JALPAIGURI GOVERNMENT ENGINEERING COLLEGE
[A GOVERNMENT AUTONOMOUS COLLEGE]
JGEC/B.TECH/ ME/ PC-ME403/ 2022-23
2023

STRENGTH OF MATERIALS

Full Marks: 70 Times: 3 Hours

The figures in the margin indicate full marks.
Candidates are instructed to write the answers in their own words as far as practicable.
Any missing data may be assumed suitably with proper justification.

GROUP-A

5x2=10

Answer ***all*** questions

1. What do you mean by tensile, compressive and shear forces? Give Examples.
2. Draw a typical stress-strain diagram of a mild steel specimen subjected to tension test indicating its salient points.
3. What is a spring? Define 'stiffness' and 'solid length' of a spring.
4. What is meant by pressure vessels or shells? How do you distinguish between thin and thick pressure vessels? What types of stresses are induced in thin pressure vessels?
5. What is 'equivalent length of a column'? Give the ratios of equivalent length and actual length of columns with various end conditions.

GROUP-B

15 x 4 = 60

Answer any ***FOUR*** questions from this Group

6. Answer ***any three*** **(5x3 = 15)**

i) A bar has three sections of different diameters, 120 mm, 80 mm, and 100 mm, and is subjected to loads as shown in **Fig.1**. Find the total elongation of the bar and the maximum stress in the material. Take E = 2 x 10^5 N/mm^2. 5

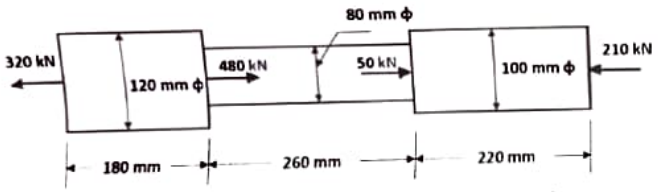

Fig. 1

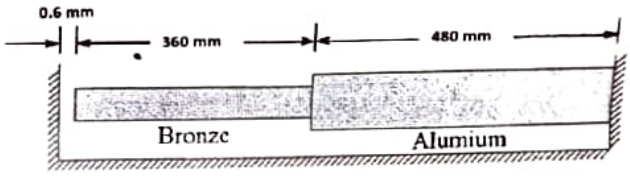

Fig. 2

ii) In the arrangement shown in **Fig.2**, a gap of 0.6 mm exists at the left end of the bronze bar at a temperature of 30^{0}C. Find the temperature at which the normal stress in the aluminium bar will be 80 N/mm^2. Use the following data. 5

For bronze: A_b = 1600 mm^2, E_b= 100 GPa, α_b= 18 x 10^{-6}/°C
For aluminium: A_a = 1800 mm^2, E_a= 70 GPa, α_a= 23 x 10^{-6}/°C

iii) An axial load of 45 kN is applied to a bar of 35 mm diameter and 1.2 m length. The extension of the bar is measured to be 0.27 mm whereas the reduction in diameter is 0.0032 mm. Calculate Poisson's ratio and the values of the three elastic constants. 5

iv) A steel bar of rectangular section 32 mm x 42 mm rigidly fixed at one end and hinged at the other end, is subjected to axial compression. The bar is 1.8 m long. Determine the buckling load using Euler's formula. Also determine the minimum length for which Euler's equation may be used to determine the buckling load, if the proportional limit of the material is 200 N/mm^2. Take E = 2 x 10^5 N/mm^2. 5

7. i) A cylindrical pressure vessel, of diameter 1.2 m and length 2 m, is subjected to an internal pressure of 1.8 MPa. If the hoop stress is limited to 44 MPa and the longitudinal stress to 30 MPa, find the minimum thickness required. What will be the change in volume of the cylinder under this pressure? Take E = 200 GPa and Poisson's ratio = 0.3. 6

ii) **Fig.3** shows a straight shaft ABCD subjected to three torques 2 kNm, 2 kNm and 10 kNm. Each segment of the shaft is 600 mm long. The diameter of the segments AB, BC and CD are 80 mm, 70 mm and 60 mm respectively. Determine 9

a) The maximum shear stress in the shaft and

b) The angle of twist at the end D.

