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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2011 SESSION

SUBJECT CODE	:	FMD 11102
SUBJECT TITLE	:	MACHINE ELEMENTS
LEVEL	:	DIPLOMA
TIME / DURATION	:	8.00pm – 10.00pm (2 HOURS)
DATE	:	13 MAY 2011

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of TWO (2) sections. Section A and B. Answer ALL questions in Section A. For Section B, answer ANY two (2) questions.
6. Answer all questions in ENGLISH ONLY.

THERE ARE 5 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

INSTRUCTIONS: Answer ALL three (3) questions.
Please use the answer booklet provided.

Question 1

(a) A chain transmission is chosen to run a simple conveyor that run through a large oven. The temperature of the oven is at approximately 120°C. List 3 critical conditions that need to be observed in choosing the correct chain for the system.

(15 marks)

(b) Another common type of chain is the silent chain. Use a simple sketch and describe 2 of its important features.

(5 marks)

Question 2

a) There are many types of gears are used in industrial applications. The arrangement of the shafts position and gears are the important issues that related to the types of gear to be chosen. Explain the use of the following gears that relate to the shaft arrangement and position:-

(i) bevel gears

(10 marks)

(ii) helical gears

(10 marks)

Question 3

(a) Some of belt transmission system, the synchronous belt or 'timing belt' is used. List 2 reasons of using this belt in the system.

(10 marks)

(b) An area of contact between the belt and pulleys is important to allow the maximum torque to be transmitted between the pulleys in the system. When a contact area of single belt is not enough, explain 2 methods to overcome this manner.

(10 marks)

SECTION B (40 marks)

INSTRUCTIONS: Answer only TWO (2) questions.
Please use the answer booklet provided.

Question 4

A fan is belt driven by an electric motor running at 1500 rpm. The pulley diameters for the fan and motor are 500 and 355mm, respectively. A flat belt has been selected with a width of 100mm, thickness of 3.5mm, coefficient of friction of 0.8, density of 1100 kg/m^3 and permissible stress of 11MN/m^2. The centre distance is 1500mm. Determine the power capacity of the belt.

i. Find the arc contact of the pulleys.

(5 marks)

ii. Find maximum permissible stress on the belt.

(5 marks)

iii. Find the belt velocity

(5 marks)

iv. Find the mass per unit length

(5 marks)

Question 5

Select a wedge belt and determine the pulley diameters for a reciprocating compressor driven by a 28kW two-cylinder diesel engine. The engine speed is 1500 rpm and the compressor speed is 950 rpm. The proposed distances between the engine and compressor shaft centers are approximately 1.5 m. The system is expected to be used for less than 10 hours per day

i. Find the speed ratio

(4 marks)

ii. Find Service Factor (Please use **table 8.2** in the attachment)

(4 marks)

iii. Find Design Power

(4 marks)

iv. Find belt types (Please use **Chart of 8.5** in the attachment)

(4 marks)

v. Find Pulley diameter of D_1 (Please use **Table 8.4** in the attachment)

(4 marks)

Question 6

A chain drive is required for a gear pump operating at 400 rpm driven by a 5.5 Kw electric motor running at 1440 rpm. The centers distance between the motor and pump shafts are approximately 470mm.

i. Find the reduction ratio

(5 marks)

ii. Find the number of the driving sprocket (N_1)(Please refer to **table 8.9** in the attachment)

(5 marks)

iii. Find the number of Driven sprocket (N_2)(Please refer to **table 8.9** in the attachment)

(5 marks)

iv. State the application factor f_1(Please refer to **table 8.10** in the attachment)

(5 marks)

END OF QUESTIONS

Attachment

$$\theta_d = \pi - 2\sin^{-1}\frac{D-d}{2C}$$

$$\theta_d = \pi + 2\sin^{-1}\frac{D-d}{2C}$$

$$F_{1,max} = \sigma_{max} A$$

$$V = rpm\ x\ \frac{2\pi}{60}\ x\ \frac{d}{2}$$

$$F_c = \rho V^2 A = mV^2$$

$$\frac{F_1 - F_c}{F_2 - F_c} = e^{\mu\theta}$$

$$\text{Power} = (F_1 - F_2)V$$

$$S_{ratio} = \frac{N_1}{N_2}$$

$$P_{Design} = (P)(F_{service})$$

$$P_{corrected}\ /\ Belt = (Rated\ power\ per\ belt + Additional\ power\ per\ belt)(arc\ correction\ factor)$$

$$Number\ of\ belt\ to\ used = \frac{P_{design}}{P_{corrected}}$$

$$P_{selection} = (P)(f_1)(f_2)$$

$$L = \frac{N_1 + N_2}{2} + \frac{2C}{p} + \left(\frac{N_2 - N_1}{2\pi}\right)^2 \frac{p}{C}$$

$$C = \frac{p}{8}\left[2L - N_2 - N_1 + \sqrt{(2L - N_2 - N_1)^2 - \frac{\pi}{3.88}(N_2 - N_1)^2}\right]$$

