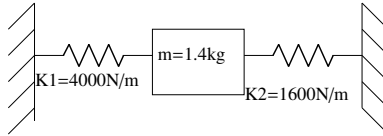
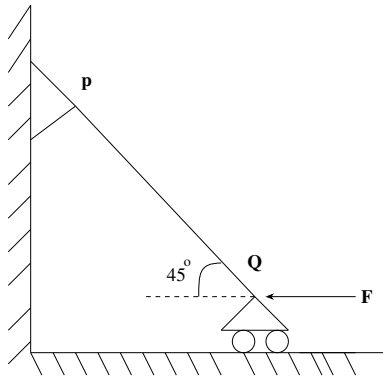


35) The natural frequency of the spring mass system shown in figure is closest to



- a) 8 Hz b) 10 Hz c) 12 Hz d) 14 Hz

36) The rod PQ of length L and with flexural rigidity EI is hinged at both ends. For what minimum force is it expected to buckle?



- a) $\pi^2 EI / L^2$ c) $\pi^2 EI / \sqrt{2} L^2$
b) $\sqrt{2} \pi^2 EI / L^2$ d) $\pi^2 EI / 2 L^2$

37) In a cam design, the rise motion is given by a simple harmonic motion (SHM) $s = (h/2)(1 - \cos \pi \theta / \beta)$ where h is total rise, θ is camshaft angle, β is the total angle of the rise interval. The jerk is given by

- a) $h/2(1 - \cos \pi \theta / \beta)$ c) $\pi^2 / \beta^2 h / 2 \cos \pi \theta / \beta$
b) $\pi / \beta h / 2 \sin \pi \theta / \beta$ d) $-\pi^3 / \beta^3 h / 2 \cos \pi \theta / \beta$

38) A uniform rigid rod of mass $m = 1 \text{ kg}$ and length $l = 1 \text{ m}$ is hinged at center and laterally supported at one end by a spring of spring constant $k = 300 \text{ N/m}$. The natural frequency ω_n in rad/s is

a) 10

b) 20

c) 30

d) 40

39) A compression spring is made of music wire of 2mm diameter having a shear strength and shear modulus of 800MPa and 80 GPa respectively. The mean coil diameter is 20 mm, free length is 40 mm and the number of active coils is 10. If the mean coil diameter is reduced to 10 mm, the stiffness of the spring is approximately

- a) decreased by 8 times b) decreased by 2 times c) increased by 2 times. d) increased by 8 times.

40) A journal bearing has a shaft diameter of 40 mm and a length of 40 mm. The shaft is rotating at 20 rad/s and the viscosity of the lubricant is 20 mPas. The clearance is 0.020 mm. The loss of torque due to the viscosity of the lubricant is approximately

- a) 0.040 Nm b) 0.252 Nm c) 0.400 Nm d) 0.652 Nm.

41) A clutch has outer and inner diameters 100 mm and 40 mm respectively. Assuming a uniform pressure of 2 MPa and coefficient of friction of liner material 0.4, the torque carrying capacity of the clutch is

- a) 148 Nm b) 196 Nm c) 372 Nm d) 490 Nm

42) A spur gear has a module of 3 mm, number of teeth 16, a face width of 36 mm and a pressure angle of 20. It is transmitting a power of 3 kW at 20 rev/s. Taking a velocity factor of 1.5, and a form factor of 0.3, the stress in the gear tooth is about

- a) 32 MPa b) 46 MPa c) 58 MPa d) 70 MPa

43) Match the type of gears with their most appropriate description.

Type of gear	Description
P: Helical	1. Axes non-parallel and non-intersecting
Q: Spiral Bevel	2. Axes parallel and teeth are inclined to the axis
R: Hypoid	3. Axes parallel and teeth are parallel to the axis
S: Rack and pinion	4. Axes are perpendicular and intersecting, and teeth are inclined to the axis
	5. Axes are perpendicular and used for large speed reduction
	6. Axes parallel and one of the gears has infinite radius

a) P-2, Q-4, R-1, S-6

c) P-2, Q-6, R-4, S-2

b) P-1, Q-4, R-5, S-6

d) P-6, Q-3, R-1, S-5

44) A gas expands in a frictionless piston-cylinder arrangement. The expansion process is very slow, and is resisted by an ambient pressure of 100 kPa. During the expansion process, the pressure of the system (gas) remains constant at 300 kPa. The change in volume of the gas is 0.01 m^3 . The maximum amount of work that could be utilized from the above process is

