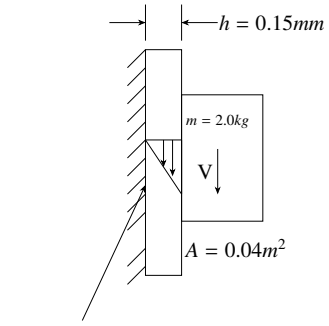
ASSIGNMENT-4
GATE ME-2018

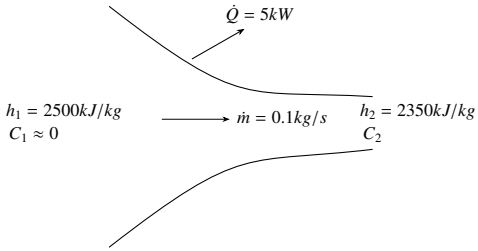
EE24BTECH11019 - DWARAK A

Q.26 to Q.55 carry two marks each.

1) A solid block of $2.0kg$ mass slides steadily at a velocity V along a vertical wall as shown in the figure below. A thin oil film of thickness $h = 0.15mm$ provides lubrication between the block and the wall. The surface area of the face of the block in contact with the oil film is $0.04m^2$. The velocity distribution within the oil film gap is linear as shown in the figure. Take dynamic viscosity of oil as $7 \times 10^{-3} Pa - s$ and acceleration due to gravity as $10m/s^2$. Neglect weight of the oil. The terminal velocity V (in m/s) of the block is _____ (correct to one decimal place).

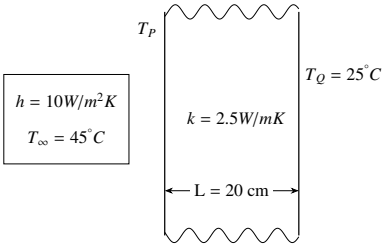


2) A tank of volume $0.05m^3$ contains a mixture of saturated water and saturated steam at $200°C$.The mass of the liquid present is $8kg$. The entropy (in kJ/kgK) of the mixture is _____ (correct to two decimal places).
   Property data for saturated steam and water are:
   At $200°C, p_{sat} = 1.5538MPa$
   $v_f = 0.001157m^3/kg, v_g = 0.12736m^3/kg$
   $s_{fg} = 4.1014kJ/kgK,\ s_f = 2.3309kJ/kgK$
3) Steam flows through a nozzle at a mass flow rate of $\dot{m} = 0.1kg/s$ with a heat loss of 5 kW. The enthalpies at inlet and exit are 2500 kJ/kg and 2350 kJ/kg, respectively. Assuming negligible velocity at inlet ($C_1 \approx 0$), the velocity C_2 of steam (in m/s) at the nozzle exit is _____ (correct to two decimal places).
4) An engine working on air standard Otto cycle is supplied with air at $0.1MPa$ and $35°C$. The compression ratio is 8. The heat supplied is $500kJ/kg$. Property data

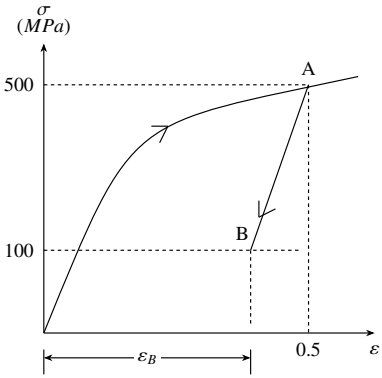


for air: $c_p = 1.005kJ/kgK$, $c_v = 0.718kJ/kgK$, $R = 0.287kJ/kgK$. The maximum temperature (in K) of the cycle is _____ (correct to one decimal place).

5) A plane slab of thickness L and thermal conductivity k is heated with a fluid on one side (P),and the other side (Q) is maintained at a constant temperature, T_Q of $25°C$, as shown in the figure. The fluid is at $45°C$ and the surface heat transfer coefficient, h, is $10W/m^2K$. The steady state temperature, T_P, (in $°C$) of the side which is exposed to the fluid is _____ (correct to two decimal places).



6) The true stress (σ) - true strain (ε) diagram of a strain hardening material is shown in figure. First, there is loading up to point **A**, i.e., up to stress of $500MPa$ and strain of 0.5. Then from point **A**, there is unloading up to point **B**, i.e., to stress of $100MPa$. Given that the Young's modulus $E = 200GPa$, the natural strain at point **B**(ε_B) is _____ (correct to two decimal places).



7) An orthogonal cutting operation is being carried out in which uncut thickness is $0.010mm$, cutting speed is $130m/min$, rake angle is $15°$ and width of cut is $6mm$. It is observed that the chip thickness is $0.015mm$, the cutting force is $60N$ and the thrust force is $25N$. The ratio of friction energy to total energy is _____ (correct to two decimal places).
8) A bar is compressed to half of its original length. The magnitude of true strain produced in the deformed bar is _____ (correct to two decimal places).
9) The minimum value of $3x + 5y$ such that:

$$3x + 5y \leq 15$$

$$4x + 9y \leq 8$$

$$13x + 2y \leq 2$$

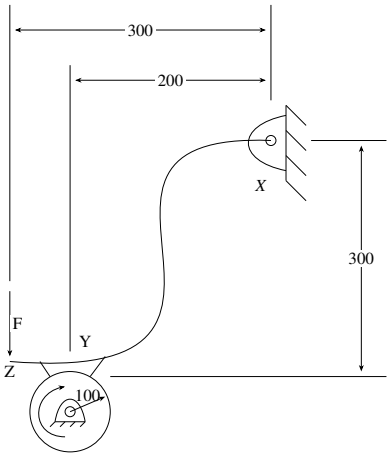
$$x \geq 0, y \geq 0$$

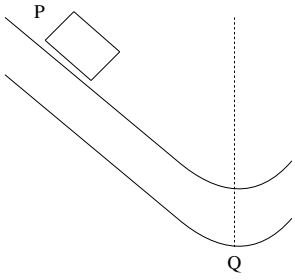
is _____.
10) Processing times (including setup times) and due dates for six jobs waiting to be processed at a work centre are given in the table. The average tardiness (in days) using shortest processing time rule is _____ (correct to two decimal places).

Job	Processing time (days)	Due date (days)
A	3	8
B	7	16
C	4	4
D	9	18
E	5	17
F	13	19

11) The schematic of an external drum rotating clockwise engaging with a short shoe is shown in the figure. The shoe is mounted at point **Y** on a rigid lever **XYZ** hinged at point **X**. A force $F = 100N$ is applied at the free end of the lever as shown. Given that the coefficient offriction between the shoe and the drum is 0.3, the braking torque (in Nm) applied on thedrum is _____ (correct to two decimal places).
12) Block P of mass $2kg$ slides down the surface and has a speed $20m/s$ at the lowest point, **Q**, where the local radius of curvature is $2m$ as shown in the figure. Assuming $g = 10m/s^2$, the normal force (in N) at **Q** is _____ (correct to two decimal places).

13) An electrochemical machining (ECM) is to be used to cut a through hole into a $12mm$ thick aluminum plate. The hole has a rectangular cross-section, $10mm \times 30mm$. The ECM operation will be accomplished in 2 minutes, with efficiency of 90%. Assuming specific removal rate for aluminum as $3.44 \times 10^{-2} mm^3/(As)$, the current (in A) required is _____ (correct to two decimal places).


300
200
X
300
F
Y
Z
100


P
Q