Chapter **31** (Benson)

E01 $\Delta\phi = BA(\cos 120^0 - 1) = -2.52\text{mWb}$.

E04 $L = 5\,\text{cm}$, $R = 0.2\,\Omega$, $B = 0.25\,\text{T}$ & $I = 2\,\text{A}$: (**a**) $\mathcal{E} = BLv$, $v = IR/BL = 32\,\text{m/s}$; (**b**) $F_{ext} = ILB = 2.5\times10^{-2}\,\text{N}$.

E07 $N_c = 12$, $R_c = 3\,\text{cm}$, $I_s = 4.8\sin(60\pi t)\,\text{A}$, $L_s = 30\,\text{cm}$, $N_s = 240$ & $R_s = 2\,\text{cm}$. $\mathcal{E} = -N_c d\phi/dt = -N_c A_c dB_s/dt = -\mu_0(N_s/L_s)N_c A_c dI_s/dt$. Find $\mathcal{E} = -30.9\cos(60\pi t)\,\text{mV}$.

E10 $B = 0.18\,\text{T}$, $v = 20\,\text{m/s}$, $R = 1.2\,\Omega$ & $L = 0.25\,\text{m}$: (**a**) $\mathcal{E} = BLv = 0.9\,\text{V}$; (**b**) $F_m = ILB = (\mathcal{E}/R)LB = 3.38\times10^{-2}\,\text{N}$ (**c**) $I^2R = 0.675\,\text{W}$; (**d**) $Fv = 0.675\,\text{W}$

E15 (**a**) $F_y = mg - ILB = 0$, where $I = \mathcal{E}/R = BLv/R$. Thus $v_T = mgR/(BL)^2$; (**b**) $U_g = mgy$, $dU_g/dt = -mgv_T = -(mg/BL)^2R$. $P_{ele} = I^2R = (mg/BL)^2R$.

E21 (**a**) $\mathcal{E}_0 = NAB\omega = 0.201\,\text{V}$; (**b**) $\tau = \mu B = NIAB = N(\mathcal{E}_0/R)AB = 7.15\times10^{-4}\,\text{N·m}$.

E24 $\int \vec{E}\cdot d\vec{l}$ is not zero even though $d\phi_B/dt = 0$.

E29 $\mathcal{E} = \pi f BR^2$, $f = 119\,\text{rev/s} = 7150\,\text{rpm}$.

E34 (**a**) $I = NAB\omega/(R + r) = 0.014\,\omega$, $P_R = I^2R = 12$, so $\omega = 151\,\text{rad/s}$; (**b**) Maximum $\tau = \mu B = NIAB = 8.86\times10^2\,\text{N·m}$.

P01 $E_x = Bv = (\mu_0 I/2\pi x)v$, $\Delta V = \int_d^{d+L} E_x dx = (\mu_0 Iv/2\pi)\ln[(d + L)/d]$.

P03 (**a**) $a = dv/dt = -(ILB)/m$, where $I = \mathcal{E}/R = (BLv)/R$. $dv/dt = -(LB)^2v/mR$, so $\int dv/v = -\int (LB)^2 dt/mR$. With $\tau \equiv mR/(LB)^2$, find $v = v_0\exp(-t/\tau)$; (**b**) $dx = v_0\exp(-t/\tau)dt$, so $\Delta x = \int dx = v_0\tau$; (**c**) Energy loss $= \int P dt = \int (\mathcal{E}^2/R)dt = [(BLv_0)^2/R] \int \exp(-2t/\tau)dt = (BLv_0)^2\tau/2R = mv_0^2/2$. (Teacher: Jyh-Shinn Yang, 90.06.06)

P07 $I = I_0\sin(\omega t)$. $d\phi = BdA = (\mu_0 I/2\pi x)(cdx)$, thus $\phi = \int d\phi = (\mu_0 Ic/2\pi)\ln[(b + a)/a]$; $\mathcal{E} = d\phi/dt = (\mu_0\omega I_0 c/2\pi)\ln[(b + a)/a]\,\cos(\omega t)$.

P08 (**a**) $I = (\mathcal{E}_0 - BLv)/R$ and $F = ILB = mdv/dt$; (**b**) Set $dv/dt = 0$ to have $v_T = \mathcal{E}_0/BL$.