M.E. MECHANICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAMINATION, 2017

DESIGN OF INDUSTRIAL DRIVES

Time: 3 hours Full Marks: 100

(Answer any four)
(Assume data if required)

1. a) Sketch and describe different types of single pulley drive arrangements.

   b) Calculate the various belt tensions for a 30-inch belt conveyor shown in the figure 1, with 300-ft centers, and a lift of 50-ft. capacity is 500 tph, of material weighing 100 pounds per cubic ft, at a belt speed of 350 fpm. The belt is carried on 5-inch diameter class C5 idlers with 3/4th inch shafts, 35^0 end roll angle. Idlers are spaced every 3.5 ft away. The material contains 50% lumps. Belt weight is 15 lbs/ft, W_b. Material weight is 47.5 lbs/ft, W_m. Temperature is 60^0F. T_e has been calculated and is equal to 3030 lbs. Also find the belt tensions at point 'X" on the carrying run. Assume $A_i = 2.8$; $K_t = 1.0$; $L_x = 1000\,\text{ft}$; $H_x = 31.3\,\text{ft}$.

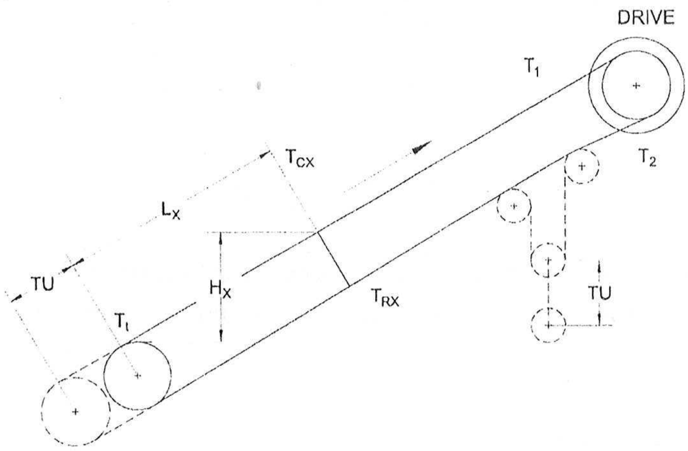


Figure 1

9+16=25

2. a) Explain and compare regenerative dual pulley drive on return run with regenerative dual pulley drive with primary drive on tail pulley.

   b) Figure 2 shows a horizontal belt conveyor with convex vertical curve with head pulley drive. Calculate the belt tensions at point 'X" both on the carrying and return run as well assuming data from the question no. 1 (b). Given: $L_x = 350\,\text{ft}$ on 9% slope; $H_x = 31.3\,\text{ft}$; $T_t = 1788$ lbs;

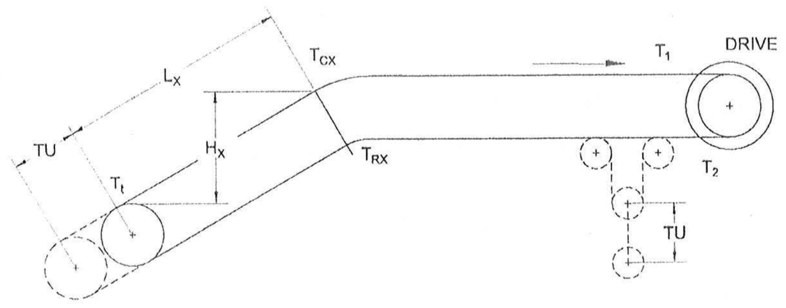


Figure 2

10+15=25

3. a) With respect to the following figure 3, find the expression for no. of equally spaced planets 2 in planetary gear train. Assume no. of teeth on gears 1, 2 and 3 are respectively N_1, N_2 and N_3 .

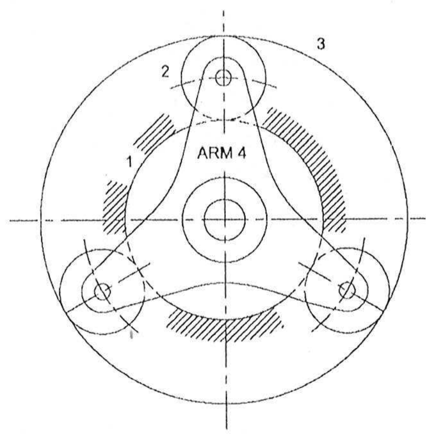


Figure 3

b) Explain the power flow in the following differential (figure 4) with the help of branch control circuit. Also determine the circulating power in the branch control circuit if, $\omega_A = 3600$ rpm in the direction shown, and the power input is 5 hp.

