Programme-Specific Formulae for Transposition

This resource has been designed to help mathematics lecturers teaching transposition. Rather than using abstract equations, mathematics lecturers can use equations and formulae that students have seen or will see in their programme modules.

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1 Biology Formulae

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{Molarity}_1\text{Volume}_1 = \text{Molarity}_2\text{Volume}_2$$

$$\text{Concentration} = \frac{\text{mass}}{\text{volumne}} \times \frac{1}{\text{molecular weight}}$$

$$\%\ \text{mass} = \frac{\text{mass solute}}{\text{mass solution}} \times 100\%$$

$$\text{molality} = \frac{\text{moles solute}}{\text{mass solvent}}$$

$$\text{molarity} = \frac{\text{moles solute}}{\text{volume solution}}$$

$$A = \varepsilon C L$$

$$C_1 V_1 = C_2 V_2$$

$$Q = mc\Delta T$$

$$Q = ml$$

$$Q = \frac{kA\Delta T\, t}{d}$$

$$H = \frac{kA\Delta T}{d}$$

$$Q = e\sigma A T^4 t$$

$$H = e\sigma A T^4$$

$$H = e\sigma A(T^4_{\text{surface}} - T^4_{\text{environment}})$$

$$H = \frac{A\Delta T}{R_1 + R_2}$$

$$R = \frac{d}{k}$$

$$n_1 \sin\theta_i = n_2 \sin\theta_r$$

$$\frac{n_1}{n_2} = \frac{\text{Real depth}}{\text{Apparent Depth}}$$

$$\frac{1}{f} = (n-1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

$$m = -\frac{v}{u}$$

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

$$m_\theta = \frac{\theta'}{\theta} = \frac{P_n}{u} = \left(\frac{1}{f} - \frac{1}{v}\right) P_n$$

$$n\lambda = d\sin\theta$$

$$y = \frac{n\lambda L}{d}$$

$$\Delta l = l_0 \alpha \Delta T$$

$$\log_{10}(K_a) = \log_{10}([H^+]) + \log_{10}\left(\frac{[A^-]}{[\text{HA}]}\right)$$

$$\text{pH} = \text{pK}_a + \log_{10}\left(\frac{[A^-]}{[\text{HA}]}\right).$$

2 Civil & Structural Engineering Formulae

Soil Mechanics

$$\rho = \rho_d(1+w)$$

$$S_r e = w\,G_s$$

$$\rho_d = \frac{G_s\,\rho_w}{1+e}$$

$$\rho_d = \frac{G_s\,\rho_w}{1+w\,G_s}(1-A_v)$$

$$k = \frac{q\,\ln\left(\frac{r_2}{r_1}\right)}{2\pi D(h_2-h_1)}$$

$$k = \frac{q\,\ln\left(\frac{r_2}{r_1}\right)}{\pi(h_2^2-h_1^2)}$$

Geotech

$$q_{\max} = \frac{V}{B} + \frac{6V\,e}{B^2}$$

$$z = \frac{2c_u}{\gamma}$$

$$q_{\max} = \frac{2V}{3x}$$

$$F = \frac{c_u R^2 \theta}{W d}$$

$$\sigma'_{\text{ha}} = K_a \sigma'_v - 2c'\sqrt{K_a}$$

$$\text{FOS} = \left(1 - \frac{\gamma_w h}{\gamma z}\right)\frac{\tan\phi'}{\tan\beta}$$

$$\text{FOS} = \frac{c' + (\gamma z - \gamma_w h)(\cos^2\beta)(\tan\phi')}{\gamma z(\sin\beta)(\cos\beta)}$$

