

Modelling and control summaries



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Modelling principles and analogies 1:

Tutorial sheet on units

1. First ensure you own a book which has all the conversion factors, then try the following.

- Which mass is lightest ? 2.6 kg, 20 g, 3 oz or 7×10^{-3} slugs?
- Which distance is shortest ? 190 in., 4.9 m, 500 cm or 4.2 yards
- Which area is largest ? 4000 cm², 0.0039 m², 0.35 yards² or 8.7 ft²
- Which volume is greatest ? 2000 cm³, 2 m³, or 1.9 ft³
- Which temperature is highest ? 2 deg Celsius, 300 deg Kelvin or 50 deg Fahrenheit
- Which pressure is smallest ? 800 kN/ m², 7.8 bar, 120 lbf/in², or 8 atm
- Which power is smallest ? 100 kW or 5000 Btu/hr

2. List the types of attributes a user should consider before beginning the modelling process.

Approximate conversion factors (use a technical source for more accurate values)

Mass	1kg = 1000 g 1g = 0.001 kg	1 oz = 28.35g	1 slug = 14.59 kg	1 lb = 0.4536 kg
Distance	1cm = 0.01m	1 ft = 0.3048m	1 in = 2.54 cm	1 yd = 0.9144 m
Area	$1 \text{ cm}^2 = 10^{-4} \text{ m}^2$	$1 \text{ yd}^2 = 0.8361 \text{ m}^2$	$1 \text{ ft}^2 = 0.0929 \text{ m}^2$	$1 \text{ in}^2 = 6.452 \times 10^{-4} \text{ m}^2$
Volume	$1 \text{ cm}^3 = 10^{-6} \text{ m}^3$	$1 \text{ ft}^3 = 0.02832 \text{ m}^3$	1 gallon = 4.546 litre	$1 \text{ in}^3 = 16.39 \text{ cm}^3$
Temperature	$x \text{ deg C} + 273.15 = y \text{ deg K}$	$5/9(x \text{ deg F} - 32) + 273.15 = y \text{ deg K}$	$5/9(x \text{ deg F} - 32) = y \text{ deg C}$	
Pressure	1 bar = 100 kN/m ² 1 Pascal = 0.001 kN/m ²	1 lb _f /in ² = 6.895 kN/m ²	1 atm = 101.33 kN/m ²	1 mmHg = 0.1333 kN/m ²
Power	1 Btu/sec = 1.055 kW	1 B.h.p. = 0.7457 kW		

Concise solutions

- 1a) The lightest mass is 20 g.
- b) The shortest distance is 4.2 yards.
- c) The largest area is largest 8.7 ft².
- d) The greatest volume is greatest 2 m³.
- e) The highest temperature is 300K.
- f) The smallest pressure is 7.8 bar.
- g) The smallest power is 5000 Btu/hr.

Note: 1 slug = 37.17 lb, 1 Btu/s = 778 ft-lb_f/s & 1 ft-lb_f/s = 1.356 x 10⁻³ kW

2. Typical attributes are:

- Entities (or components).
- Interconnections (between these entities and with the outside world)
- Inputs (or forcing functions) comprising :
 - Adjustable (i.e. manipulable) controls and
 - Uncontrolled disturbances (e.g. load disturbances etc.).
- Dependent-variables (or states) resulting from :
 - the effect of inputs on the system.
 - the effect of Initial Conditions.
- Initial Conditions of the dependent variables immediately before the inputs take effect.
- Outputs : A selection (often just one) of the dependent variables which is of major importance to the purpose.
- Purpose (or Objective) : The reason for the system's existence or use {eg. to generate a wanted voltage (or voltage waveform in time) or a desired pattern of movement of some object within the system}.
- Control : From a subsystem that adjusts inputs in an attempt to achieve the system's purpose.