Take $G = 8 \times 10^4$ N/mm^2.

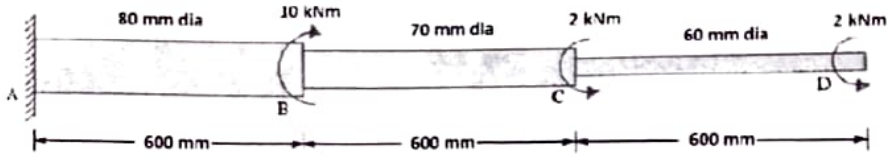

Fig. 3

8. Draw the Shear Force and Bending Moment diagrams for the overhanging beam (supported at B and D) carrying loads as shown in **Fig.4.** Indicate on the diagrams the values of shear force and bending moment at significant points. Show the location and magnitude of maximum bending moment. Also locate the point of contraflexure, if any. 15

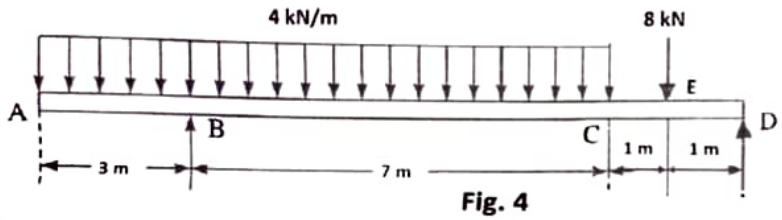

Fig. 4

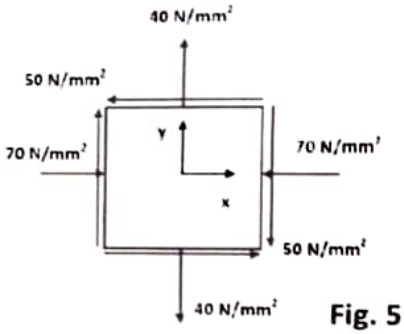

Fig. 5

9. i) *A rectangular block of material is subjected to a compressive stress of 70 N/mm^2 on one plane and a tensile stress of 40 N/mm^2 on the plane at right angles to the former as shown in* **Fig.5**. *Each of the above stresses is accompanied by a shear stress of 50 N/mm^2 and that associated with the tensile stress tends to rotate the block anti-clockwise. Determine* 9

(a) the principal stresses and their planes

(b) the maximum shear stress and its plane and

(c) the normal and the shear stresses on an oblique plane inclined at an clockwise angle of 30^0 with the direction of 40 N/mm^2 stress.

ii) A composite spring consists of two close-coiled helical springs connected in series. Each spring has 15 coils at a mean diameter of 22 mm. The stiffness of the composite spring is 900 N/m. If the wire diameter of one spring is 2.6 mm, find the wire diameter of the other. 6

What will be the maximum load which can be carried by the composite spring and the corresponding deflection for a maximum shear stress of 160 MPa? Take G = 80 GPa

10. A simply supported beam of 9 m length carries two point loads of 60 kN and 50 kN at 2 m and 5m respectively from the left hand end. Find the deflection under each load and the maximum deflection. 15
Take $E = 2 \times 10^5$ N/mm^2 and $I = 22 \times 10^7$ mm^4

11. i) A cast iron beam 2.8 m long has one support at the left end and the other support at 0.8 m from the right end. The beam is of T-section consisting of a top flange 160 mm x 20 mm and a web 20 mm wide and 90 mm deep. If the tensile and compressive stresses are not to exceed 40 N/mm^2 and 72 N/mm^2 respectively, find the safe concentrated load W that can be applied at the right end of the beam. 7

ii) A beam has an I-section having top flange 90 mm wide and 20 mm thick and web of height 220 mm and thickness 20 mm. The bottom flange is 160 mm wide and 30 mm thick. The beam is simply supported on a span of 6 metres. The beam carries a uniformly distributed load of 2 kN/m over the entire span. Find the maximum shear stress and draw the shear stress distribution diagram, marking the salient values. 8

