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Level 3 Technical Level
DESIGN ENGINEERING
MECHATRONIC ENGINEERING

Unit 1 Materials Technology and Science

Formula sheet

Area of a circle $A = \pi r^2$ or $A = \dfrac{\pi D^2}{4}$	Density $\rho = \dfrac{m}{V}$
Stress $\sigma = \dfrac{F}{A}$	Strain $\varepsilon = \dfrac{\delta L}{L}$
Angular measure $360^0 \equiv 2\pi$ radians	Newton's second law $F = ma$
Trigonometry $\sin = \dfrac{opp}{hyp}$, $\cos = \dfrac{adj}{hyp}$ and $\tan = \dfrac{opp}{adj}$	Young's Modulus $E = \dfrac{\sigma}{\varepsilon}$
Ohm's Law $V = IR$	Electrical power $P = VI$, $P = I^2R$ and $P = \dfrac{V^2}{R}$
Resistance in series $R_{total} = R_1 + R_2 + R_3 \ldots$	Resistance in parallel $R_{total} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3} \ldots$ Two resistors in parallel $R_{total} = \dfrac{R_1 R_2}{R_1 + R_2}$
Straight line graph $y = mx + c$	Energy $PE = mgh$ and $KE = \dfrac{mv^2}{2}$
Frequency $f = \dfrac{1}{T}$ and $f = \dfrac{\omega}{2\pi}$	Boyle's law $P_1 V_1 = P_2 V_2$

Charles' law $$\frac{V_1}{T_2} = \frac{V_2}{T_2}$$	The combined gas laws $$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$
The equation of state $$\frac{PV}{T} = mR$$	The pressure law $$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$
Torque $$T = Fr$$	Gear ratio (2 gears) $$R = \frac{\omega_{in}}{\omega_{out}} = \frac{N_{out}}{N_{in}}$$
Friction $$F = \mu N$$	Efficiency $$\eta = \frac{\text{Output}}{\text{Input}} \text{ and } \eta_\% = \frac{\text{Output}}{\text{Input}} \times 100$$
Conversion from bar to Pascals $$bar \times 101 \times 10^3 N\,\text{m}^{-2}$$	The gravitation constant $$g = 9.81\ m\ s^{-2}$$