$$s_c = m_v \Delta\sigma' H$$

Wastewater

$$\frac{F}{M} = \frac{QS_0}{XV}$$

$$F_T = 1.072^{T-15}$$

$$\text{BOD removal efficiency} = \frac{t}{0.018 + 0.02t}$$

$$\text{SS removal efficiency} = \frac{t}{0.0075 + 0.014t}$$

Structures

$$\delta = \frac{PL^3}{3EI}$$

$$k = \frac{3EI}{L^3}$$

$$\omega = \sqrt{\frac{3EI}{ML^3}}$$

$$T = 2\pi\sqrt{\frac{mL^3}{3EI}}$$

$$\delta = \frac{PL^3}{48EI}$$

$$k = \frac{48EI}{L^3}$$

$$\omega = \sqrt{\frac{48EI}{ML^3}}$$

$$T = 2\pi\sqrt{\frac{ML^3}{48EI}}$$

$$G = \frac{E}{2(1+v)}$$

$$\omega_d = \omega\sqrt{1-\xi^2}$$

Hydrology, Hydraulics and Flood Control

$$\rho = \frac{M}{V}$$

$$w = \rho g$$

$$P = \rho g h$$

$$F = \rho g h_G A$$

$$h_P = h_G + \frac{I_G}{A h_G}$$

$$I_G = \frac{LD^3}{12}$$

$$F = \frac{\rho g h^2}{12}$$

$$\text{Moment} = \frac{\rho g h^3}{6}$$

$$F = \rho g V$$

$$Q = AV$$

$$\text{Reynolds Number} = \text{Re} = \frac{\rho V D}{\mu}$$

$$\text{Re} = \frac{VD}{\nu}$$

$$P_1 A_1 - P_2 A_2 \cos\theta - F_{Rx} = \rho Q^* (V_2 \cos\theta - V_1)$$

$$F_{\text{Ry}} - P_2 A_2 \sin\theta = \rho Q^* (V_2 \sin\theta)$$

$$H_f = \frac{4 f L V^2}{2gD}$$

$$R = \frac{A}{P}$$

$$V = (1/n) R^{2/3} S_O^{2/3}$$

$$V = C (R S_O)^{1/2}$$

$$\frac{\delta P}{h} = \frac{180 \mu V (1 - e^2)}{e^3 d^2}$$

$$V_S = \frac{g D^2 (SG - 1)}{18\nu}$$

$$\text{(Dillon Equation)} \qquad I = 152.4 \cdot \frac{T_p^{\frac{1}{5}}}{t^{\frac{3}{5}}}$$

$$\text{(Bilham Equation)} \qquad R = 25.4 \cdot \left(\frac{t}{48N} \right)^{0.282} - 2.54.$$

Design

Solve for d:

$$\frac{6 M_y}{b d^2} = f_b.$$

Solve for A:

$$\frac{P}{A} = f$$

Solve for P:

$$\frac{P}{A} = f$$

Solve for d:

$$\frac{P}{bd} = f$$

3 Elec. Engineering Formulae

$$f_r = \frac{1}{2\pi} \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$I_D = I_s \left(e^{\frac{q V_d}{N k T}} - 1 \right)$$

Industrial Electronics

$$V = IR$$

$$P = VI$$

$$P = RI^2$$

$$R = R_1 + R_2$$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$C = \frac{Q}{V}$$

$$V(t) = V_s(1 - e^{-t/RC})$$

$$\beta = \frac{I_C}{I_B}$$

Electronic Engineering

$$R_f = \frac{1}{2\pi f_C C}$$

$$V_0 = D \cdot V_S$$

$$V_0 = \frac{V_S}{1 - D}$$

$$\frac{\Delta V_0}{V_0} = \frac{D}{RCf}$$

4 Mechanical Engineering Formulae

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}$$

$$F_{\text{centrifugal}} = Mr\omega^2 = \frac{Mv^2}{r}$$

$$\omega = \sqrt{\frac{g}{L}}$$

$$\omega = \sqrt{\frac{k}{M}}$$

$$x = \frac{\frac{F}{m}}{\omega_n^2 - \omega_f^2}$$

Stress and Strain; Forces and Materials

$$F = -ks$$

$$\sigma = \frac{F}{A}$$

$$\varepsilon = \frac{x}{L}$$

$$E = \frac{\sigma}{\varepsilon}$$

$$\rho = \frac{m}{v}$$

$$\mu = \frac{F}{R}$$

$$p = \frac{F}{A}$$

$$p = \rho g h$$

$$T = A p_c$$

$$P \propto \frac{1}{V}$$

$$\%\ \text{Elongation} = \frac{\text{increase in length}}{\text{original length}} \times 100\%$$