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MANUFACTURING PROCESS

Full Marks: 70 Times: 3 Hours

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GROUP-A
[OBJECTIVE TYPE QUESTIONS]

Answer ***all*** questions 5x2=10

1. What is Ray Diagram ?
2. How Tool Life is defined ?
3. What is Braze Welding ?
4. When Cetrifugal Casting process is used & Why ?
5. Find out the condition for which the metal would enter the space between the rolls automatically during rolling

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

Answer any ***four*** questions 4x15=60

6.(a) Mention the name of the Casting process you prefer for making small size complex shaped components having smooth surface with close tolerance and also explain the process with neat sketch 8

(b) With neat sketches show the different angles of a single point cutting tool in ORS system . 7

7.(a) Explain UPSET forging in brief with a diagram . Give a few examples of application of this process. 7

(b) Explain with neat diagram the operation of Compound die and Progressive die in sheet metal operation. 8

8.(a) During pure orthogonal turning of a metal rod by a tool of the following geometry -----inclination angle (λ) = 0, orthogonal rake(γ) = 0 and principal cutting edge angle (φ) = 90°-----it was noted that the magnitudes of the Tangential component (Pz) and the axial component (P_x) of the cutting force are 600N and 200 N respectively and the value of chip reduction co-efficient (ξ) is 1.732. Using MCD, determine the magnitude of the shear force (P), the friction force,(F) and the co-efficient of friction (μ) for the above conditions. 9

(b) What are the methods of manufacturing Cold Drawn Seamless Tube ? 6

9.(a) To obtain a stronger, cleaner , precision welding, mainly for Stainless steel and other alloying materials and also for aluminum and magnesium but a bit expensive process without the danger of corrosion using no flux , which process is preferred ? Describe the process with a neat sketch . 6

(b) A machine tool bed of size 5m x 1m x 1m solid casting is to be produced by keeping entirely in Pit mold. A cope box of height 300 mm is placed with a gating ratio of 1: 1.5: 2 and ingate area of 400 mm². To fill the cavity it is decided to use step gating system of top gate with 10 ingates provided horizontal plane around the circumference .The level of molten material in pouring Basin is 100 mm above the cope box. Find the time taken to fill the casting cavity in seconds . 9

10.(a) What are the different polarities used in Arc Welding ? Explain the effect of different polarities and also the effect of A.C and D.C in Arc Welding. 9

(b) What is Planetary Rolling Mill arrangement ? When this type of arrangement is preferred ? 6

11.(a) What is Centreless Grinding? How a Grinding wheel is specified ? 8

(b) What are different types of Pattern used in Sand Casting? What are Pattern allowances? 7

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FLUID MECHANICS AND FLUID MACHINES

Full Marks: 70 Times: 3 Hours

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GROUP-A
[OBJECTIVE TYPE QUESTIONS]

5x2=10

Answer ***all*** questions.

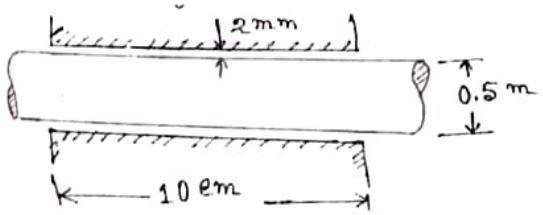
1. What is capillary rise of a liquid?
2. What is steady flow and what is laminar flow?
3. What is pathline?
4. Write the main difference between Lagrangian method and Eulerian method of describing fluid flow.
5. Why scroll casing is required in reaction turbine but not in Impulse turbine?