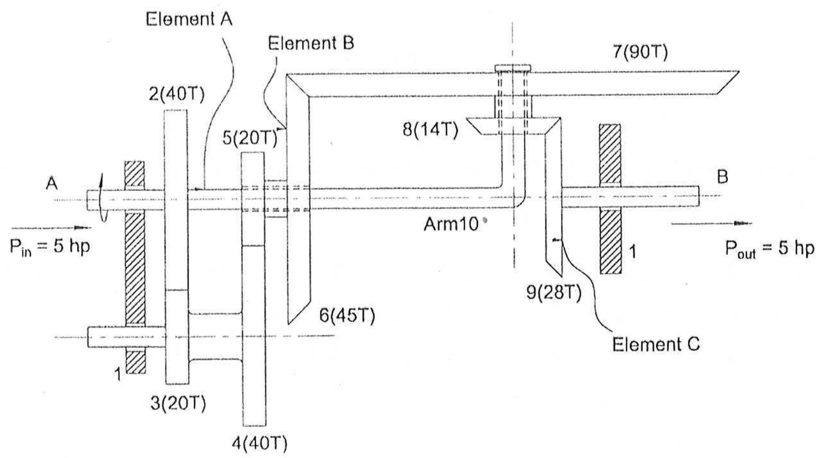


Figure 4

12+13=25

4. a) What are the advantages and disadvantages of chain drives?
   b) Explain polygonal effect in a chain drive with a sketch.
   c) It is required to design a chain drive to connect a 12 kW, 1400 rpm electric motor to a centrifugal pump running at 700 rpm. The service conditions involve moderate shocks.
      (i) Select a proper roller chain and give a list of its dimensions.
      (ii) Determine the pitch circle diameters of driving and driven sprockets.
      (iii) Determine the number of chain links.
      (iv) Specify the correct centre distance between the axes of sprockets.

6+6+13=25

5. a) Define Bearing life and dynamic load carrying capacity.
   b) A transmission shaft rotating at 700 rpm and transmitting power from pulley P to spur gear G is shown in the figure 5. The belt tensions and gear tooth forces are as follows:
      P_1 = 498 N P_2 = 166 N P_t = 497 N P_r = 181 N
      The weight of the pulley is 100 N. The diameter of the shaft at bearing B_1 and B_2 is 10 and 20 mm respectively. The load factor is 2.5 and the expected life for 90% of the bearings is 8000 hrs. Select single deep groove ball bearings at B_1 and B_2. Assume: B_1G= 100 mm, GB_2= 150 mm, B_2P= 150 mm.

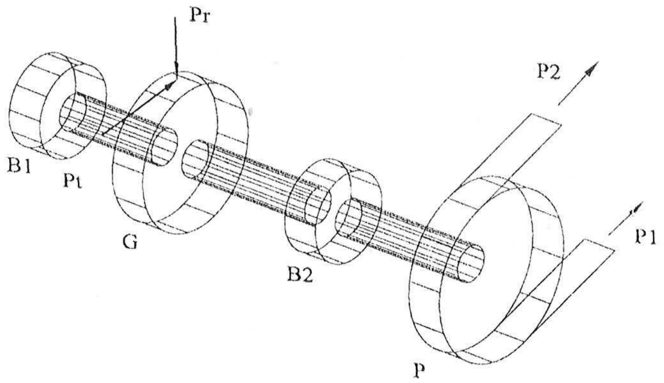


Figure 5

6+19=25

6. A pair of spur gears with 20^0 full depth involute teeth consists of a 19 teeth pinion meshing with a 40 teeth gear. The pinion is mounted on a crankshaft of 7.5 kW single cylinder diesel engine running at 1500 rpm. The driven shaft is connected to a two-stage compressor. Assume the service factor as 1.5. The pinion as well as the gear is made of steel 40C8 (S_{ut}=600 N/mm^2). The module and the face width of the gears are 4 and 40 mm respectively.
   (i) Using the velocity factor to account for the dynamic load, determine the factor of safety.
   (ii) If the factor of safety is 2 for pitting failure, recommend surface hardness for the gears.
   (iii) If the gears are machined to meet the specifications of Grade 8, determine the factor of safety for bending using Buckingham's equation.

25

7. a) What are the advantages of V-belts over flat belts?
   b) It is required to design a V belt drive to connect a 7.5 kW, 1440 rpm induction motor to a fan, running at approximately 480 rpm, for a service of 24 hours per day. Space available for centre distance of about 1 m.
   c) Write down the desirable properties of belt materials. What are the different methods of joining the ends of the belts? Give proper sketch.

4+16+5=25

Dimensions and Static and Dynamic Load Capacities of Single-row Deep Groove Ball Bearings

(Designations refer to SKF Bearings)

Principal Dimensions (mm)			Basic Load Ratings (N)		Designation
Inner dia (d)	Outer dia (D)	Axial width (B)	Dynamic load Capa. [C]	Static load Capa.[C_0]	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
12	21	5	1430	695	61801
	28	8	5070	2240	6001
	32	10	6890	3100	6201
	37	12	9750	4650	6301
15	24	5	1560	815	61802
	32	9	5590	2500	6002
	35	11	7800	3550	6202
	42	13	11400	5400	6302
17	26	5	1680	930	61803
	35	10	6050	2800	6003
	40	12	9560	4500	6202
	47	14	13500	6550	6303
	62	17	22900	11800	6403
20	32	7	2700	1500	61804
	42	8	7020	3400	16400
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
	72	19	30700	16600	6404
25	37	7	3120	1960	61805
	47	8	7610	4000	16005
	47	12	11200	5600	6005
	52	15	14000	6950	6205
	62	17	22500	11400	6305
	80	21	35800	19600	6405
30	42	7	3120	2080	61806
	55	9	11200	5850	16006
	55	13	13300	6800	6006
	62	16	19500	10000	6206
	72	19	28100	14600	6306
	90	23	43600	24000	6406

Dimensions and Static and Dynamic Load Capacities of Single-row Deep Groove Ball Bearings

(Designations refer to SKF Bearings)