$$\text{Area of Circle} = \pi r^2 = \frac{\pi d^2}{4}$$

$$\text{Area of Rectangle} = \text{width} \times \text{depth}$$

Momentum, Forces, & Uniform Motion

$$\text{momentum} = m \times v$$

$$W = m \times g$$

$$F = m \times a$$

$$v = \frac{s}{t}$$

$$v = u + at$$

$$s = \frac{1}{2}(u+v)t$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$v_1 - v_2 = -e(u_1 - u_2)$$

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

$$I = \int F\, dt = mv - mu$$

$$\text{horizontal component of force} = F \cos\theta$$

$$\text{vertical component of force} = F \sin\theta$$

$$\text{Moment} = F \times x$$

$$\tau = Fd$$

Circular & Simple Harmonic Motion

$$\theta = \frac{s}{r}$$

$$\omega = \frac{\theta}{t}$$

$$v = r\omega$$

$$a = r\omega^2 = \frac{v^2}{r}$$

$$F = mr\omega^2 = \frac{mv^2}{r}$$

$$I = I\omega = rmv$$

$$E = \frac{1}{2}I\omega^2$$

$$a = -\omega^2 x$$

$$T = \frac{1}{f} = \frac{2\pi}{\omega}$$

$$s = A\sin(\omega t_\alpha)$$

$$v = \omega\sqrt{a^2 - x^2}$$

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$T = 2\pi\sqrt{\frac{I}{mgh}}$$

Expansion & Compression of Gases

$$\frac{P_1V_1}{T} = \frac{P_2V_2}{T_2}$$

$$PV = mRT$$

$$P_1V_1^n = P_2V_2^n$$

Heat & Thermal Expansion

$$Q = c \cdot m \cdot \Delta t$$

$$x = \alpha \cdot \Delta t \cdot L$$

$$\Delta A = \beta \cdot \Delta t \cdot A$$

$$\Delta A = 2\alpha \cdot \Delta t \cdot A$$

$$\Delta V = \gamma \cdot \Delta t \cdot V$$

$$\Delta V = 3\alpha \cdot \Delta t \cdot V$$

$$\frac{c_1^2}{2} + gz_1 + p_1v_1 + u_2 + Q = \frac{c_2^2}{2} + gz_2 + p_2v_2 + u_2 + W.$$

Fluids

$$\frac{1}{\sqrt{f}} = -1.8\ \log\left[\frac{6.9}{\mathrm{Re}} + \left(\frac{k/d_i}{3.71}\right)^{1.11}\right]$$

$$\frac{\Delta P}{L} = \frac{r\rho V^2}{2d_i}$$

5 Management & Enterprise Formulae

Economics

$$TC = a + bx$$

$$\text{PED} = \frac{\text{\% change in Sales Demand}}{\text{\% change in Sales Price}}$$