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

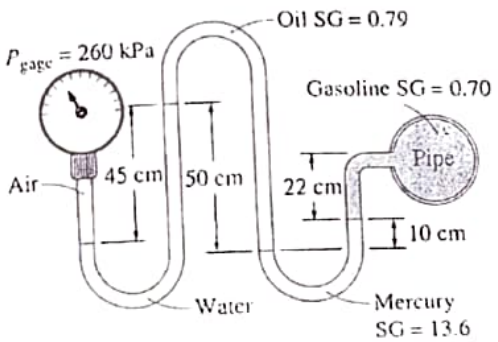
Answer any ***four*** questions. 4x15 = 60

6.(a) Viscosity of some fluids increases with temperature, but in some other fluids viscosity decreases with temperature. Explain the cause of this contrasting behavior of fluids. 6

(b) A shaft is rotating with 200 r.p.m. The shaft has a diameter 0.5 m and supported in a cylindrical sleeve of a bearing as shown in the figure below. The length of the bearing is 10 cm and inner diameter of the sleeve is 0.504 m. the gap between the shaft and the sleeve is filled up with a lubricating oil of viscosity 0.7 kg/(m-s). Find the power lost in this bearing. 9

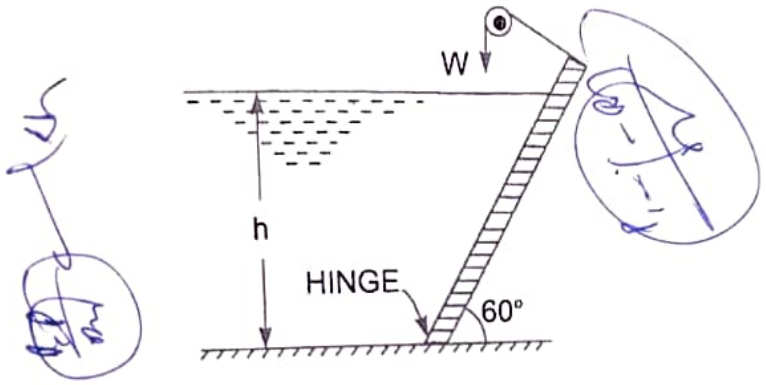


7.(a) A pipe filled with liquid gasoline is connected to a pressure gauge through a double U tube manometer which contains water, oil and mercury as manometric fluids as shown in the figure below. If the reading of the pressure gage is 260 kPa, determine the gauge pressure of the gasoline line. Take density of air 1 kg/m^3 and of water 1000 kg/m^3.Specific Gravity of oil, mercury and gasoline are given in the figure. 8



(b) Deduce the expression of continuity equation in 3dimensional flow. 7

8.(a) A rectangular gate of 6 m length X 2 m width is hinged at its base and inclined at 60^0 to the horizontal as shown in the figure below. To keep the gate in a stable position, a counter weight of 30000 N is attached at the upper end of the gate. Rope tension is perpendicular to the surface of the gate. Find the depth of water at which the gate begins to fall. Neglect the weight of the gate and also friction at the hinge and pulley. 9



(b) Deduce the expression of external force on a pipe bends in x and y direction, where p_1 and p_2 are the pressure of water at inlet and outlet respectively, A_1 and A_2 are area of inlet and outlet, V_1 and V_2 are the velocity of water at inlet and outlet, and ρ is the density of water, θ is the angle of the bend. 6

9.(a) The velocity potential function for a two-dimensional flow is $\emptyset = x(2y - 1)$. Determine the velocity vector at the point P (4, 5). Also obtain the value of stream function ψ at this point P. Given that $\psi = 0$ at (0,0) 7

(b) A horizontal venturi- meter with inlet diameter 20 cm, throat diameter 10 cm is used to measure the flow of water. The pressure at inlet is 15 N/cm^2 and vacuum pressure at throat is 40 cm of mercury. Find the discharge of water through the venturi-meter. Take coefficient of discharge = 0.9. 8

10.(a) A wooden cylinder of specific gravity 0.7 having length = 3 m, circular in cross-section with radius = 3.6 m is required to float in oil of specific gravity 0.92. Find whether the cylinder can float with its axis vertical in stable equilibrium condition? 7

