2021-ME-53-65

EE24BTECH11010 - Balaji B

1) Consider a single machine workstation to which jobs arrive according to a Poisson distribution with a mean arrival rate of 12 jobs/hour. The process time of the workstation is exponentially distributed with a mean of 4 minutes. The expected number of jobs at the workstation at any given point of time is _____ (round off to nearest integer).

[2021 ME]

2) An uninsulated cylindrical wire of radius $1.0mm$ produces electric heating at the rate of $5.0W/m$. The temperature of the surface of the wire is $75^{\circ}C$ when placed in air at $25^{\circ}C$. When the wire is coated with PVC of thickness $1.0mm$, the temperature of the surface of the wire reduces to $55^{\circ}C$. Assume that the heat generation rate from the wire and the convective heat transfer coefficient are same for both uninsulated wire and the coated wire. The thermal conductivity of PVC is _____ $W/m.K$(round off to two decimal places).

[2021 ME]

3) A solid sphere of radius $10mm$ is placed at the centroid of a hollow cubical enclosure of side length $30mm$. The outer surface of the sphere is denoted by 1 and the inner surface of the cube is denoted by 2. The view factor F_{22} for radiation heat transfer is _____ (round off to two decimal places).

[2021 ME]

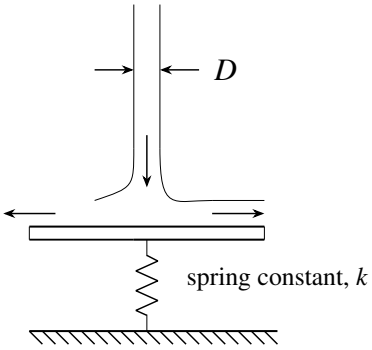
4) Consider a steam power plant operating on an ideal reheat Rankine cycle. The work input to the pump is $20kJ/kg$. The work output from the high pressure turbine is $750kJ/kg$. The work output from the low pressure turbine is $1500kJ/kg$. The thermal efficiency of the cycle is 50%. The enthalpy of saturated liquid and saturated vapour at condenser pressure are $200kJ/kg$ and $2600kJ/kg$, respectively. The quality of steam at the exit of the low pressure turbine is _____ % (round off to the nearest integer).

[2021 ME]

5) In the vicinity of the triple point, the equation of liquid-vapour boundary in the $P-T$ phase diagram for ammonia is $\log P = 24.38 - 3063/T$, where P is pressure (in Pa) and T is temperature (in K). Similarly, the solid-vapour boundary is given by $\log P = 27.92 - 3754/T$. The temperature at the triple point is _____K (round off to the nearest integer).

[2021 ME]

6) A cylindrical jet of water (density = $1000kg/m^3$) impinges at the center of a flat, circular plate and spreads radially outwards, as shown in the figure. The plate is resting on a linear spring with a spring constant $k = 1kN/m$. The incoming jet diameter is $D = 1cm$.



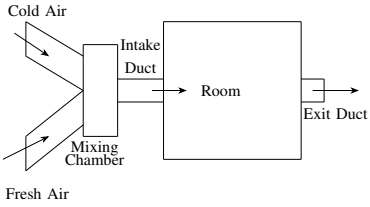
If the spring shows a steady deflection of $1cm$ upon impingement of jet, then the velocity of the incoming jet is _____ m/s (round off to one decimal places).

[2021 ME]

7) A single jet Pelton wheel operates at 300 rpm. The mean diameter of the wheel is $2m$. Operating head and dimensions of jet are such that water comes out of the jet with a velocity of $40m/s$ and flow rate of $5m^3/s$. The jet is deflected by the bucket at an angle of 165°. Neglecting all losses, the power developed by the Pelton wheel is _____ MW (round off to two decimal places)

[2021 ME]

