Module 5: Short questions

1. What is lumped capacity analysis? When is it applicable? What is the physical significance of the Biot number?

2. The Biot number is used when considering a solid body subject to convection in a surrounding fluid. It is a comparison of
   a) Convection to conduction in the surrounding fluid
   b) Conduction in the surrounding fluid to conduction in the solid
   c) Convection at the solid surface to conduction within the solid
   d) The thermal diffusivity in the solid to the kinematic viscosity in the fluid
   e) None of the above

3. Consider heat transfer between two identical hot solid bodies and the surrounding air. The first solid is cooled by a fan, while the second one is cooled by natural convection in air. For which case is the lumped capacity assumption more applicable?

4. Consider a hot boiled potato kept on a plate and cooled by natural convection in air. During the first minute, the temperature drops by 10ºC. During the second minute, will the temperature drop be more than, less than or same as that during the first minute?

5. In what medium will the lumped capacity assumption more likely to be valid: in air or in water?

6. Consider a sphere and a cylinder of equal volume and made of copper. Both are heated to the same temperature and then kept in air for cooling. Which one is likely to cool faster?

7. A block of metal is cooled in a water bath. Its unsteady temperature is considered uniform and is thus modelled using a lumped capacitance method. The product of the block's resistance to convection and its lumped thermal capacitance is
   a) Bi
   b) Nu
   c) Fo
   d) τ
   e) None of the above

8. In transient heat transfer analysis, when is it proper to treat an actual cylinder as an infinitely long one, and when is it not?

9. Why are the transient temperature charts prepared using non-dimensionalised quantities such as the Biot and the Fourier numbers and not the actual variables such as thermal conductivity and time?

10. What is the physical significance of the Fourier number? Will the Fourier number of a specific transient heat transfer problem double if the time is doubled?

11. What is a semi-infinite medium? Give examples of solid bodies that can be treated as semi-infinite mediums for the purpose of transient heat transfer studies? Under what conditions can a plane wall be treated as a semi-infinite medium?

Multiple choice questions:

1) When modelling the unsteady conduction in a semi-infinite slab with convection at the surface, there is no geometric length scale with which to construct a Biot number. The appropriate length scale for this is therefore

(a) $(\alpha t)^{0.5}$
(b) αt
(c) $(ht)^{0.5}$
(d) $\rho c t$
(e) none of the above

2) The Biot number is used when considering a solid body subject to convection in a surrounding fluid. It is a comparison of
a) Convection to conduction in the surrounding fluid
b) Conduction in the surrounding fluid to conduction in the solid
c) Convection at the solid surface to conduction within the solid
d) The thermal diffusivity in the solid to the kinematic viscosity in the fluid
e) None of the above

3) A block of metal is cooled in a water bath. Its unsteady temperature is considered uniform and is thus modelled using a lumped capacitance method. The product of the block's resistance to convection and its lumped thermal capacitance is
a) Bi
b) Nu
c) Fo
d) τ
e) None of the above