Principal Dimensions (mm)			Basic Load Ratings (N)		Designation
Inner dia (d)	Outer dia (D)	Axial width (B)	Dynamic load Capa. [C]	Static load Capa. [C_0]	
35	47	7	4030	3000	61807
	62	9	12400	6950	16007
	62	14	15900	8500	6007
	72	17	25500	13700	6207
	80	21	33200	18000	6307
	100	25	55300	31000	6407
40	52	7	4160	3350	61808
	68	9	13300	7800	16008
	68	15	16800	9300	6008
	80	18	30700	16600	6208
	90	23	41000	22400	6308
	110	27	63700	36500	6408

Proportions of Standard Involute Teeth

	14.5^0 Full Depth System	20^0 Full Depth System	20^0 Stub system
Pressure angle	14.5^0	20^0	20^0
Addendum	m	m	0.8 m
Dedendum	1.157 m	1.25 m	m
Clearance	0.157 m	0.25 m	0.2 m
Working depth	2 m	2 m	1.6 m
Whole depth	2.157 m	2.25 m	1.8 m
Tooth thickness	1.5708 m	1.5708 m	1.5708 m

Recommended Series of Gear Module In mm

Choice 1 (Preferred)	1.0	1.25	1.5	2.0	2.5	3.0	4.0
	5.0	6.0	8.0	10	12	16	20
Choice 2	1.125	1.375	1.75	2.25	2.75	3.5	4.5
	5.5	7.0	9.0	11.0	14.0	18.0	

X And Y Factors For Single Row Deep Groove Ball Bearings

$\left(\frac{F_a}{C_0}\right)$	$\left(\frac{F_a}{F_r}\right) \le e$		$\left(\frac{F_a}{F_r}\right) > e$		e
	X	Y	X	Y	
0.025	1	0	0.56	2.0	0.22
0.040	1	0	0.56	1.8	0.24
0.070	1	0	0.56	1.6	0.27
0.130	1	0	0.56	1.4	0.31
0.250	1	0	0.56	1.2	0.37
0.500	1	0	0.56	1.0	0.44

Deformation Constant/Factor (C) In N/mm^2

Material		14.5^0 Full Depth Teeth	20^0 Full Depth Teeth	20^0 Stub Teeth
Pinion	Gear			
Grey CI	Grey CI	5500	5700	5900
Steel	Grey CI	7600	7900	8100
Steel	Steel	11000	11400	11900

Tolerances On The Adjacent Pitch

Grade	e (Microns)
1	$0.08 + 0.06\ \varphi$
2	$1.25 + 0.10\ \varphi$
3	$2.00 + 0.16\ \varphi$
4	$3.20 + 0.25\ \varphi$
5	$5.00 + 0.40\ \varphi$
6	$8.00 + 0.63\ \varphi$
7	$11.00 + 0.90\ \varphi$
8	$16.00 + 1.25\ \varphi$
9	$22.00 + 1.80\ \varphi$
10	$32.00 + 2.50\ \varphi$
11	$45.00 + 3.55\ \varphi$
12	$63.00 + 5.00\ \varphi$

Values Of Modulus of Elasticity And Poisson's Ratio For Gear Materials

Material	Modulus of Elasticity (N/mm^2)	Poisson's Ratio
Steel	206000	0.3
Cast steel	202000	0.3
Spheroidal cast iron	173000	0.3
Cast tin bronze	103000	0.3
Tin bronze	113000	0.3
Grey cast iron	118000	0.3

Values of The Lewis Form Factor Y For 20^0 Full-Depth Involute System

z	Y	z	Y	z	Y
15	0.289	27	0.348	55	0.415
16	0.295	28	0.352	60	0.421
17	0.302	29	0.355	65	0.425
18	0.308	30	0.358	70	0.429
19	0.314	32	0.364	75	0.433
20	0.32	33	0.367	80	0.436
21	0.326	35	0.373	90	0.442
22	0.33	37	0.38	100	0.446
23	0.333	39	0.386	150	0.458
24	0.337	40	0.389	200	0.463
25	0.34	45	0.399	300	0.471
26	0.344	50	0.408	Rack	0.484

Values of Load Factors

	Types of Drives	Load Factor
(A)	Gear Drive Rotating machine free from impact like electric motors and turbo-compressors Reciprocating machines like internal combustion engines and compressors Impact machines like hammer mills	 1.2 - 1.4 1.4 - 1.7 2.5 - 3.5
(B)	Belt Drives V-belts Single-ply leather belts Double-ply leather belts	 2.0 3.0 3.5
(C)	Chain Drives	1.5

Dimensions And Breaking Loads of Roller Chains

ISO Chain Number	Pitch (mm)	Roller Diameter (mm)	Width (mm)	Transverse Pitch (mm)	Breaking Load for Single Strand Chain (kN)
06B	9.525	6.35	5.72	10.24	10.7
08B	12.7	8.51	7.75	13.92	18.2
10B	15.875	10.16	9.65	16.59	22.7
12B	19.05	12.07	11.68	19.46	29.5
16B	25.4	15.88	17.02	31.88	65
20B	31.75	19.05	19.56	36.45	98.1
24B	38.1	25.4	25.4	48.36	108.9
28B	44.45	27.94	30.99	59.56	131.5
32B	50.8	29.21	30.99	58.55	172.4
40B	63.5	39.37	38.1	72.29	272.2

