Answer to Selected Chapter-end Problems of Chapter 7

ME 130-01 Applied Engineering Analysis

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7-1) $u(x) = K e^{10x}$ K = constant

7-2) $u(x) = -\frac{3}{2} + K e^{2x}$ K = constant

7-3) $u(x) = -\frac{2}{\ln \frac{Cx}{x+2}}$ C = constant

7-4) $u(x) = -2x \ln Kx$ K = constant

7-5) $u(x) = \frac{3}{2} e^{2x} - \frac{1}{2}$

7-6) $u(x) = x + 9/x$

7-7) $t_e = 46.33$ s

7-8) (a) $\frac{dH(t)}{dt} = -\sqrt{2g}\left(\frac{\pi d^2}{4LW}\sqrt{H(t)}\right)$

(b) $H(t) = \left[-\sqrt{\frac{g}{2}}\frac{\pi d^2}{4LW}t + \sqrt{D}\right]^2$

(c) $t_e = 12.55$ hrs

7-9) $\frac{y^2}{\sqrt{y}}\frac{dy(t)}{dt} + \frac{d^2}{12}\sqrt{2g} = 0$

$t_e = 4.372$ min.

7-10) $[-57740 y^{-\frac{1}{2}} + 115.48 y^{\frac{1}{2}}]\frac{dy(t)}{dt} = 323564.96$

$t_e = 5.31$ s

7-11) (a) $V = 2186\ cm^3$

(b) $0.533344[y(t)]^{2.5} + 11.591[y(t)]^{1.5} + 113.36[y(t)]^{0.5} = -2510.2t + 988.3676$

(c) $t_e = 0.4$ s

7-12) (b) $H = 13.416$ cm

(c) $\frac{[y(t)]^{1.5}}{3}\frac{dy(t)}{dt} = -\frac{(1.5)^2}{4}\sqrt{2\times 981} = -24.9156$

$[y(t)]^{\frac{5}{2}} = -186.8673\,t + 659.7529$

$te = 3.53$ s

7-13) (a) Top volume $V_1 = 703.72\ cm^3$

Bottom volume $V_2 = 134\ cm^3$

$\therefore$ Total volume $V = 837.72\ cm^3$

(b) Time for draining the IV bottle:

Top portion: $te_1 = 67.6$ s

Bottom portion: $te_2 = 12.04$ s

(c) $L = 21.22$ cm

$te = 83.2 + 12.04 = 95.24$ s

7-14) (a) 23.56 kW, (b) $T(x) = 140 - 120x$

7-15) (a) $T(t) = 92\,e^{-2\times10^{-6}\alpha t} + 8$

$\alpha = 265.88\ /m^2\text{-}s$ for $T(2hrs) = 10^\circ C$

(b) $\alpha = 531.76\ /m^2\text{-}s$ to shorten cooling time to 1 hour.

7-16) (a) $T(t) = 80\exp(-3.2\times10^{-4}t) - 60$

(b) $-59.73^\circ C$

(c) required time = 1.2 hour

(d) Increas α to shorten the cooling time to $-40^\circ C$

7-17) similar to Problem 7-16)

7-18) (a) $\frac{dT(t)}{dt} = -\alpha A [T(t) - T_f]$

$T(t) = 100 e^{-0.02t} - 80$

(b) $T(1200s) = -76.23°C$

(c) $T(t_e) = -40 \rightarrow t_e = 45s$

(d) $\alpha = 0.06363 / m^2 - s$

7-19) (a) $\frac{dV(t)}{dt} + \frac{c}{m} V(t) = -g$

(b) $\frac{dV(t)}{dt} + \frac{c}{m} V(t) = +g$

(c) $V(t) = -\frac{mg}{c} + (V_0 + \frac{mg}{c}) e^{-\frac{c}{m}t}$

(d) $V(t) = \frac{mg}{c}(1 - e^{-\frac{c}{m}t})$

with $V(0) = 0$

(e) Max. height (H_{max}) and the time to reach this height (t_m):

$H_{max.} = \int_0^{t_m} V(t)\,dt$

$= 47.89 m$

$t_m = 1.871 s$

7-20) (a) $m \frac{dV(t)}{dt} + 20[v(t)]^2 = mg$

$\rightarrow 5.097 \frac{dV(t)}{dt} = 50 - [V(t)]^2$

(b) $V(t) = \frac{7.071(e^{6.3817t} - 1)}{1 + e^{6.3817t}}$

(c) Time to reach ground $t_e = 2.72$ min.

(d) Impact velocity $V_f \approx 7.071$ m/s

(e) momentum at landing $= mV_f = 720.8$ kg-m/s