

Assignment 7

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30. In a four bar planar mechanism shown in the figure, $AB = 5$ cm, $AD = 4$ cm and $DC = 2$ cm. In the configuration shown, both AB and DC are perpendicular to AD . The bar AB rotates with an angular velocity of $10 \frac{rad}{s}$. The magnitude of angular velocity (in $\frac{rad}{s}$) of bar DC at this instant is (2019)

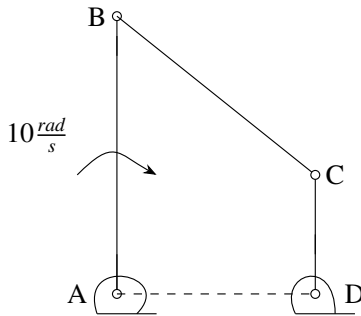


Fig. 0.1: 1

- (A) 0
(B) 10
(C) 15
(D) 25
31. The rotor of a turbojet engine of an aircraft has a mass 180 kg and polar moment of inertia $10 \text{ kg}\cdot\text{m}^2$ about the rotor axis. The rotor rotates at a constant speed of $1100 \frac{rad}{s}$ in the clockwise direction when viewed from the front of the aircraft. The aircraft while flying at a speed of 800 km per hour takes a turn with a radius of 1.5 km to the left. The gyroscopic moment exerted by the rotor on the aircraft structure and the direction of motion of the nose when the aircraft turns, are (2019)
- (A) 1629.6 N-m and the nose goes up
(B) 1629.6 N-m and the nose goes down
(C) 162.9 N-m and the nose goes up
(D) 162.9 N-m and the nose goes down
32. The wall of a constant diameter pipe of length 1 m is heated uniformly with flux q'' by wrapping a heater coil around it. The flow at the inlet to the pipe is hydrodynamically fully developed. The fluid is incompressible and the flow is assumed to be laminar and steady all through the pipe. The bulk temperature of the fluid is equal to 0°C at the inlet and 50°C at the exit. The wall temperatures are measured at three locations, P, Q and R, as shown in the figure. The flow thermally develops after some distance

Point	P	Q	R
Wall Temp ($^{\circ}\text{C}$)	50	80	90

TABLE 0: 3

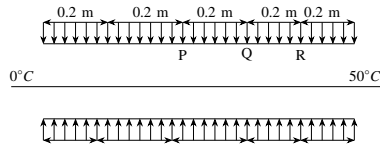


Fig. 0.2: 2

from the inlet. The following measurements are made: (2019) Among the location P, Q and R, the flow is thermally developed at (2019)

- (A) P, Q and R
- (B) P and Q
- (C) Q and R only
- (D) R only

33. A gas is heated in a duct as it flows over a resistance heater. Consider a 101 kW electric heating system. The gas enters the heating section of the duct at 100 kPa and 27°C with a volume flow rate of $15 \frac{\text{m}^3}{\text{s}}$. If heat is lost from the gas in the duct to the surroundings at a rate of 51 kW, the exit temperature of the gas is (2019)

- (A) 32°C
- (B) 37°C
- (C) 53°C
- (D) 76°C

34. A plane-strain compression (forging) of a block is shown in the figure. The strain in the z-direction is zero. The yield strength (S_y) in uniaxial tension/compression of the material of the block is 300 MPa and it follows the Tresca (maximum shear stress) criterion. Assume that the entire block has started yielding. At a point where $\sigma_x = 40$ MPa (compressive) and $\tau_{xy} = 0$, the stress component σ_y is (2019)

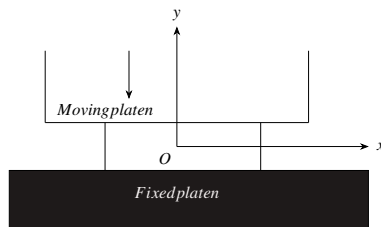


Fig. 0.3: 3

- (A) 340 MPa (compressive)
- (B) 340 MPa (tensile)

(C) 260 MPa(compressive)

