Module 6: Short questions

1. How does forced convection differ from natural convection? Is convection caused by wind forced or natural convection?

2. How does external forced convection differ from internal forced convection? Can a heat transfer system involve both internal and external convection at the same time? Give an example.

3. In which mode of heat transfer is the heat transfer coefficient usually higher: natural convection or forced convection?

4. What is the physical significance of the Nusselt number?

5. Distinguish between incompressible flow and incompressible fluid.

6. In forced convection, distinguish between upstream velocity and free stream velocity. For which type of flow are the two same?

7. What is the difference between skin friction drag and pressure drag? Which is usually significant for slender bodies such as airfoils?

8. For laminar flow over a flat plate, how do the local heat transfer coefficient and the friction coefficient vary with distance from the leading edge?

9. Define hydrodynamic entry length for flow in a tube. Is the entry length longer in laminar or turbulent flow?

10. How is thermal entry length defined for flow in a tube?

11. Consider the flow of oil in a circular tube. How will the hydrodynamic and thermal entry lengths compare if the flow is laminar? How would they compare if the flow is turbulent?

12. Consider the flow of mercury in a circular tube. How will the hydrodynamic and thermal entry lengths compare if the flow is laminar? How would they compare if the flow is turbulent?

13. How does Rayleigh number differ from Grashof number?

Multiple choice questions:

1) In a laminar boundary layer near a heated flat plate of zero emissivity, the heat flux away from the plate is due to
a) conduction
b) macroscopic eddies
c) thermal radiation
d) subspace waves
e) None of the above

2) A rectangular plate with the dimensions $L \times 2L$ is at a fixed temperature different than the fluid that surrounds it. Two orientations are considered with the plate parallel to an oncoming irrotational uniform flow 1) With the longer side normal to the oncoming flow 2)With the shorter side normal to the flow. Choose the true statement below
a) The heat transfer is always higher for configuration 1)
b) The heat transfer is always higher for configuration 2)
c) The Nusselt number increases with x until Re_x=2300
d) The heat transfer on either is higher if the boundary layer is tripped at $x = 0$
e) None of the above

3) In a staggered array of 1 cm tubes, the oncoming flow of 2 m/s gas ($\nu = 3 \times 10^{-5} m^2/s$) enters the bundle to cool it. If S_L = 2 cm, S_T = 3 cm, the Reynolds number used to calculate Nusselt number is:
a) 1000
b) 1111
c) 3333
d) 10000
e) None of the above

4) Choose the false statement for steady laminar flow in a circular pipe with uniform wall temperature unequal to the inlet fluid temperature
a) $hD/k = 3.66$ once the flow is fully developed
b) The Nusselt number in the development region is greater than the Nusselt number in the fully developed flow
c) When the flow is fully developed, the fluid temperature equals the wall temperature
d) The Reynolds number is less than 500000
e) None of the above

5) Two identical heated plates are exposed to still air, thus generating natural convection. One plate is vertical with a Grashof number of Gr_1, while the other faces down at an angle of 45 degrees and has a Grashof number of Gr_2. The ratio Gr_2/Gr_1 is
a) 0.5
b) 0.7071

c) 1
d) 1.414
e) None of the above

6) A 1 cm cylinder at 400 K is surrounded by still air at 300 K is inside the orbiting space shuttle ($\varepsilon = 1.0$). If $\nu^2 = 2 \times 10^{-10}$ m^4/s^2, the Grashof number is
a) 10^9
b) 10^{-9}
c) 14014
d) 7007
e) None of the above