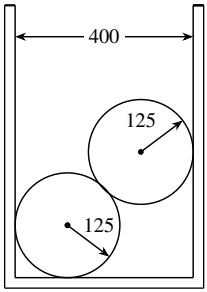
8) An air-conditioning system provides a continuous flow of air to a room using an intake duct and an exit duct, as shown in the figure. To maintain the quality of the indoor air, the intake duct supplies a mixture of fresh air with a cold air stream. The two streams are mixed in an insulated mixing chamber located upstream of the intake duct. Cold air enters the mixing chamber at $5^\circ C$, $105kPa$ with a volume flow rate of $1.25m^3/s$ during steady state operation. Fresh air enters the mixing chamber at $34^\circ C$ and $105kPa$. The mass flow rate of the fresh air is 1.6 times of the cold air stream. Air leaves the room through the exit duct at $24^\circ C$.



Assuming the air behaves as an ideal gas with $C_p = 1.005kJ/kq.K$ and $R = 0.287kJ/kg.K$, the rate of heat gain by the air from the room is _____ (round off to two decimal places).

[2021 ME]

9) Two smooth identical spheres each of radius $125mm$ and weight $100N$ rest in a horizontal channel having vertical walls. The distance between vertical walls of the channel is $400mm$.

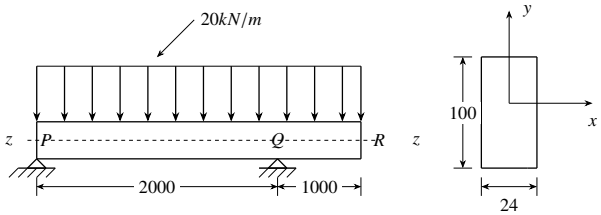


All dimensions are in *mm*

The reaction at the point of contact between two spheres is _____ N (round off to one decimal place).

[2021 ME]

10) An overhanging beam PQR is subjected to uniformly distributed load 20 kN/m as shown in the figure.

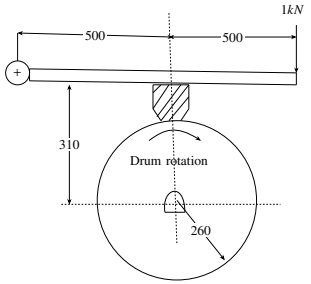


All Dimensions are in *mm*

The maximum bending stress developed in the beam is _____ MPa (round off to one decimal place).

[2021 ME]

11) A short shoe drum (radius 260mm) brake is shown in the figure. A force of 1kN is applied to the lever. The coefficient of friction is 0.4.

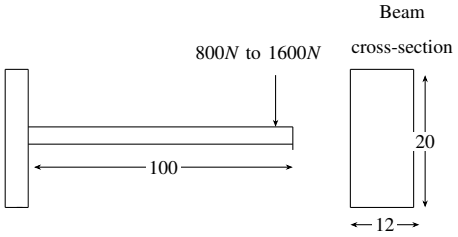


All dimension are in *mm*

The magnitude of the torque applied by the brake is _____$N.m$ (round off to one decimal place).

[2021 ME]

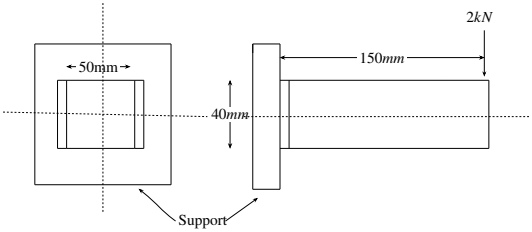
12) A machine part in the form of cantilever beam is subjected to fluctuating load as shown in the figure. The load varies from $800N$ to $1600N$. The modified endurance, yield and ultimate strengths of the material are $200MPa$, $500MPa$ and $600MPa$, respectively.



All dimension are in *mm*

The factor of safety of the beam using modified Goodman criterion is _____ (round off to one decimal place). [2021 ME]

13) A cantilever beam of rectangular cross-section is welded to a support by means of two fillet welds as shown in figure. A vertical load of 2 kN acts at free end of the beam.



Considering that the allowable shear stress in weld is $60N/mm^2$, the minimum size (leg) of the weld required is _____ *mm* (round off to one decimal place).

[2021 ME]