(D) 260 MPa(tensile)

35. In orthogonal turning of a cylindrical tube of wall thickness 5 mm, the axial and the tangential cutting forces were measured as 1259 N and 1601 N, respectively. The measured chip thickness after machining was found to be 0.3 mm. The rake angle was 10° and the axial feed was $100 \frac{\text{mm}}{\text{min}}$. The rotational speed of the spindle was 1000 rpm. Assuming the material to be perfectly plastic and Merchant's first solution, the shear strength of the material is closest to (2019)

(A) 722 MPa

(B) 920 MPa

(C) 200 MPa

(D) 875 MPa

36. A circular shaft having diameter $65.00_{-0.05}^{+0.01}$ mm is manufactured by turning process. A $50\mu\text{m}$ thick coating of TiN is deposited on the shaft. Allowed variation in TiN film thickness is $\pm 5\mu\text{m}$. The minimum hole diameter (in mm) to just provide clearance fit is (2019)

(A) 65.01

(B) 65.12

(C) 64.95

(D) 65.10

37. Match the following sand mold casting defects with their respective causes (2019)

	Defect		Cause
P	Blow hole	1	Poor collapsibility
Q	Misrun	2	Mold erosion
R	Hot tearing	3	Poor permeability
S	Wash	4	Insufficient fluidity

TABLE 0: 3

(A) P-4, Q-3, R-1, S-2

(B) P-3, Q-4, R-2, S-1

(C) P-2, Q-4, R-1, S-3

(D) P-3, Q-4, R-1, S-2

38. A truss is composed of members AB, BC, CD, AD and BD, as shown in the figure. A vertical load of 10 kN is applied at point D. The magnitude of force (in kN) in the (2019)

39. Consider an elastic straight beam of length $L = 10\pi\text{m}$, with square cross-section of side $a = 5\text{mm}$ and Young's modulus $E = 200\text{GPa}$. This straight beam was bent in such a way that the two ends meet, to form a circle of mean radius R. Assuming that Euler-Bernouli beam theory is applicable to this bending problem, the maximum tensile bending stress in the bent beam isMPa (2019)

40. Consider a prismatic straight beam of length $L = \pi\text{m}$, pinned at the 2 ends as shown in the figure. The beam has a square cross section of side $p = 6\text{mm}$. The Young's

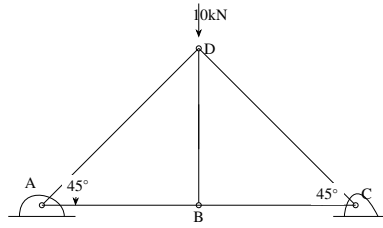


Fig. 0.4: 4

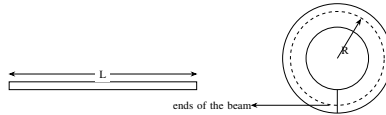


Fig. 0.5: 5

modulus $E = 200 \text{ GPa}$, and the coefficient of thermal expansion $\alpha = 3 \times 10^{-6} \text{ K}^{-1}$. The minimum temperature rise required to cause Euler buckling of the beam isK. (2019)

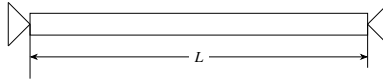


Fig. 0.6: 6

41. In a UTM experiment, a sample of length 100 mm, was loaded in tension until failure. The failure load was 40 kN. The displacement, measured using the cross-head motion at failure, was 15 mm. The compliance of the UTM is constant and is given by $5 \times 10^{-8} \frac{\text{m}}{\text{N}}$. The strain at failure in the sample is.....%. (2019)
42. At a critical point in a component, the state of stress is given as $\sigma_{xx} = 100 \text{ MPa}$, $\sigma_{yy} = 220 \text{ MPa}$, $\sigma_{xy} = \sigma_{yx} = 80 \text{ MPa}$ and all other stress components are zero. The yield strength of the material is 468 MPa. The factor of safety on the basis of maximum shear stress theory is.....(round off to one decimal place). (2019)