$$\%\Delta Q_d = \frac{Q_2 - Q_1}{Q_1} \times \frac{100}{1}\%$$

$$\%\Delta P = \frac{P_2 - P_1}{P_1} \times \frac{100}{1}\%$$

$$\%\Delta Y = \frac{Y_2 - Y_1}{Y_1}$$

$$P = a - bx$$

$$\text{MR} = a - 2bx$$

$$\text{ROI} = \frac{\text{Profit}}{\text{Capital Invested}} \times 100\%$$

$$\text{Residual Income} = \text{Profit pa} - \text{ Targeted return rate}$$

$$q_{\max} = \frac{V}{B} + \frac{6V\,e}{B^2}$$

$$K_e = \frac{D_1}{P_0} + G$$

$$K_p = \frac{D_0}{P_0}$$

$$K_{d,\text{irred}} = \frac{i(1-t)}{MVd}$$

$$\text{APL} = \frac{Q}{\text{no. of workers}}$$

$$\text{MPL} = \frac{\Delta Q}{\Delta\text{no. of workers}}$$

$$\text{TC} = \text{FC} + \text{VC}$$

$$\text{MC} = \frac{\Delta\,\text{TC}}{\Delta\,\text{Q}}$$

$$\text{AVC} = \frac{\text{VC}}{Q}$$

$$\text{ATC} = \frac{\text{TC}}{Q}$$

$$\text{TR} = P \times Q$$

$$\text{MR} = \frac{\Delta\,\text{TR}}{\Delta Q}$$

$$\text{Profit} = \text{TR} - \text{TC}$$

$$Q_s = c + dP$$

$$C = a + bYd$$

$$\text{ARR} = \frac{\text{Average income per year}}{\text{Initial capital}} \times \frac{100}{1}.$$

$$\text{FV} = P(1+i)^n$$

$$P = \frac{A}{(1+i)^n}$$

$$\text{IRR} = \frac{N_1 r_2 - N_2 r_1}{N_1 - N_2}$$

Accountancy

$$\text{Debt Equity Ratio} = \frac{\text{Total Value of Debt}}{\text{Total Value of Equity}}$$

$$\text{Dividend Cover} = \frac{\text{Earnings per Share}}{\text{Dividend per Share}}$$

$$\text{Dividend per Share} = \frac{\text{Total Dividends to Ordinary Shareholders}}{\text{Number of ordinary shares issued}}$$

$$\text{Price Earnings Ratio} = \frac{\text{Market Price per Share}}{\text{Earnings per Share}}$$

$$\text{Indicative Share Price} = \frac{D_1}{r - g}$$

$$R_s = R_f + \beta(R_f - R_m)$$

$$\text{Trade Receivables Days} = \frac{\text{Trade Receivables}}{\text{Credit Revenue}} \times 365$$

$$\text{Trade Payable Days} = \frac{\text{Trade Payables}}{\text{Credit Purchases}} \times 365$$

$$\text{Inventory Days} = \frac{\text{Average Inventory}}{\text{Cost of Sales}} \times 365$$

$$\text{Cash Conversion Cycle} = \text{Trade Receivable Days} + \text{Inventory Days} - \text{Trade Payable Days}$$

6 Physical Sciences Formulae

Chemistry

$$PV = nRT$$

$$V = aT$$

$$P = b\frac{1}{V}$$

$$V = cn$$

$$\chi_j = \frac{n_j}{\sum_i n_i}$$

$$c = \left(\frac{3RT}{M}\right)^{\frac{1}{2}}$$

$$\left(P + a\left(\frac{n}{V}\right)^2\right)(V - nb) = nRT$$

$$C = \frac{n}{V}$$

$$n = \frac{m}{M_r}$$

$$b = \frac{n}{m}\frac{\text{mol}}{\text{kg}}$$

$$\text{ppm} = \frac{m}{V}\frac{\text{mg}}{\text{L}}$$

$$\rho = \frac{m}{V}$$

$$\text{pH} = -\log_{10}\left[H^+\right]$$

$$\text{p}K_\text{a} = -\log_{10}(K_a)$$

$$\text{pH} = \text{p}K_\text{a} - \log_{10}\left(\frac{[\text{Salt}]}{[\text{Acid}]}\right)$$

$$\Delta U = q + w$$

$$q = C \cdot \Delta T$$

$$q = m \cdot c \cdot \Delta T$$

$$H = U + PV$$

$$\Delta H = \Delta U + \Delta(PV)$$

$$\Delta H = \Delta U + P\Delta V + V\Delta P$$

$$\Delta H = \Delta U + p\Delta V$$

$$\Delta H = \Delta U + \Delta n_g RT$$

$$\Delta S^\ominus = \Sigma\nu S^\ominus{}_{\text{products}} - \Sigma\nu S^\ominus{}_{\text{reactants}}$$