Power Rating For Simple Roller Chain

Pinion Speed (rpm)	Power (kW)				
	06B	08B	10B	12B	16B
50	0.14	0.34	0.64	1.07	2.59
100	0.25	0.64	1.18	3.01	4.83
200	0.47	1.18	2.19	3.75	8.94
300	0.61	1.7	3.15	5.43	13.06
500	1.09	2.72	5.01	8.53	20.57
700	1.48	3.66	6.71	11.63	27.73
1000	2.03	5.09	8.97	15.65	34.89
1400	2.73	6.81	11.67	18.15	38.47
1800	3.44	8.1	13.03	19.85	-
2000	3.8	8.67	13.49	20.57	-

Service Factor Ks

Type of Input Power	Type of Driven Load		
	Smooth	Moderate Shock	Heavy Shock
IC Engine with Hydraulic Drive	1	1.2	1.4
Electric Motor	1	1.3	1.5
IC Engine with Mechanical Drive	1.2	1.4	1.7

Multiple Strand Factor K_1

Number of Strands	K_1
1	1
2	1.7
3	2.5
4	3.3
5	3.9
6	4.6

Tooth Correction Factor K_2

Number of Teeth on Driving Sprocket	K_2
15	0.85
16	0.92
17	1
18	1.05
19	1.11
20	1.18
21	1.26
22	1.29
23	1.35
24	1.41
25	1.46
30	1.73

The basic formula for calculating the effective tension, T_e, is:

$$T_e = LK_t(K_x + K_y W_b + 0.015 W_b) + W_m(LK_y \pm H) + T_p + T_{am} + T_{ac} \quad (2)$$

Belt Tension Calculations

The following symbols will be used to assist in the identification and evaluation of the individual forces that cumulatively contribute to T_e and that are therefore components of the total propelling belt tension required at the drive pulley:

A_i = belt tension, or force, required to overcome frictional resistance and rotate idlers, lbs (see page 91)

C_1 = friction modification factor for regenerative conveyor

H = vertical distance that material is lifted or lowered, ft

K_t = ambient temperature correction factor (see Figure 6.1)

K_x = factor used to calculate the frictional resistance of the idlers and the sliding resistance between the belt and idler rolls, lbs per ft (see equation 3, page 91)

K_y = carrying run factor used to calculate the combination of the resistance of the belt and the resistance of the load to flexure as the belt and load move over the idlers (see equation 4, page 94, and Table 6-2). For return run use constant 0.015 in place of K_y. See T_{yr}.

L = length of conveyor, ft

Q = tons per hour conveyed, tph, short tons of 2,000 lbs

S_i = troughing idler spacing, ft

T_{ac} = total of the tensions from conveyor accessories, lbs:

$$T_{ac} = T_{sb} + T_{pl} + T_{tr} + T_{bc}$$

T_{am} = tension resulting from the force to accelerate the material continuously as it is fed onto the belts, lbs

T_b = tension resulting from the force needed to lift or lower the belt, lbs (see page 116):

$$T_b = \pm H \times W_b$$

T_{bc} = tension resulting from belt pull required for belt-cleaning devices such as belt scrapers, lbs

T_e = effective belt tension at drive, lbs

T_m = tension resulting from the force needed to lift or lower the conveyed material, lbs:

$$T_m = \pm H \times W_m$$

T_p = tension resulting from resistance of belt to flexure around pulleys and the resistance of pulleys to rotation on their bearings, total for all pulleys, lbs

T_{pl} = tension resulting from the frictional resistance of plows, lbs

T_{sb} = tension resulting from the force to overcome skirtboard friction, lbs

T_{tr} = tension resulting from the additional frictional resistance of the pulleys and the flexure of the belt over units such as trippers, lbs

T_x = tension resulting from the frictional resistance of the carrying and return idlers, lbs:

$$T_x = L \times K_x \times K_t$$

T_{yb} = total of the tensions resulting from the resistance of the belt to flexure as it rides over both the carrying and return idlers, lbs:

$$T_{yb} = T_{yc} + T_{yr}$$

T_{yc} = tension resulting from the resistance of the belt to flexure as it rides over the carrying idlers, lbs:

$$T_{yc} = L \times K_y \times W_b \times K_t$$

T_{ym} = tension resulting from the resistance of the material to flexure as it rides with the belt over the carrying idlers, lbs:

$$T_{ym} = L \times K_y \times W_m$$

T_{yr} = tension resulting from the resistance of the belt to flexure as it rides over the return idlers, lbs:

$$T_{yr} = L \times 0.015 \times W_b \times K_t$$

V = design belt speed, fpm

$W_b =$ weight of belt in pounds per foot of belt length. When the exact weight of the belt is not known, use average estimated belt weight (see Table 6-1)

