FORMULA SHEET FOR MECHANICAL TECHNOLOGY (FITTING AND MACHINING)

1. BELT DRIVES

$$\text{Belt speed} = \frac{\pi \, D \, N}{60} \qquad or \qquad v = \frac{\pi \, D \, N}{60}$$

$$\text{Speed ratio} = \frac{\text{diameter of driven pulley}}{\text{diameter of driver pulley}}$$

$$N_1 D_1 = N_2 D_2$$

$$\text{Ratio of tight side to slack side} = \frac{T_1}{T_2}$$

$$Power\,(P) = \frac{(T_1 - T_2)\pi DN}{60}$$

where T_1 = force in the tight side

T_2 = force in slack side

$T_1 - T_2$ = effective tensile force (T_e)

2. STRESS AND STRAIN

$$\text{Stress} = \frac{\text{Force}}{\text{Area}} \quad \text{or} \quad (\sigma = \frac{F}{A})$$

$$\text{Strain } (\varepsilon) = \frac{\text{change in length } (\Delta L)}{\text{original length } (L)}$$

$$\text{Young's modulus } (E) = \frac{\text{stress}}{\text{strain}} \quad \text{or} \quad (E = \frac{\sigma}{\varepsilon})$$

$$A_{shaft} = \frac{\pi d^2}{4}$$

$$A_{pipe} = \frac{\pi (D^2 - d^2)}{4}$$

$$\text{Safety factor} = \frac{\text{break stress}}{\text{safe working stress}}$$

3. HYDRAULICS

$$\text{Pressure}\,(P) = \frac{\text{force}\,(F)}{\text{area}\,(A)}$$

$$\text{Volume} = \text{area} \times \text{stroke length}$$

4. KEYS AND KEYWAYS

$$\text{Width of key} = \frac{\text{diameter of shaft}}{4}$$

$$\text{Thickness of key} = \frac{\text{diameter of shaft}}{6}$$

$$\text{Length of key} = 1{,}5 \times \text{diameter of shaft}$$

$$\text{Standard taper for taper key: } 1 \text{ in } 100 \text{ or } 1 : 100$$

5. GEAR DRIVES

$$\text{Power}\,(P) = \frac{2\pi N T}{60}$$

$$N_1 T_1 = N_2 T_2$$

$$\text{Gear ratio} = \frac{\text{product of the number of teeth on driven gears}}{\text{product of the number of teeth on driving gears}}$$

$$\frac{N_{\text{input}}}{N_{\text{output}}} = \frac{\text{product of the number of teeth on driven gears}}{\text{product of the number of teeth on driving gears}}$$

$$\text{Torque} = \text{force} \times \text{radius}$$

$$\text{Torque transmitted} = \text{gear ratio} \times \text{input torque}$$

$$\text{Module}\,(m) = \frac{\text{pitch-circle diameter(PCD)}}{\text{number of teeth}\,(T)}$$

$$\text{Pitch-circle diameter}\,(PCD) = \text{module}\,(m) \times \text{number of teeth}\,(T)$$

$$\text{Pitch-circle diameter (PCD)} = \frac{\text{circular pitch (CP)} \times \text{number of teeth (T)}}{\pi}$$

$$\text{Outside diameter (OD)} = \text{PCD} + 2 \text{ module}$$

$$\text{Addendum (a)} = \text{module (m)}$$

$$\text{Dedendum (b)} = 1{,}157 \text{ m} \quad \text{or} \quad \text{Dedendum (b)} = 1{,}25 \text{ m}$$

$$\text{Cutting depth (h)} = 2{,}157 \text{ m} \quad \text{or} \quad \text{Cutting depth (h)} = 2{,}25 \text{ m}$$

$$\text{Clearance (c)} = 0{,}157 \text{ m} \quad \text{or} \quad \text{Clearance (c)} = 0{,}25 \text{ m}$$

$$\text{Circular pitch (CP)} = \text{m} \times \pi$$

$$\text{Add}_c = \text{m} + \frac{\text{Tm}}{2}\left(1 - \cos\frac{90°}{\text{T}}\right) \quad \text{(chordal addendum)}$$

$$t_c = \text{Tm} \sin\frac{90°}{\text{T}} \quad \text{or} \quad t_c = \text{PCD}\sin\frac{90°}{\text{T}} \quad \text{(chordal tooth thickness)}$$

6. TAPER TURNING

$$\text{Tailstock set-over} = \frac{\text{L}(\text{D} - \text{d})}{2\text{l}}$$

where L = Distance between centres
l = Taper length
D = Large diameter
d = Small diameter

(Compound slide angle) $$\tan\frac{\theta}{2} = \frac{\text{D} - \text{d}}{2\,\text{l}}$$

where :
D = large diameter
d = small diameter
l = length of taper
θ = included angle

7. SCREW THREADS

Pitch diameter = outside diameter – ½ pitch

Pitch circumference = $\pi \times$ pitch diameter

Lead = pitch $\times$ number of starts

Height of screw thread = $0{,}866 \times p$ where p = pitch of the screw thread

Depth of screw thread = $0{,}613 \times p$ where p = pitch of the screw thread

$$\text{Number of turns} = \frac{\text{length}}{\text{lead}}$$

$$\text{Helix angle } \tan\theta = \frac{\text{lead}}{\text{pitch circumference}}$$

$$\text{Leading tool angle} = 90° - (\text{helix} + \text{clearance angle})$$

$$\text{Following tool angle} = 90° + (\text{helix} - \text{clearance angle})$$

8. CINCINNATI DIVIDING HEAD TABLE FOR THE MILLING MACHINE

Hole circles											
Side 1	24	25	28	30	34	37	38	39	41	42	43
Side 2	46	47	49	51	53	54	57	58	59	62	66

Change gears										
24 x 2	28	32	40	44	48	56	64	72	86	100

$$\text{Simple indexing} = \frac{40}{n} \quad (\text{where n = number of divisions})$$

$$\text{Angular indexing} = \frac{n}{9°} \quad (\text{where n = given angle})$$

$$\text{Change gears: } \frac{Dr}{Dn} = (A - n) \times \frac{40}{A} \quad \text{or} \quad \frac{Dr}{Dn} = \frac{(A - n)}{A} \times \frac{40}{1}$$

(where A = chosen divisions) (where n = real divisions)