(b) Deduce the expression of velocity of liquid in case of viscous pipe flow as a function of radius, when known parameters are: Radius of the pipe = R, Pressure gradient = dp/dx, dynamic viscosity = μ. Flow is steady and fully developed. Also find maximum velocity and average velocity of flow. 8

11.(a) A Pelton wheel has a mean bucket diameter of 0.8 m and is running at 1000 rpm. The net available head on the Pelton wheel is 400m. If the blade angle at exit is 15^0 and discharge through the nozzle is 150 lit/sec, find (a) Power available at the nozzle (b) Power available at the bucket and (c) hydraulic efficiency of the turbine. Consider coefficient of velocity =1 and blade friction factor = 1. 9

(b) A steady incompressible, two- dimensional velocity field is given by the following components in the x-y plane; $u = 1.85 + 2.33x + 0.656y$ and $v = 0.754 - 2.18x - 2.33y$. Calculate the acceleration components a_x and a_y at (-1, 2). 6

12.(a) An inward radial flow reaction turbine has external and internal diameters as 0.9 m and 0.45 m respectively. The turbine is running at 200 rpm. The flow component of velocity of water is constant for inlet and outlet and is equal to 1.8 m/s. the guide vane angle is 10^0 at the inlet with respect to the direction of whirl. The actual velocity of discharge at the outlet is perfectly radial. Determine (a) the absolute velocity of water at inlet, (b) the relative velocity at inlet and (c) blade angle at outlet. 12

(b) Find the surface tension in a soap bubble of 30 mm diameter when the inside pressure is 2 N/m^2 above atmosphere. 3

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2023
METROLOGY AND INSTRUMENTATION

Full Marks: 70 Times: 3 Hours

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Candidates are instructed to write the answers in their own words as far as practicable.

GROUP-A
[OBJECTIVE TYPE QUESTIONS] 5x2=10

Answer ***all*** questions

1. Explain Abbe's principle for maximum accuracy
2. How is it possible to measure angle of $43°35'25''$?
3. What is meant by calibration?
4. What is the Maximum and minimum Metal conditions shaft and hole basic system.
5. What is Allowance?

GROUP-B
[LONG ANSWER TYPE QUESTIONS] 4x15 = 60

Answer any ***four*** questions

6. i) Tolerance for a hole and shaft assembly having a nominal size of 50 mm are as follows: 10
Hole $=40^{+0.021}_{-0.000}$ mm and shaft $40^{-0.040}_{-0.075}$ mm. Determine the following
a)Maximum and Minimum clearances
b)Tolerance on shaft and hole
c) Allowance
d) MML of hole and shaft
e) Nature of fit
ii) Define and classify Tolerance 5

7. i) Briefly discuss different Types of errors associated with the measurement. 7
ii) Discuss different types of Measurement Methods employed for making measurements. 5
iii) Differentiate between hole basis and shaft basis systems. 3

8. i) Define Fit and classify the Fit. 5
ii) Briefly discuss the Interchangeability manufacture approach 5
iii)Briefly discuss about Limit Gauging and Taylor's Principle 5

9. i)Write down the working principle of Vernier Height Gauge 5
ii)Write down the working principle of Cooke's Optical Comparator 5
iii)Write down the working principle of inside micrometer 5

10. i) Describe the working principle of Vernier calipers and its construction, Also calculate the Least Count of the forward Vernier caliper. 7
ii) Write down the working principle of Universal Bevel Protractor. 4
iii) Write down the working of Sigma comparator 4

11. i) Write done the working principal of Clinometer 5
ii) Write down the working principle of Linear Variable Differential Transformer and its advantages 5

iii) Explain why Metrologists avoid using sine bars for angles greater than 45° 5

12. i) Write down the Working principle of Autocollimater 5

ii) Explain the construction and working Principle of the Sine bar. 5

iii)Write down the working Mechanism of Dial Indicators 5

_____END_____