

Energy Systems Engineering

MTech Admission Test

May 18, 2003

Time 1 hour

Name: _____

Gate Registration: _____

Percentile: _____

Max. Marks: 45

1. If two geometrically similar objects, at initial temperature T_0 are cooked at a given surface temperature T_1 to the same dimensionless temperature distribution Θ , then the dimensionless time $\tau = \alpha t/L^2$ (where t is time, α is thermal diffusivity and L is some characteristic length), will have to be same for both the objects. Using this concept find the time required to boil a 50g potato when it is known that the time required to boil a 10g potato is 5 min. [5]
2. Sketch the function $y = f(x)$ for $10 \geq x \geq 0$ where it is given that $f(0) = 1$, $f(1) = 2$, $f(4) = -1$, $f(x) \rightarrow 0$ as $x \rightarrow \infty$. It is known that $f(x)$ is differentiable and has a maximum at $x=1$, a minimum at $x=4$, and a point of inflection at $x=2$. [3]
3. Maximize the function $f(x) = \ln x - 3x^2$ [3]
4. Obtain a general solution of the differential equation $\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 4y = 0$. [5]
5. Properties of a certain fluid are related as follows: $u = 196 + 0.718 t$ and $pv = 0.287 (t + 273)$, where u is the specific internal energy (kJ/kg), t is the temperature ($^{\circ}\text{C}$), p is pressure (kN/m²) and v is the specific volume (m³/kg). Find c_p and c_v for this fluid. [2]
6. Following Kirchhoff's laws, prove that if two ideal current sources are connected in series, then they must be equal. [3]
7. If 20 kJ of heat is added to a Carnot cycle at a temperature of 100°C and 14.6 kJ of heat is rejected at 0°C , determine the location of absolute zero on the Celsius scale. [3]
8. The full-load speed of a 50 Hz induction motor is 460 rpm. Find the number of poles and the slip at full-load. [4]
9. A voltage source of V volts and internal resistance of r ohm supplies current to a coil for heating water. Calculate the resistance R of the coil so that (i) heating takes place most rapidly, and (ii) $\frac{3}{4}$ of the total energy developed by the source is absorbed by the water. [5]