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Daffodil International University

Department of Nutrition and Food Engineering
Faculty of Health and Life Sciences
BSc. in Nutrition and Food Engineering
Midterm Examination Spring 2026

Course Code: 0732-3101 **Section:** 241 All **Course Title:** Food Plant and Machine Design
Level and Term: L-3, T-1 **Course Teacher Initials:** DSAM, MNR
Time: 1 hour 30 minutes **Total Marks:** 25

Maintaining the order of the questions is highly appreciated

				Marks
1	(a)	Illustrate a flowchart showing the major steps involved in food plant design.	[CLO1,PLO1,C2]	3
	(b)	Explain the differences between food processing plant layout and non-food processing plant layout.	[CLO1,PLO1,C2]	2
2	(a)	How do different factors influence the selection of a suitable site for establishing a food processing plant?	[CLO1,PLO1,C4]	2
	(b)	Suppose, you want to design a plant layout where both continuous and batch production will be applied. Choose the best plant layout option for you in this situation with proper illustration.	[CLO1,PLO1,C1]	3
3	(a)	Identify the characteristics of doors.	[CLO2,PLO3,C3]	2
	(b)	Write the concept of different types of floors with their unique characteristics and application.	[CLO2, PLO3, C3]	3
4	(a)	List out the composition, characteristics and uses of most commonly used stainless steel in food industry.	[CLO2,PLO3,C1]	2
	(b)	Analyze the properties of any three non-ferrous metals used in food machinery design.	[CLO2,PLO3,C4]	3
5		A belt drive is to be designed for F1/F2=3, while transmitting 50 hp at 2550 rpm of the driver D_1; m_w=1.9; use a medium double belt, cemented joint, a squirrel-cage, compensator-motor drive with mildly jerking loads; center distance is expected to be about twice the diameter of larger pulley.		
	(a)	Choose the appropriate iron-pulley sizes based on the given design data.	[CLO2,PLO3,C5]	2
	(b)	Determine the belt width for a maximum permissible s=295 psi and evaluate your results from question (a).	[CLO2,PLO3,C5]	3

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Minimum Pulley Diameter, Inches

Belt Speed	Single		Double Ply			Triple Ply	
V_m in fpm	t=11/64"	t=13/64"	t=18/64"	t=20/64"	t=23/64"	t=30/64"	t=34/64"
	Medium	**Heavy**	**Light**	**Medium**	**Heavy**	**Medium**	**Heavy**
up to 2500	$2\frac{1}{2}$	3	4	5*	8*	16**	20**
2500-4000	3	$3\frac{1}{2}$	$4\frac{1}{2}$	6*	9*	18**	22**
4000-6000	$3\frac{1}{2}$	4	5	7*	10*	20**	24**

*For belts over 8 in. wide, add 2 in. to the minimum diameters shown
**For belts over 8 in. wide, add 4 in. to the minimum diameters shown

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Note: Use these Equations and Tables to solve the problem and don't forget to mention the equation/table no. in the answer

1. $F_1 - F_2 = F_t$, $hp = Fv_m/33{,}000 = Fv_s/550$; also $hp = Tn/63{,}000$ where T in-lb. and n rpm apply to the same pulley.

2. (17.2) $$F_1 - F_2 = bt\left(s - \frac{12\rho v_s^2}{32.2}\right)\left(\frac{e^{f\theta} - 1}{e^{f\theta}}\right),$$

where $e = 2.718\ldots$. For design, use

$\rho = 0.035$ lb/cu. in. for leather;
$\rho = 0.045$ lb/cu. in. for flat rubber belting.

3. Leather on iron or steel, $f = 0.3$;
Leather on paper pulleys, $f = 0.5$.

4. **17.7 LENGTH OF BELTS.** Exact lengths are as detailed in Figs. 17.5 and 17.6; closely, the belt lengths may be computed from

(17.3) $$L \approx 2C + 1.57(D_2 + D_1) + \frac{(D_2 - D_1)^2}{4C},$$

[OPEN BELT, FIG. 17.5]

(g) $$L \approx 2C + 1.57(D_2 + D_1) + \frac{(D_2 + D_1)^2}{4C},$$

[CROSSED BELT, FIG. 17.6]

5. Belt speed expressed by V_m

$$V_m = \frac{\pi D n}{12}\ ft/min$$

Where D = inch
n = rpm

6. **17.8 ANGLE OF CONTACT.** For an *open belt*, the angles of contact are

(17.4) $$\theta = \pi \pm 2\sin^{-1}\frac{R - r}{C} \approx \pi \pm \frac{D_2 - D_1}{C}\ \text{radians},$$

from Fig. 17.5, where it is seen that $\alpha = \sin^{-1}(R - r)/C$. Use the *plus* sign for the *larger* pulley and the *minus* sign for the *smaller* pulley. For *crossed*

7. $$S_{max} = \frac{F_1}{bt};$$

8. $s_d = 400\eta$

endless, the ends must be joined: by cementing ($\eta = 1.00$); by wire lacing with machine ($\eta = 0.88$); by metal hooks ($\eta = 0.55$); and by other methods;

9. ALBA Equation $hp = (hp/in.; \text{Table } 17.1)(bC_mC_p)(C_{f1}C_{f2}\ldots)$.

which is the nominal horsepower that the belt is to transmit (or the nameplate horsepower for an electric motor), and

b in. is the belt width,

C_m is the correction factor for the type of drive; except for electric motors, use $C_m = 1$;

C_p is the correction factor for the size of the smallest pulley; the smaller the pulleys, the greater is the flexure.

