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

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. GIVEN $A_{MIN} = 750\ \text{mm}^2$; IN U.S. UNITS: $A_{MIN} = 1.162\ \text{IN}^2$
APP. 15-1; L 2 X 2 X 3/8, $A = 1.36\ \text{IN}^2 = 890\ \text{mm}^2$
APP 15-3; ANGLES 50 X 100 X 6 AND 75 X 75 X 5 HAVE $A = 864\ \text{mm}^2$

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 $= V = A \times L = \left(\pi D^2/4\right) \times L$

$$V = \frac{\pi (0.035\ \text{m})^2}{4} \times 0.675\ \text{m} = 6.49 \times 10^{-4}\ \text{m}^3$$

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

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

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

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

$\text{SCALE} = T/\theta = 180\ \text{LB·IN}/35° = \underline{5.14\ \text{LB·IN/DEGREE}}$

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

26. ENERGY = POWER × TIME

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

$E = \underline{1.03 \times 10^{11}\ \text{FT·LB/YEAR}}$

$$E = 1.03 \times 10^{11}\ \frac{\text{FT·LB}}{\text{YEAR}} \times \frac{1.356\ \text{J}}{\text{FT·LB}} \times \frac{1.0\ \text{N·m}}{\text{J}} \times \frac{1.0\ \text{W}}{\text{N·m/S}} \times \frac{1\ \text{h}}{3600\ \text{S}}$$

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

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

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

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

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