- a) 0 KJ b) 1 kJ c) 2 KJ d) 3 KJ

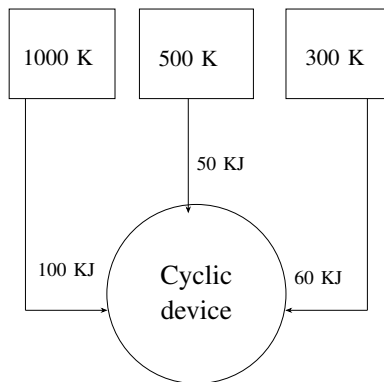
45) The logarithmic mean temperature difference (LMTD) of a counterflow heat exchanger is 20°C . The cold fluid enters at 20°C and the hot fluid enters at 100°C . Mass flow rate of the cold fluid is twice that of the hot fluid. Specific heat at constant pressure of the hot fluid is twice that of the cold fluid. The exit temperature of the cold fluid

- a) is 40°C c) is 30°C
b) is 60°C d) cannot be determined

46) A two dimensional fluid element rotates like a rigid body. At a point within the element, the pressure is 1 unit. Radius of the Mohr's circle, characterizing the state of stress at that point, is

- a) 0.5 unit b) 0 unit c) 1 unit d) 2 units

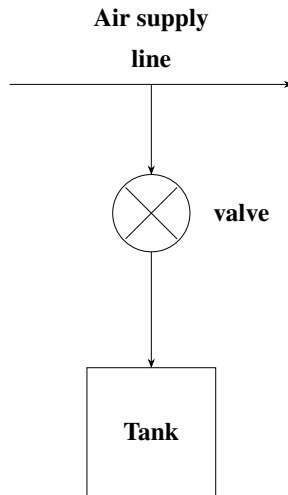
47) A cyclic device operates between three thermal reservoirs, as shown in the figure. Heat is transferred to/from the cyclic device. It is assumed that heat transfer between each thermal reservoir and the cyclic device takes place across negligible temperature difference. Interactions between the cyclic device and the respective thermal reservoirs that are shown in the figure are all in the form of heat transfer.



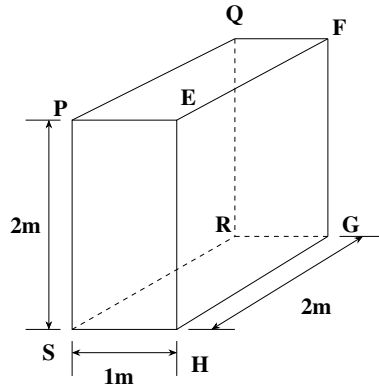
The cyclic device can be

- a) reversible heat engine
b) a reversible heat pump or a reversible refrigerator
c) an irreversible heat engine
d) an irreversible heat pump or an irreversible refrigerator
- 48) A balloon containing an ideal gas is initially kept in an evacuated and insulated room. The balloon ruptures and the gas fills up the entire room. Which one of the following statements is TRUE at the end of above process?

- a) The internal energy of the gas decreases from its initial value, but the enthalpy remains constant
 - b) The internal energy of the gas increases from its initial value, but the enthalpy remains constant
 - c) Both internal energy and enthalpy of the gas remain constant
 - d) Both internal energy and enthalpy of the gas increase
- 49) A rigid, insulated tank is initially evacuated. The tank is connected with a supply line through which air (assumed to be ideal gas with constant specific heats) passes at 1 MPa, 350°C . A valve connected with the supply line is opened and the tank is charged with air until the final pressure inside the tank reaches 1 MPa. The final temperature inside the tank

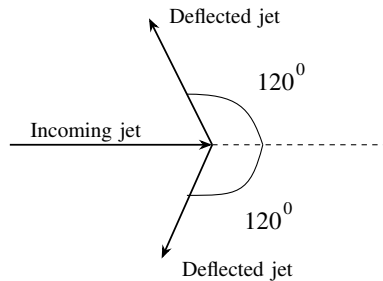


- a) is greater than 350°C
 - b) is less than 350°C
 - c) is equal to 350°C
 - d) may be greater than, less than, or equal to 350°C , depending on the volume of the tank
- 50) For the three-dimensional object shown in the figure below, five faces are insulated. The sixth face (PQRS), which is not insulated, interacts thermally with the ambient, with a convective heat transfer coefficient of $10\text{W}/\text{m}^2\cdot\text{K}$. The ambient temperature is 30°C . Heat is uniformly generated inside the object at the rate of $100\text{W}/\text{m}^3$. Assuming the face PQRS to be at uniform temperature, its steady state temperature is



- a) 10°C b) 20°C c) 30°C d) 40°C

51) Water, having a density of 1000kg/m^3 , issues from a nozzle with a velocity of 10m/s and the jet strikes a bucket mounted on a Pelton wheel. The wheel rotates at 10rad/s . The mean diameter of the wheel is 1m . The jet is split into two equal streams by the bucket, such that each stream is deflected by 120° , as shown in the figure, Friction in the bucket may be neglected. Magnitude of the torque exerted by the water on the wheel, per unit mass flow rate of the incoming jet, is



- a) $0(\text{N.m})/(\text{kg/s})$ c) $2.5(\text{N.m})/(\text{kg/s})$
 b) $1.25(\text{N.m})/(\text{kg/s})$ d) $3.75(\text{N.m})/(\text{kg/s})$