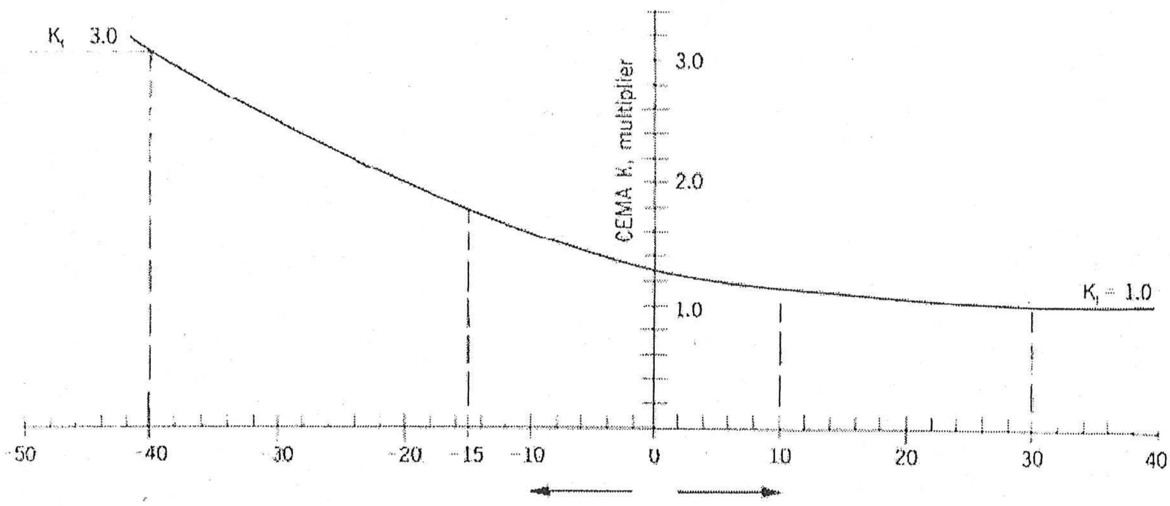
$W_m =$ weight of material, lbs per foot of belt length:

$$W_m = \frac{Q \times 2,000}{60 \times V} = \frac{33.33 \times Q}{V}$$

Three multiplying factors, K_t, K_x, and K_y, are used in calculations of three of the components of the effective belt tension, T_e.

K_t— Ambient Temperature Correction Factor

Idler rotational resistance and the flexing resistance of the belt increase in cold weather operation. In extremely cold weather the proper lubricant for idlers must be used to prevent excessive resistance to idler rotation.



Operation at temperatures below –15°F involves problems in addition to horsepower considerations. Consult conveyor manufacturer for advice on special belting, greasing, and cleaning specifications and necessary design modification.

Figure — Variation of temperature correction factor, K_t, with temperature.

Table — Estimated average belt weight, multiple- and reduced-ply belts, lbs/ft.

Belt Width	Material Carried, lbs/ft^3		
inches (*b*)	30-74	75-129	130-200
18	3.5	4.0	4.5
24	4.5	5.5	6.0
30	6.0	7.0	8.0
36	9.0	10.0	12.0
42	11.0	12.0	14.0
48	14.0	15.0	17.0
54	16.0	17.0	19.0
60	18.0	20.0	22.0
72	21.0	24.0	26.0
84	25.0	30.0	33.0
96	30.0	35.0	38.0

1. Steel-cable belts — increase above value by 50 percent.
2. Actual belt weights vary with different constructions, manufacturers, cover gauges, etc. Use the above values for estimating. Obtain actual values from the belt manufacturer whenever possible.

Table — Wrap factor, C_w (Rubber-surfaced belt).

Type of Pulley Drive	θ Wrap	Automatic Takeup		Manual Takeup	
		Bare Pulley	Lagged Pulley	Bare Pulley	Lagged Pulley
Single, no snub	180°	0.84	0.50	1.2	0.8
Single with snub	200°	0.72	0.42	1.0	0.7
	210°	0.66	0.38	1.0	0.7
	220°	0.62	0.35	0.9	0.6
	240°	0.54	0.30	0.8	0.6
Dual*	380°	0.23	0.11	0.5	0.3
	420°	0.18	0.08	—	—

***Dual values based on ideal distribution between primary and secondary drive.**

For wet belts and smooth lagging, use bare pulley factor.

For wet belts and grooved lagging, used lagged pulley factor.

If wrap is unknown, assume the following:

Type of Drive	Assumed Wrap
Single–no snub	180°
Single –with snub	210°
Dual	380°

Table – Factor K_y values.

Conveyor Length (ft)	$W_b + W_m$ (lbs/ft)	Percent Slope 0	3	6	9	12	24	33
		Approximate Degrees 0	2	3.5	5	7	14	18
250	20	0.035	0.035	0.034	0.031	0.031	0.031	0.031
	50	0.035	0.034	0.033	0.032	0.031	0.028	0.027
	75	0.035	0.034	0.032	0.032	0.030	0.027	0.025
	100	0.035	0.033	0.032	0.031	0.030	0.026	0.023
	150	0.035	0.035	0.034	0.033	0.031	0.025	0.021
	200	0.035	0.035	0.035	0.035	0.032	0.024	0.018
	250	0.035	0.035	0.035	0.035	0.033	0.021	0.018
	300	0.035	0.035	0.035	0.035	0.032	0.019	0.018
400	20	0.035	0.034	0.032	0.030	0.030	0.030	0.030
	50	0.035	0.033	0.031	0.029	0.029	0.026	0.025
	75	0.034	0.033	0.030	0.029	0.028	0.024	0.021
	100	0.034	0.032	0.030	0.028	0.028	0.022	0.019
	150	0.035	0.034	0.031	0.028	0.027	0.019	0.016
	200	0.035	0.035	0.033	0.030	0.027	0.016	0.014
	250	0.035	0.035	0.034	0.030	0.026	0.017	0.016
	300	0.035	0.035	0.034	0.029	0.024	0.018	0.018
500	20	0.035	0.033	0.031	0.030	0.030	0.030	0.030
	50	0.034	0.032	0.030	0.028	0.028	0.024	0.023
	75	0.033	0.032	0.029	0.027	0.027	0.021	0.019
	100	0.033	0.031	0.029	0.028	0.026	0.019	0.016
	150	0.035	0.033	0.030	0.027	0.024	0.016	0.016
	200	0.035	0.035	0.030	0.027	0.023	0.016	0.016
	250	0.035	0.035	0.030	0.025	0.021	0.016	0.015
	300	0.035	0.035	0.029	0.024	0.019	0.018	0.018
600	20	0.035	0.032	0.030	0.029	0.029	0.029	0.029
	50	0.033	0.030	0.029	0.027	0.026	0.023	0.021
	75	0.032	0.030	0.028	0.026	0.024	0.020	0.016
	100	0.032	0.030	0.027	0.025	0.022	0.016	0.016
	150	0.035	0.031	0.026	0.024	0.019	0.016	0.016
	200	0.035	0.031	0.026	0.021	0.017	0.016	0.016
	250	0.035	0.031	0.024	0.020	0.017	0.016	0.016
	300	0.035	0.031	0.023	0.018	0.018	0.018	0.018
800	20	0.035	0.031	0.030	0.029	0.029	0.029	0.029
	50	0.032	0.029	0.028	0.026	0.025	0.021	0.018
	75	0.031	0.029	0.026	0.024	0.022	0.016	0.016
	100	0.031	0.028	0.025	0.022	0.020	0.016	0.016
	150	0.034	0.028	0.023	0.019	0.017	0.016	0.016
	200	0.035	0.027	0.021	0.016	0.016	0.016	0.016
	250	0.035	0.026	0.020	0.017	0.016	0.016	0.016
	300	0.035	0.025	0.018	0.018	0.018	0.018	0.018

