

CHAPTER 1

THE NATURE OF MECHANICAL DESIGN

Problems 1 - 14 require the specification of functions and design requirements for design projects and have no unique solution.

15. $D = 1.75 \text{ in.} \times 25.4 \text{ mm/in} = \underline{44.5 \text{ mm}}$

16. $L = 46 \text{ FT} \times 0.3048 \text{ m/FT} = \underline{14.0 \text{ m}}$

17. $T = 12\,550 \text{ LB}\cdot\text{IN} \times 0.1130 \text{ N}\cdot\text{m/LB}\cdot\text{IN} = \underline{1418 \text{ N}\cdot\text{m}}$

18. $A = 4.12 \text{ in}^2 \times 645.2 \text{ mm}^2/\text{in}^2 = \underline{2658 \text{ mm}^2}$

19. $Z = 14.8 \text{ in}^3 \times 1.639 \times 10^4 \text{ mm}^3/\text{in}^3 = \underline{2.43 \times 10^5 \text{ mm}^3}$

20. $I = 88.0 \text{ in}^4 \times 4.162 \times 10^5 \text{ mm}^4/\text{in}^4 = \underline{3.66 \times 10^7 \text{ mm}^4}$

21. IN APPENDIX A-16, AREAS ARE GIVEN IN INCHES².

$$A = 750 \text{ mm}^2 \times 1 \text{ in}^2 / 645.2 \text{ mm}^2 = 1.16 \text{ in}^2$$

$$\underline{L^2 \times 2 \times \frac{3}{8}} : A = 1.36 \text{ in}^2$$

22. $P = 7.5 \text{ hp} \times 745.7 \text{ W/hp} = 5.59 \times 10^3 \text{ W} = \underline{5.59 \text{ kW}}$

23. $S_u = 127 \text{ ksi} \times 6.895 \text{ MPa/ksi} = \underline{876 \text{ MPa}}$

24. LET $D = 0.035 \text{ m}$; $L = 0.675 \text{ m}$; $VOLUME = V = A \times L = \left(\frac{\pi D^2}{4}\right) \times L$
 $V = \frac{\pi (0.035 \text{ m})^2}{4} \times 0.675 \text{ m} = 6.49 \times 10^{-4} \text{ m}^3$

$$MASS = DENSITY \times V = 7680 \text{ kg/m}^3 \times 6.49 \times 10^{-4} \text{ m}^3 = 4.98 \text{ kg}$$

$$WEIGHT = m \times g = 4.98 \text{ kg} \times 9.81 \text{ m/s}^2 = 48.9 \text{ kg}\cdot\text{m/s}^2 = \underline{48.9 \text{ N}}$$

$$25. \quad T = 180 \text{ LB}\cdot\text{IN} \times 0.1130 \text{ N}\cdot\text{m} / \text{LB}\cdot\text{IN} = \underline{20.3 \text{ N}\cdot\text{m}}$$

$$\theta = 35^\circ \times \pi \text{ RAD} / 180^\circ = \underline{0.611 \text{ RAD.}}$$

$$\text{SCALE} = T/\theta = 180 \text{ LB}\cdot\text{IN} / 35^\circ = \underline{5.14 \text{ LB}\cdot\text{IN} / \text{DEGREE}}$$

$$\text{SCALE} = T/\theta = 20.3 \text{ N}\cdot\text{m} / 0.611 \text{ RAD.} = \underline{33.3 \text{ N}\cdot\text{m} / \text{RAD.}}$$

$$26. \quad \text{ENERGY} = \text{POWER} \times \text{TIME}$$

$$E = 12.5 \text{ hp} \times \frac{16 \text{ h}}{\text{DAY}} \times \frac{5 \text{ DAYS}}{\text{WEEK}} \times \frac{52 \text{ WKS}}{\text{YEAR}} \times \frac{550 \text{ FT}\cdot\text{LB}}{\text{S}\cdot\text{hp}} \times \frac{3600 \text{ S}}{\text{h}}$$

$$E = \underline{1.03 \times 10^8 \text{ FT}\cdot\text{LB} / \text{YEAR}}$$

$$E = 1.03 \times 10^8 \frac{\text{FT}\cdot\text{LB}}{\text{YEAR}} \times \frac{1.356 \text{ J}}{\text{FT}\cdot\text{LB}} \times \frac{1.0 \text{ N}\cdot\text{m}}{\text{J}} \times \frac{1.0 \text{ W}}{\text{N}\cdot\text{m} / \text{S}} \times \frac{1 \text{ h}}{3600 \text{ S}}$$

$$E = 38.8 \times 10^6 \text{ W}\cdot\text{h} / \text{YEAR} = \underline{38.8 \text{ MW}\cdot\text{h} / \text{YEAR}}$$

$$27. \quad \text{VISCOSITY } \mu = 3.75 \text{ REYN} \times \frac{1.0 \text{ LB}\cdot\text{S}}{\text{IN}^2 \cdot \text{REYN}} \times \frac{144 \text{ IN}^2}{\text{FT}^2} = \underline{540 \frac{\text{LB}\cdot\text{S}}{\text{FT}^2}}$$

$$\mu = 3.75 \frac{\text{LB}\cdot\text{S}}{\text{IN}^2} \times \frac{4.448 \text{ N}}{\text{LB}} \times \frac{1.0 \text{ IN}^2}{645.2 \text{ mm}^2} \times \frac{10^6 \text{ mm}^2}{\text{m}^2} = \underline{25.9 \times 10^3 \frac{\text{N}\cdot\text{S}}{\text{m}^2}}$$

$$28. \quad \text{LIFE} = \frac{1750 \text{ REV}}{\text{MIN}} \times \frac{24 \text{ h}}{\text{DAY}} \times \frac{60 \text{ MIN.}}{\text{h}} \times \frac{365 \text{ DAYS}}{\text{YEAR}} \times 5 \text{ YEARS}$$

$$\text{LIFE} = \underline{4.60 \times 10^9 \text{ REVOLUTIONS}}$$