C_f is the correction factor for the environmental conditions, and more than one of these factors may apply; thus a vertical drive

10. Design hp $= N_d$ (transmitted hp).

Adjusted rated hp $= K_\theta K_L$ (rated hp),

$B = 4L - 6.28(D_2 + D_1)$,

11. (17.5) $$\text{Rated hp} = \left[a\left(\frac{10^3}{v_m}\right)^{0.09} - \frac{c}{K_\theta D_1} - e\frac{v_m^2}{10^3}\right]\frac{v_m}{10^3},$$

12. $$\text{No. of belts} = \frac{\text{Design hp, equation (m)}}{\text{Adjusted rated hp, equation (n)}}$$

13. $$C = \frac{B + \sqrt{B^2 - 32(D_2 - D_1)^2}}{16}.$$

14. $$C = \frac{D_1 + D_2}{2} + D_1 \quad \text{or} \quad C = D_2, \quad \text{[MINIMUMS]}$$

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REFERENCE BOOK: DESIGN OF MACHINE ELEMENTS (WRITER- V.M. FAIRES

TABLE 17.1 RATED HORSEPOWER PER INCH OF WIDTH, LEATHER BELTS

Belt Speed fpm	Single Ply		Double Ply			Triple Ply	
	t =11/64"	13/64"	18/64"	20/64"	23/64"	30/64"	34/64"
	Med.	Heavy	Light	Medium	Heavy	Medium	Heavy
600	1.1	1.2	1.5	1.8	2.2	2.5	2.8
800	1.4	1.7	2.0	2.4	2.9	3.3	3.6
1000	1.8	2.1	2.6	3.1	3.6	4.1	4.5
1200	2.1	2.5	3.1	3.7	4.3	4.9	5.4
1400	2.5	2.9	3.5	4.3	4.9	5.7	6.3
1600	2.8	3.3	4.0	4.9	5.6	6.5	7.1
1800	3.2	3.7	4.5	5.4	6.2	7.3	8.0
2000	3.5	4.1	4.9	6.0	6.9	8.1	8.9
2200	3.9	4.5	5.4	6.6	7.6	8.8	9.7
2400	4.2	4.9	5.9	7.1	8.2	9.5	10.5
2600	4.5	5.3	6.3	7.7	8.9	10.3	11.4
2800	4.9	5.6	6.8	8.2	9.5	11.0	12.1
3000	5.2	5.9	7.2	8.7	10.0	11.6	12.8
3200	5.4	6.3	7.6	9.2	10.6	12.3	13.5
3400	5.7	6.6	7.9	9.7	11.2	12.9	14.2
3600	5.9	6.9	8.3	10.1	11.7	13.4	14.8
3800	6.2	7.1	8.7	10.5	12.2	14.0	15.4
4000	6.4	7.4	9.0	10.9	12.6	14.5	16.0
4200	6.7	7.7	9.3	11.3	13.0	15.0	16.5
4400	6.9	7.9	9.6	11.7	13.4	15.4	16.9
4600	7.1	8.1	9.8	12.0	13.8	15.8	17.4
4800	7.2	8.3	10.1	12.3	14.1	16.2	17.8
5000	7.4	8.4	10.3	12.5	14.3	16.3	18.2
5200	7.5	8.6	10.5	12.8	14.6	16.8	18.5
5400	7.6	8.7	10.6	12.9	14.8	17.1	18.8
5600	7.7	8.8	10.8	13.1	15.0	17.3	19.0
5800	7.7	8.9	10.9	13.2	15.1	17.5	19.2
6000	7.8	8.9	10.9	13.2	15.2	17.6	19.3

TABLE 17.2 EXPERIENCE FACTORS

Type of Drive	C_1
Any except electric motor	1
Squirrel cage, compensator starting	0.67
Squirrel cage, line starting	0.5
Slipring, and high starting torque	0.4
Pulley Size, in.	**C_2**
4 or less	0.5
4½ to 8	0.6
9 to 12	0.7
13 to 16	0.8
17 to 30	0.9
Over 30	1.0
Operating Conditions	**C_3**
Oily, wet or dusty atmosphere	0.75
Vertical drives	0.85
Jerky loads	0.85
Shock and reversing loads	0.71

Minimum Pulley Diameters, Inches

rpm to							
2500	2½	3	4	5*	8*	16**	30**
2500-4000	3	3½	4½	6*	9*	18**	32**
4000-6000	3½	4	5	7*	10*	20**	34**

* For belts over 5 in. wide, add 2 in. to the minimum diameters shown.
** For belts over 8 in. wide, add 5 in. to the minimum diameters shown.

FIG: 17.1 OPEN BELT