Idler spacing: The above values of K_y are based on the following idler spacing.

(W_b+W_m), lbs per ft	S_i, ft	(W_b+W_m), lbs per ft	S_i, ft
Less than 50	4.5	100 to 149	3.5
50 to 99	4.0	150 and above	3.0

Table Factor K_y values.

Conveyor Length (ft)	$W_b + W_m$ (lbs/ft)	Percent Slope: 0 / Approximate Degrees: 0	3 / 2	6 / 3.5	9 / 5	12 / 7	24 / 14	33 / 18
1000	50	0.031	0.028	0.026	0.024	0.023	0.019	0.016
	75	0.030	0.027	0.024	0.022	0.019	0.016	0.016
	100	0.030	0.026	0.022	0.019	0.017	0.016	0.016
	150	0.033	0.024	0.019	0.016	0.016	0.016	0.016
	200	0.032	0.023	0.017	0.016	0.016	0.016	0.016
	250	0.033	0.022	0.017	0.016	0.016	0.016	0.016
	300	0.033	0.021	0.018	0.018	0.018	0.018	0.018
1400	50	0.029	0.026	0.024	0.022	0.021	0.016	0.016
	75	0.028	0.024	0.021	0.019	0.016	0.016	0.016
	100	0.028	0.023	0.019	0.016	0.016	0.016	0.016
	150	0.029	0.020	0.016	0.016	0.016	0.016	0.016
	200	0.030	0.021	0.016	0.016	0.016	0.016	0.016
	250	0.030	0.020	0.017	0.016	0.016	0.016	0.016
	300	0.030	0.019	0.018	0.018	0.018	0.018	0.018
2000	50	0.027	0.024	0.022	0.020	0.018	0.016	0.016
	75	0.026	0.021	0.019	0.016	0.016	0.016	0.016
	100	0.025	0.020	0.016	0.016	0.016	0.016	0.016
	150	0.026	0.017	0.016	0.016	0.016	0.016	0.016
	200	0.024	0.016	0.016	0.016	0.016	0.016	0.016
	250	0.023	0.016	0.016	0.016	0.016	0.016	0.016
	300	0.022	0.018	0.018	0.018	0.018	0.018	0.018
2400	50	0.026	0.023	0.021	0.018	0.017	0.016	0.016
	75	0.025	0.021	0.017	0.016	0.016	0.016	0.016
	100	0.024	0.019	0.016	0.016	0.016	0.016	0.016
	150	0.024	0.016	0.016	0.016	0.016	0.016	0.016
	200	0.021	0.016	0.016	0.016	0.016	0.016	0.016
	250	0.021	0.016	0.016	0.016	0.016	0.016	0.016
	300	0.020	0.018	0.018	0.018	0.018	0.018	0.018
3000	50	0.024	0.022	0.019	0.017	0.016	0.016	0.016
	75	0.023	0.019	0.016	0.016	0.016	0.016	0.016
	100	0.022	0.017	0.016	0.016	0.016	0.016	0.016
	150	0.022	0.016	0.016	0.016	0.016	0.016	0.016
	200	0.019	0.016	0.016	0.016	0.016	0.016	0.016
	250	0.018	0.016	0.016	0.016	0.016	0.016	0.016
	300	0.018	0.018	0.018	0.018	0.018	0.018	0.018

Idler spacing: The above values of K_y are based on the following idler spacing

(W_b+W_m), lbs per ft	S_i, ft	(W_b+W_m), lbs per ft	S_i, ft
Less than 50	4.5	100 to 149	3.5
50 to 99	4.0	150 and above	3.0

K_y values in Tables 6-2 and 6-3 are applicable for conveyors up to 3,000 ft long with a single slope and a 3% maximum sag of the belt between the troughing and between the return idlers. The return idler spacing is 10 ft nominal and loading of the belt is uniform and continuous.

