

Module 4: Short questions

1. For what kind of problems in multidimensional heat transfer are analytical solutions possible? Name some common analytical methods in steady state multidimensional heat transfer?
2. What are the limitations of analytical methods? In spite of their limitations, why are analytical solutions useful?
3. What is meant by “shape factor” in two-dimensional heat transfer analysis? What is the advantage of using such a method? Is there a shape factor in 1D heat transfer?
4. How do numerical solution methods differ from analytical methods? What are the advantages and disadvantages of numerical and analytical methods?
5. What is the basis of energy balance method in numerical analysis? How does it differ from the formal finite difference method using Taylor series approximation? For a specified nodal network, will these two methods result in the same or a different set of equations?

6. Consider a medium in which the finite difference formulation of a general interior node is given in its simplest form as

$$\frac{T_{m-1} - 2T_m + T_{m+1}}{\Delta x^2} + \frac{\dot{q}_m}{k} = 0$$

- (a) Is heat transfer in this medium steady or transient?
 - (b) Is heat transfer one-, two-, or three-dimensional?
 - (c) Is there heat generation in the medium?
 - (d) Is the nodal spacing constant or variable?
 - (e) Is thermal conductivity of the medium constant or variable?
7. Consider a medium in which the finite difference formulation of a general interior node is given in its simplest form as

$$T_{left} + T_{top} + T_{right} + T_{bottom} - 4T_{node} + \frac{\dot{q}_m l^2}{k} = 0$$

- (a) Is heat transfer in this medium steady or transient?
 - (b) Is heat transfer one-, two-, or three-dimensional?
 - (c) Is there heat generation in the medium?
 - (d) Is the nodal spacing constant or variable?
 - (e) Is thermal conductivity of the medium constant or variable?
8. What is an irregular boundary? What is a practical way of handling irregular boundary surfaces with the finite difference method?
 9. When performing numerical calculations of heat diffusion on a structured Cartesian grid in two dimensions, a simplified form of the equations states that the

temperature at a node is simply the average of its four adjacent neighbours. What assumption is NOT required to allow this simplified form

- a) must have no heat generation
- b) must not be at a domain boundary
- c) must have uniform cell dimensions in both directions
- d) must be a solid medium