Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, January 2021

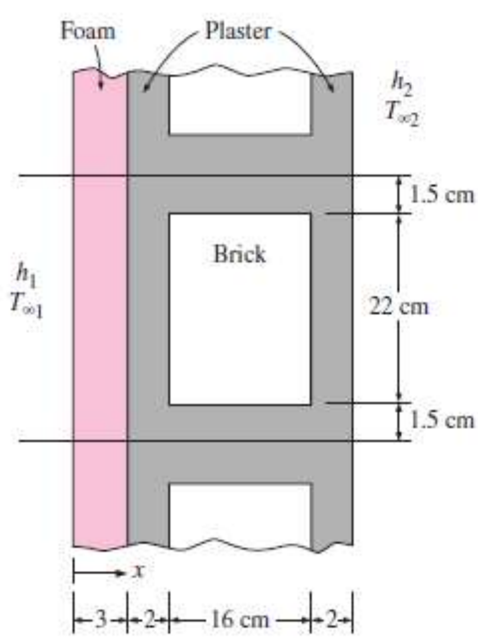
Course: Advanced Fluid Mechanics and Heat Transfer-ASEG7019 **Semester: I**
Programme: M.Tech CFD
Time: 03 hrs. **Max. Marks: 100**

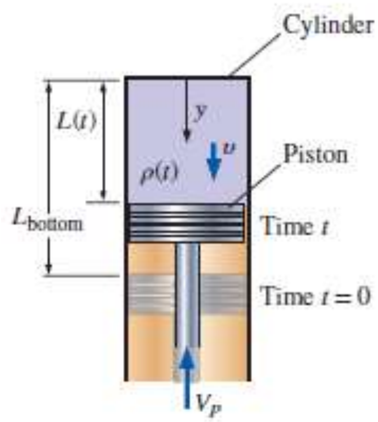
SECTION A

S. No.	This section is having six Question and all are Compulsory to answer	**Marks**	**CO**
Q 1	Consider laminar natural convection from a vertical hot plate. Will the heat flux be higher at the top or at the bottom of the plate? Why ?	**5**	**CO1**
Q 2	What is a boundary condition? How many boundary conditions do we need to specify for a two dimensional heat transfer problem?	**5**	**CO3**
Q 3	What does the coefficient of compressibility of a fluid represent? How does it differ from isothermal compressibility?	**5**	**CO1**
Q 4	Consider two identical small glass balls dropped into two identical containers, one filled with water and the other with oil. Which ball will reach the bottom of the container first? Why?	**5**	**CO1**
Q 5	Consider two identical fans, one at sea level and the other on top of a high mountain, running at identical speeds. How would you compare (a). the volume flow rates and (b). the mass flow rates of these two fans?	**5**	**CO2**
Q6.	Consider a sphere and a cylinder of equal volume made of copper. Both the sphere and the cylinder are initially at the same temperature and are exposed to convection in the same environment. Which do you think will cool faster, the cylinder or the sphere? Why?	**5**	**CO3**

SECTION B

Q 7	A steel ball [c=0.46 kJ/kg ^oC, k=35 W/m. ^oC] 5.0 cm in diameter and initially at a uniform temperature of 450^oC is suddenly placed in a controlled environment in which the temperature is maintained at 100^oC. The convection heat transfer coefficient is 10 W/m^2. ^oC. Calculate the time required for the ball to attain a temperature of 150^o C. Use the following data: ρ= 7800 kg/m^3, h = 10 W/m^2. ^oC,	**10**	**CO3**

Q 8	For a flow in the xy plane, the x component of velocity is given by $u=Ax^2y^2$, where A $=0.3\ m^{-3}.\ S^{-1}$, and x and y are measured in meters. Find a possible y component for steady incompressible flow. Is it also valid for unsteady, incompressible flow? Why? How many possible y components are there? Determine the equation of the streamline for the simplest y component of velocity. Plot the streamlines through (1,4) and (2,4) use approximate scale.	**10**	**CO2**
Q 9	A 3 m high and 5 m wide wall consists of long 16 cm × 22 cm cross section horizontal bricks (k=0.72 W/m .°C) separated by 3 cm thick plaster layers (k=0.22 W/m.°C) there are also 2 cm thick plaster layer on each side of the brick and 3 cm thick rigid foam (k=0.026 W/m. °C) on the inner side of the wall. The indoor and the outdoor temperatures are 20°C and -10°C, and the convection heat transfer coefficient on the inner and the outer sides are h_1=10 W/m². °C and h_2=25 W/m². °C, Respectively. Assuming one dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.  (OR) The velocity in a certain two dimentional flow field is given by the equation	**10**	**CO4**

