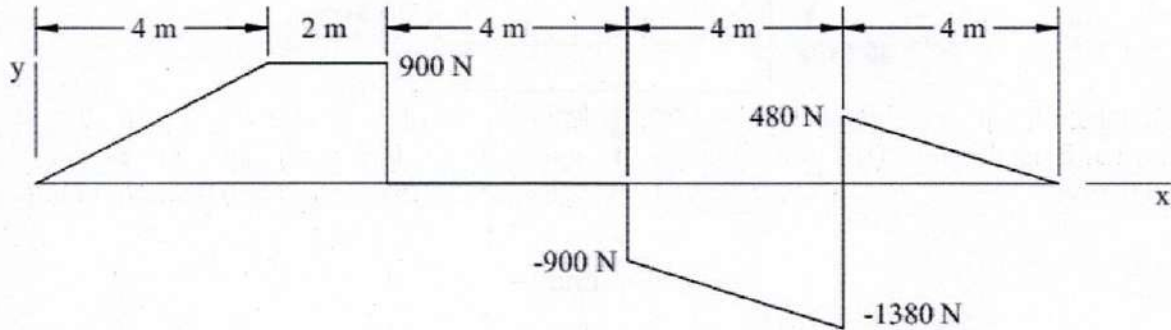


SECTION-B

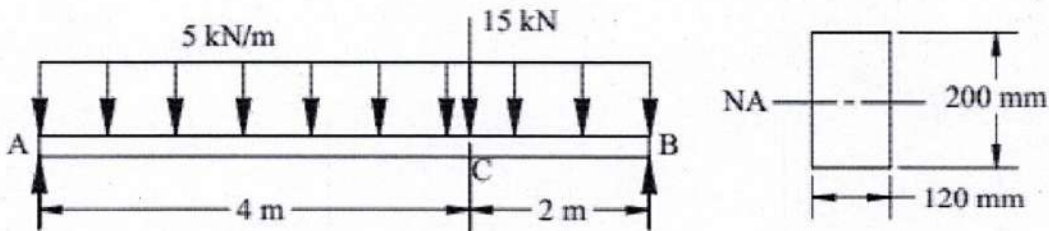
- 5(a) The overhanging beam ABC in figure carries a concentrated load and distributed load. 18
 (i) Derive the shear force and bending moment equation, and (ii) draw shear force and bending moment diagrams. Neglect the weight of the beam.



- 5(b) Draw moment and load diagrams corresponding to the given shear diagram as shown. Specify values at all change of load positions and at all points of zero shears. 17



- 6(a) A simple supported beam has a rectangular cross-section 120 mm wide and 200 mm high. 18
 (i) Compute maximum bending stress in the beam. (ii) Sketch bending stress distribution over the cross-section on which the maximum bending stress occurs.

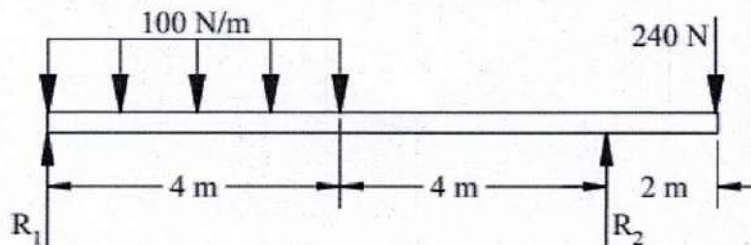


- 6(b) Two C310×45 channels are latticed together so they have equal moments of inertia about the principal axes. Determine the minimum length of a column having this section, assuming pinned ends, $E = 200$ GPa, and a proportional limit of 240 MPa. What safe load will the column carry for a length of 12 m with a factor of safety of 2.5? 17

- 7(a) Derive the differential equation of elastic curve of a beam due to beam deflection – 17

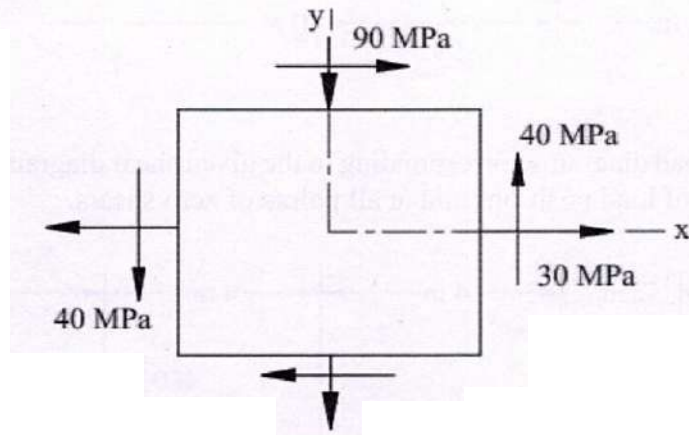
$$EI \frac{d^2y}{dx^2} = M$$

- 7(b) Calculate the slope of the elastic curve over the right support for the beam loaded as shown. 18



8(a) Derive the expressions for maximum and minimum normal and in-plane shear stress formula 17
for a variation of stresses acting at a point.

8(b) If a point is subjected to the state of stress shown, determine the principal stresses and 18
maximum in-plane shearing stress. Show all results on complete sketches of differential
elements.



- End -