Table 13.13 *Preferred pitch diameters of pulleys (mm)*

Belt section					
Z	*A*	*B*	*C*	*D*	*E*
50	75	125	200	355	500
53	80	132	212	375	530
56	85	140	224	400	560
60	90	150	236	425	600
63	95	160	250	450	630
67	100	170	265	475	670
71	106	180	280	500	710
75	112	190	300	530	750
80	118	200	315	560	800
85	125	224	355	600	900
90	132	250	375	630	1000
95	140	280	400	710	1120
100	150	300	450	750	1250
112	160	315	500	800	1400
125	170	355	530	900	1500
140	180	375	560	1000	1600
160	190	400	600	1060	1800
180	200	450	630	1120	1900
200	224	500	710	1250	2000
250	250	530	750	1400	2240
315	280	560	800	1500	2500
400	300	600	900	1600	—
500	315	630	1000	1800	—
630	350	710	1200	2000	—
800	400	750	1250	—	—
—	450	800	1400	—	—
—	500	900	1600	—	—
—	560	1000	—	—	—
—	630	1120	—	—	—
—	710	—	—	—	—
—	800	—	—	—	—

Tolerance on the pitch diameter is ± 0.8 per cent

Table 13.14 *Nominal pitch lengths for standard sizes of V-belts*

Pitch lengths of belts L_p (mm)					
Z	*A*	*B*	*C*	*D*	*E*
405	630	930	1560	2740	4660
475	700	1000	1760	3130	5040
530	790	1100	1950	3330	5420
625	890	1210	2190	3730	6100
700	990	1370	2420	4080	6850
780	1100	1560	2720	4620	7650
920	1250	1690	2880	5400	9150
1080	1430	1760	3080	6100	12230
1330	1550	1950	3310	6840	13750
1420	1640	2180	3520	7620	15280
1540	1750	2300	4060	8410	16800
	1940	2500	4600	9140	
	2050	2700	5380	10700	
	2200	2870	6100	12200	
	2300	3200	6820	13700	
	2480	3600	7600	15200	
	2570	4060	9100		
	2700	4430	10700		
	2910	4820			
	3080	5370			
	3290	6070			
	3540				

Table 13.15 *Correction factors according to service (F_a)*

Service	*Type of driven Machine*	*Type of driving units*					
		AC Motor: normal torque, squirrel cage, synchronous and split phase *DC Motor*: shunt wound—multi cylinder IC engine over 600 rpm			*AC Motor*: high torque, induction, single phase *DC Motor*: series and compound wound—*single cylinder IC engine,* Multi cylinder IC engine under 600 rpm—line shaft, *clutches and brakes*		
		Operational hours per day (h)			Operational hours per day (h)		
		0–10	10–16	16–24	0–10	10–16	16–24
Light duty	Agitator, blower, exhauster, centrifugal pumps, compressor and fans up to 7.5 kW and light duty conveyor	1.0	1.1	1.2	1.1	1.2	1.3
Medium duty	Belt conveyor, fans over 7.5 kW, generator, line shaft, machine tools, presses, positive displacement pumps and vibrating screen	1.1	1.2	1.3	1.2	1.3	1.4
Heavy duty	Bucket elevator, hammer mill, piston pump, saw mill, exciter and wood working machinery	1.2	1.3	1.4	1.4	1.5	1.6
Extra-heavy duty	Crusher, mill and hoist	1.3	1.4	1.5	1.5	1.6	1.8

Table 13.17 *Power ratings in kW (Pr) for B-Section V-Belts, 17 mm wide with 180° arc of contact on smaller pulley*