	$$V = 2xt\hat{\imath} - 2yt\hat{\jmath}$$ Where the velocity is in ft/s when x, y and t are in feet and seconds, respectively. Determine expressions for the local and convective components of acceleration in the x and y directions what is the magnitude and direction of the velocity and the accelration at the point x=y= 1ft at the time t=0		
Q 10	An air fuel mixture is compressed by a piston in a cylinder of an internal combustion engine the origin of coordinate y is at the top of the cylinder, and y points straight down as shown. The piston is assumed to move up at constant speed V_p. The distance L between the top of the cylinder and the piston decreases with time according to the linear approximation $L=L_{bottom} - V_p\, t$, where L_{bottom} is the location of the piston when it is at the bottom of its cycle at time t=0, the density of the air-fuel mixture in the cylinder is every where equal to ρ(0), Estimate the density of the air fuel mixture as a function of time and the given parameters during the piston's up stroke. 	**10**	**CO3**
Q11	Air at 20^0 C flows past a 800 mm long plate at a velocity of 45 m/s. If the surface of the plate is maintained at 300^0 C determine (a). The heat transferred from the entire plate length to air taking into consideration both laminar and turbulent portions of the boundary layer, (b). the percentage error if the boundary layer is assumed to be turbulent from the leading edge of the plate. Assume unit width of the plate. Take the properties of air at 160^0C as thermal conductivity 0.03638 W/m K, $\upsilon = 30.08 \times 10^{-6}$ m^2/s, Pr= 0.682	**10**	**CO4**

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Laminar Region:

$$\overline{h} = 0.664\,\frac{k}{x_c}\,(\mathrm{Re}_c)^{0.5}\,(\mathrm{Pr})^{0.333}$$

Turbulent Region from the Leading edge:

$$\overline{h} = 0.036\,\frac{k}{L}\,\mathrm{Re}_L^{0.8}\,\mathrm{Pr}^{0.333}$$

Turbulent Boundary Layer Region:

$$\overline{h} = 0.036\,\frac{k}{L - x_c}\,[(\mathrm{Re}_L)^{0.8} - (\mathrm{Re}_c)^{0.8}]\,\mathrm{Pr}^{0.333}$$
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<td>Q 12</td>
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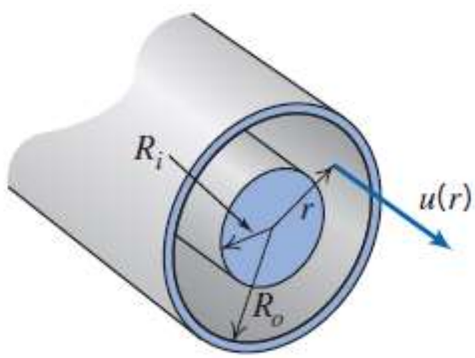
The velocity profile for laminar flow is an annulus is given by

$$u(r) = -\frac{\Delta p}{4\mu L}\left[R_o^2 - r^2 + \frac{R_o^2 - R_i^2}{\ln\left(\frac{R_i}{R_o}\right)}\ln\frac{R_o}{r}\right]$$



Where $\Delta p/L=-10$ kPa/m is the pressure gradient, μ is the viscosity (SAE 10 oil at 20^oC) 0.1 N.s/ m^2 and $R_o=5$ mm and $R_i= 1$ mm are the outer and inner radii. Find the volume flow rate, the average velocity, and the maximum velocity.
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(OR)

A chip is dissipating 0.6 W of power in a DIP with 12 pin leads. The materials
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and the dimensions of various sections of this electronic device are as given in the table below. If the temperature of the leads is 40°C, estimate the temperature at the junction of the chip.

The thermal conductivity of Silicon varies greatly with temperature from 153.5 W/m ^{0}C at 27^{0}C to 113.7 W/m.^{0}C at 100^{0}C and the value 120 W/m. ^{0}C reflects the anticipation that the temperature of the silicon chip will be close to 100 ^{0}C

Section and Material	Thermal Conductivity, W/m. ^{o}C	Thickness mm	Heat Transfer Surface Area
Junction Construction	-----	-----	Diameter 0.4 mm
Silicon Chip	120	0.4	3mm × 3mm
Eutectic bond	296	0.03	3 mm × 3 mm
Copper Lead frame	386	0.25	3mm × 3 mm
Plastic Separator	1	0.2	12 × 1 mm × 0.25 mm
Copper leads	386	5	12 × 1 mm × 0.25 mm