$$\Delta G = \Delta H - T\Delta S$$

$$E = E^0 - \frac{RT}{nF}\ln\left(\frac{\text{Red}}{\text{Ox}}\right)$$

$$E = E^0 - \frac{RT}{nF}\ln\left(\frac{[D]^d\,[E]^e}{[A]^a\,[B]^b}\right)$$

$$\Delta G = -nFE$$

Instrumentation

$$R_T = R_0(1 + \alpha T)$$

$$V_0 = \frac{V_\text{EX}}{4} \cdot \varepsilon \cdot GF$$

$$\sigma_m = 2 \cdot \sigma_0\sqrt{\frac{a}{\rho_t}}$$

$$T = T_f + (T_0 - T_f)e^{-t/\tau}$$

$$I = I_0 e^{-\mu t}$$

Optics

$$c = f\lambda$$

$$f_R = (1+\beta) f_S$$

$$f_R = \sqrt{\frac{1+\beta}{1-\beta}}\, f_S$$

$$n_a \sin\theta_a = n_b \sin\theta_b$$

$$m\lambda = d(\sin\alpha \pm \sin\beta)$$

$$m\lambda = d\sin\theta$$

$$R = \frac{\lambda}{\Delta\lambda}$$

$$R = Nm$$

$$\sin\theta = \frac{m\lambda}{a}$$

$$\sin\theta_1 = 1.22 \times \frac{\lambda}{D}$$

$$E = hf$$

$$\frac{P}{A} = \varepsilon\sigma T^4$$

$$n_c = \sqrt{n_1 n_2}$$

$$nL = m\frac{\lambda}{2}$$

$$\Delta f = \frac{c}{2nL}$$

$$\Delta\lambda = \frac{\lambda^2}{2nL}$$

$$V = \pi\frac{d}{\lambda}\sqrt{n_2^2 - n_1^2}$$

7 Tourism & Hospitality Formulae

$$\text{Occupancy} = \frac{\text{number of rooms sold}}{\text{total number of rooms}}$$

$$\text{Sleeper Occupancy} = \frac{\text{number of actual sleepers}}{\text{total number of possible sleepers}}$$

$$\text{Income Occupancy} = \frac{\text{actual income}}{\text{potential income}}$$

$$\text{Average Daily Rate} = \frac{\text{Room Revenue}}{\text{Rooms sold}}$$

$$\text{Revenue rate per guest} = \frac{\text{Room Revenue}}{\text{Total number of Guests}}$$

$$\text{Revenue per available room} = \frac{\text{Room Revenue}}{\text{Total Number of Available Rooms}}$$

$$\text{RevPar} = \text{Occupancy }\% \ \times \text{ADR}$$

$$B = D(1-i)^n$$

$$A = P(1+i)^n$$

$$A = P\left(1+\frac{i}{m}\right)^{mY}$$

$$A = R\left(\frac{(1+i)^n-1}{i}\right)$$

$$P = R\left(\frac{1-(1+i)^{-n}}{i}\right)$$

$$\text{APR} = \left(1+\frac{i}{n}\right)^n - 1$$

8 Marketing Formulae

$$\text{Attrition Rate} = \frac{\text{\# customers at beginning} + \text{\# customers acquired} - \text{\# customers at end}}{\text{\# customers at beginning}}$$

$$\text{CAC} = \frac{\text{total sales \& marketing spend}}{\text{\# new customers}}$$

$$\text{CAC Recovery Time} = \frac{\text{CAC}}{\text{Margin-Adjusted Revenue}}$$

$$\text{Marketing Originated Customer Percentage} = \frac{\text{\# customers from marketing leads}}{\text{total \# new customers}}$$

$$\text{ROMI} = \frac{(\text{incremental revenue from marketing}) \times (\text{gross margin on those revenues}) - \text{cost of marketing}}{\text{cost of marketing}}$$

$$\text{Revenue} = \text{\# Visitors} \times \text{Conversion Rate} \times \text{Average Spend}$$