Engineering Applications

Ch. 8

Engineering Applications

Examples of practical problems that require solutions for implicit variables (I.e., an algebraic solution is not possible)

- Fluid Mechanics – Moody Diagram – Colebrook formula for determining friction factors is pipe flow

$$\frac{1}{f^{0.5}} = -2.0\log\left(\frac{e/D}{3.7} + \frac{2.51}{\mathrm{Re}\, f^{0.5}}\right)$$

Using successive substitution, recast the equation:

$$f_{i+1} = \left(-2.0\log\left(\frac{e/D}{3.7} + \frac{2.51}{\mathrm{Re}\, f_i^{0.5}}\right)\right)^{-2}$$

Engineering Applications

2. Thermodynamics – Ideal gas specific heats

$$C_p = a + bT + cT^2 + dT^3$$

T = absolute temperature (K)

C_p = Specific heat (KJ/kmol-K)

- Determine the temperature for which Cp = 35.0 KJ/kmol-K.

$$\left.\begin{aligned} a &= 25.48 \\ b &= 1.52\times10^{-2} \\ c &= -0.7155\times10^{-5} \\ d &= 1.52\times10^{-9} \end{aligned}\right\}\ \text{Constants for } O_2$$

Engineering Applications

2. <u>Thermodynamics</u> – Ideal gas specific heats

$$f(T)=a+bT+cT^2+dT^3-C_p=0$$

$$f(T)=25.48+1.52\times10^{-2}T-0.7155\times10^{-5}T^2+1.312\times10^{-9}T^3-35.0=0$$

If we use the **Newton-Raphson** Technique we need *f'(x)*

$$f'(T)=1.52\times10^{-2}-1.43\times10^{-5}T+3.936\times10^{-9}T^2=0$$

$$T_{i+1}=T_i-\frac{f(T_i)}{f'(T_i)}$$

Engineering Applications

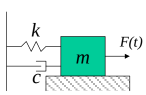
3. <u>Vibration Analysis</u> – Linear Dynamic Systems

$$m\ddot{x}+c\dot{x}+kx=F(t)$$

$$x(t)=e^{rt}$$ → Assume exponential solution

$$\dot{x}(t)=re^{rt}$$

$$\ddot{x}(t)=re^{rt}$$



Characteristic Equation for the Homogeneous problem

$$mr^2+cr+k=0$$