



# Level 3 Technical Level

## DESIGN ENGINEERING

### MECHATRONIC ENGINEERING

Unit 1 Materials technology and science

### Formula sheet

|                                                                                                                                                    |                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Area of a circle</p> $A = \pi r^2 \text{ or } A = \frac{\pi D^2}{4}$                                                                            | <p>Density</p> $\rho = \frac{m}{V}$                                                                                                                                                    |
| <p>Stress</p> $\sigma = \frac{F}{A}$                                                                                                               | <p>Strain</p> $\varepsilon = \frac{\delta L}{L}$                                                                                                                                       |
| <p>Angular measure</p> $360 \equiv 2\pi \text{ radians}$                                                                                           | <p>Newton's second law</p> $F = ma$                                                                                                                                                    |
| <p>Trigonometry</p> $\sin = \frac{\text{opp}}{\text{hyp}}, \cos = \frac{\text{adj}}{\text{hyp}} \text{ and } \tan = \frac{\text{opp}}{\text{adj}}$ | <p>Young's Modulus</p> $E = \frac{\sigma}{\varepsilon}$                                                                                                                                |
| <p>Ohm's Law</p> $V = IR$                                                                                                                          | <p>Electrical power</p> $P = VI, P = I^2R \text{ and } P = \frac{V^2}{R}$                                                                                                              |
| <p>Resistance in series</p> $R_{\text{total}} = R_1 + R_2 + R_3 \dots$                                                                             | <p>Resistance in parallel</p> $R_{\text{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \dots$ <p>Two resistors in parallel</p> $R_{\text{total}} = \frac{R_1 R_2}{R_1 + R_2}$ |
| <p>Straight line graph</p> $y = mx + c$                                                                                                            | <p>Energy</p> $PE = mgh \text{ and } KE = \frac{mv^2}{2}$                                                                                                                              |
| <p>Frequency</p> $f = \frac{1}{T} \text{ and } f = \frac{\omega}{2\pi}$                                                                            | <p>Boyle's law</p> $P_1 V_1 = P_2 V_2$                                                                                                                                                 |
| <p>Charles' law</p> $\frac{V_1}{T_1} = \frac{V_2}{T_2}$                                                                                            | <p>The combined gas laws</p> $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$                                                                                                               |

|                                                                             |                                                                                                                                      |
|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <p>The equation of state</p> $\frac{PV}{T} = mR$                            | <p>The pressure law</p> $\frac{P_1}{T_1} = \frac{P_2}{T_2}$                                                                          |
| <p>Torque</p> $T = Fr$                                                      | <p>Gear ratio (2 gears)</p> $R = \frac{\omega_{in}}{\omega_{out}} = \frac{N_{out}}{N_{in}}$                                          |
| <p>Friction</p> $F = \mu N$                                                 | <p>Efficiency</p> $\eta = \frac{\text{Output}}{\text{Input}} \text{ and } \eta_{\%} = \frac{\text{Output}}{\text{Input}} \times 100$ |
| <p>Conversion from bar to Pascals</p> $bar \times 101 \times 10^3 N m^{-2}$ | <p>The gravitation constant</p> $g = 9.81 m s^{-2}$                                                                                  |