Speed of faster shaft	*Power rating for smaller pulley pitch diameter of*									*Additional power increment per belt for speed ratio of*									
	125 mm	*132 mm*	*140 mm*	*150 mm*	*160 mm*	*170 mm*	*180 mm*	*190 mm*	*200 mm*	*1.00 to 1.01*	*1.02 to 1.04*	*1.05 to 1.08*	*1.09 to 1.12*	*1.13 to 1.18*	*1.19 to 1.24*	*1.25 to 1.34*	*1.35 to 1.51*	*1.52 to 1.99*	*2.00 and over*
rpm	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*	*kW*
720	1.61	1.79	1.99	2.24	2.48	2.73	2.97	3.21	3.45	0.00	0.03	0.05	0.08	0.10	0.13	0.15	0.18	0.20	0.23
960	2.02	2.24	2.50	2.82	3.13	3.44	3.75	4.05	4.35	0.00	0.03	0.07	0.10	0.14	0.17	0.20	0.24	0.27	0.30
1440	2.72	3.03	3.39	3.83	4.26	4.68	5.09	5.50	5.90	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.36	0.41	0.46
2880	3.96	4.44	4.95	5.55	6.11	6.62	7.08	7.48	--	0.00	0.10	0.20	0.30	0.41	0.50	0.61	0.71	0.81	0.91
100	0.32	0.35	0.38	0.43	0.47	0.51	0.55	0.59	0.63	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03
200	0.57	0.63	0.69	0.77	0.85	0.92	1.00	1.08	1.15	0.00	0.01	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.06
300	0.80	0.88	0.97	1.08	1.19	1.31	1.42	1.53	1.64	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
400	1.01	1.11	1.23	1.38	1.52	1.67	1.81	1.96	2.10	0.00	0.01	0.03	0.04	0.06	0.07	0.08	0.10	0.11	0.13
500	1.21	1.33	1.48	1.66	1.84	2.01	2.19	2.36	2.54	0.00	0.02	0.04	0.05	0.07	0.09	0.11	0.12	0.14	0.16
600	1.40	1.55	1.72	1.93	2.14	2.35	2.55	2.76	2.96	0.00	0.02	0.04	0.06	0.08	0.11	0.13	0.15	0.17	0.19
700	1.58	1.75	1.94	2.19	2.43	2.66	2.90	3.13	3.37	0.00	0.02	0.05	0.07	0.10	0.12	0.15	0.17	0.20	0.22
800	1.75	1.94	2.16	2.44	2.70	2.97	3.24	3.50	3.78	0.00	0.03	0.06	0.08	0.11	0.14	0.17	0.20	0.23	0.25
900	1.92	2.13	2.37	2.68	2.97	3.27	3.56	3.85	4.13	0.00	0.03	0.06	0.10	0.13	0.16	0.19	0.22	0.25	0.29
1000	2.08	2.31	2.58	2.91	3.23	3.55	3.87	4.18	4.49	0.00	0.04	0.07	0.10	0.14	0.18	0.21	0.25	0.28	0.32
1100	2.23	2.49	2.78	3.13	3.48	3.83	4.17	4.51	4.84	0.00	0.04	0.08	0.12	0.16	0.19	0.23	0.27	0.31	0.35
1200	2.38	2.66	2.96	3.35	3.72	4.09	4.46	4.81	5.17	0.00	0.04	0.08	0.13	0.17	0.21	0.25	0.30	0.34	0.38
1300	2.53	2.82	3.15	3.55	3.95	4.34	4.73	5.11	5.48	0.00	0.05	0.09	0.14	0.18	0.23	0.27	0.32	0.37	0.41
1400	2.66	2.97	3.32	3.75	4.17	4.59	4.98	5.39	5.78	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.39	0.44
1500	2.79	3.12	3.49	3.94	4.38	4.82	5.24	5.66	6.06	0.00	0.05	0.10	0.16	0.21	0.26	0.32	0.37	0.42	0.48
1600	2.92	3.26	3.65	4.12	4.58	5.04	5.48	5.91	6.33	0.00	0.06	0.11	0.17	0.23	0.28	0.34	0.39	0.45	0.51
1700	3.04	3.40	3.80	4.29	4.77	5.24	5.70	6.14	6.58	0.00	0.06	0.12	0.18	0.24	0.30	0.36	0.42	0.48	0.54
1800	3.15	3.52	3.94	4.45	4.95	5.44	5.90	6.36	6.80	0.00	0.06	0.13	0.19	0.25	0.32	0.38	0.44	0.51	0.57
1900	3.26	3.65	4.08	4.61	5.12	5.62	6.10	6.56	7.00	0.00	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.54	0.60
2000	3.36	3.76	4.21	4.75	5.28	5.78	6.27	6.74	7.19	0.00	0.07	0.14	0.21	0.28	0.35	0.42	0.49	0.56	0.63
2100	3.45	3.87	4.33	4.88	5.42	5.94	6.43	6.91	7.36	0.00	0.07	0.15	0.22	0.30	0.37	0.44	0.52	0.59	0.67
2200	3.54	4.00	4.44	5.01	5.55	6.07	6.58	7.05	7.50	0.00	0.08	0.16	0.23	0.31	0.39	0.46	0.54	0.62	0.70
2300	3.62	4.06	4.54	5.12	5.68	6.20	6.70	7.18	7.62	0.00	0.08	0.16	0.24	0.32	0.41	0.49	0.57	0.65	0.73

(Contd)

Table 13.21 *Correction factors for belt pitch length (F_c)*

Correction Factor	*Belt pitch length (mm)*					
	Belt cross section					
	Z	*A*	*B*	*C*	*D*	*E*
0.80		630				
0.81			930			
0.82		700		1560	2740	
0.83			1000			
0.84		790		1760		
0.85			1100			
0.86	405	890			3130	
0.87			1210	1950	3330	
0.88		990				
0.89						
0.90	475	1100	1370	2190	3730	4660
0.91				2340		
0.92	530		1560	2490	4080	5040
0.93		1250				
0.94				2720	4620	5420
0.95	625		1760	2800		
0.96		1430		3080		6100
0.97			1950		5400	
0.98	700	1550		3310		
0.99		1640	2180	3520		6850
1.00	780	1750	2300		6100	
1.02		1940	2500	4060		7650
1.03					6840	
1.04	920	2050	2700			
1.05		2200	2850	4600	7620	9150
1.06		2300				
1.07	1080				8410	9950
1.08		2480	3200	5380		
1.09		2570			9140	10710
1.10		2700	3600			
1.11				6100		
1.12		2910			10700	12230
1.13		3080	4060			
1.14		3290		6860		13750
1.15			4430			
1.16		3540	4820	7600	12200	
1.17			5000		13700	15280
1.18			5370			
1.19			6070		15200	16800
1.20				9100		
1.21				10700		

Table 13.22 *Correction factor for arc of contact (F_d)*

$\frac{D-d}{C}$	*Arc of contact on smaller pulley (in degrees)*	*Correction Factor F_d*
0.00	180	1.00
0.05	177	0.99
0.10	174	0.99
0.15	171	0.98
0.20	169	0.97
0.25	166	0.97
0.30	163	0.96
0.35	160	0.95
0.40	157	0.94
0.45	154	0.93
0.50	151	0.93
0.55	148	0.92
0.60	145	0.91
0.65	142	0.90
0.70	139	0.89
0.75	136	0.88
0.80	133	0.87
0.85	130	0.86
0.90	127	0.85
0.95	123	0.83
1.00	120	0.82