Table 8.2 Service factors

	Type of prime mover					
	Soft starts Electric motors: AC, star delta start DC, shunt wound IC engines with four or more cylinders Prime movers fitted with centrifugal clutches, dry or fluid couplings or electronic soft start drives			Heavy starts Electric motors: AC, star delta start DC, shunt wound IC engines with less than four cylinders Prime movers not fitted with soft start drives		
	Duty (hours per day)					
Types of driven machine	<10	10–16	>16	<10	10–16	>16
Light duty, e.g. agitators (uniform density), blowers, exhausters and fans (up to 7.5 kW), centrifugal compressors, rotodynamic pumps, uniformly loaded belt conveyors	1.0	1.1	1.2	1.1	1.2	1.3
Medium duty, e.g. agitators (variable density), blowers exhausters and fans (over 7.5 kW), rotary compressors and pumps (other than centrifugal), nonuniformly loaded conveyors, generators, machine tools, printing machinery, sawmill machinery	1.1	1.2	1.3	1.2	1.3	1.4
Heavy duty, e.g. brick machinery, bucket elevators, reciprocating compressors and pumps, heavy duty conveyors, hoists, pulverizers, punches, presses, quarry plant, textile machinery	1.2	1.3	1.4	1.4	1.5	1.6
Extra heavy duty, e.g. crushers	1.3	1.4	1.5	1.5	1.6	1.8

After Fenner Power Transmission UK.

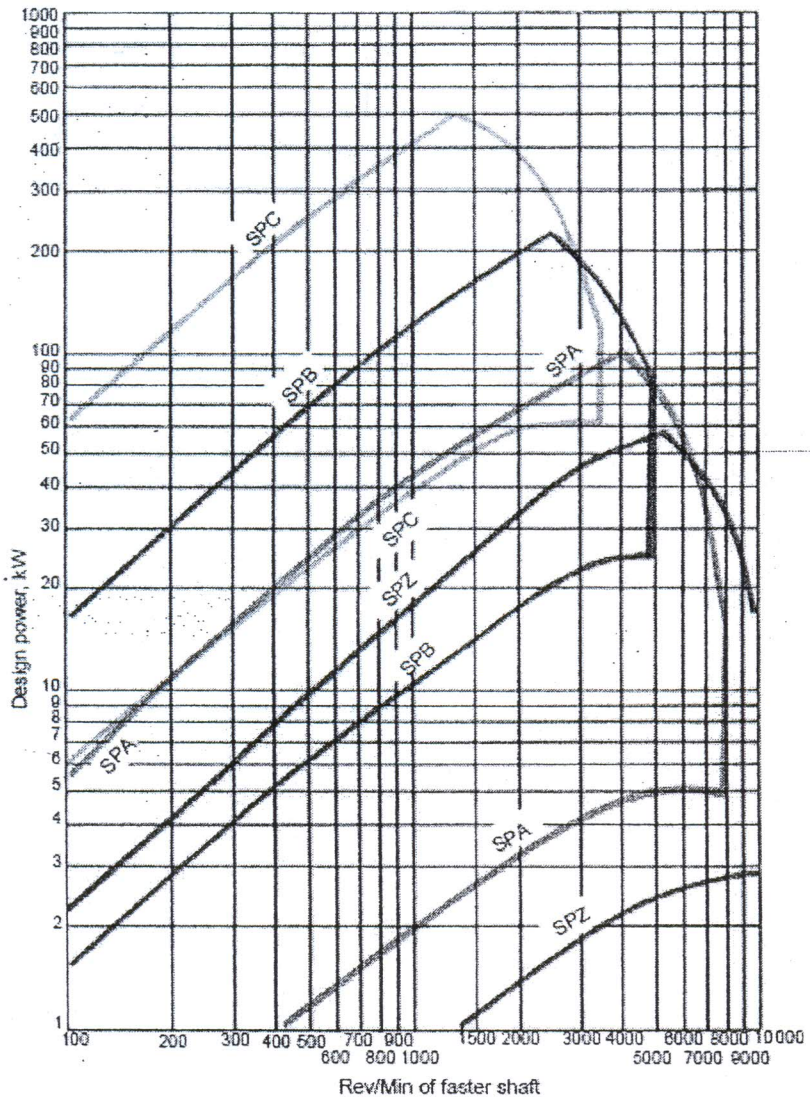


Figure 8.5 Selection chart for wedge belts (courtesy of Fenner Drives UK).

Table 8.5 Power ratings for SPB wedge belts

Speed of faster shaft (rpm)	Rated power (kW) per belt for small pulley pitch diameter (mm)												
	140	150	160	170	180	190	200	212	224	236	250	280	315
100	0.73	0.82	0.92	1.01	1.10	1.20	1.29	1.40	1.51	1.62	1.74	2.01	2.33
200	1.33	1.51	1.69	1.87	2.05	2.22	2.40	2.61	2.82	3.02	3.26	3.78	4.37
300	1.89	2.15	2.41	2.67	2.93	3.18	3.44	3.74	4.04	4.35	4.70	5.44	6.30
400	2.42	2.76	3.09	3.43	3.77	4.10	4.43	4.83	5.22	5.61	6.07	7.04	8.15
500	2.92	3.33	3.75	4.16	4.57	4.98	5.39	5.87	6.36	6.84	7.39	8.58	9.94
600	3.40	3.89	4.38	4.87	5.35	5.83	6.31	6.89	7.45	8.02	8.67	10.06	11.66
700	3.86	4.43	4.99	5.55	6.11	6.66	7.21	7.87	8.52	9.17	9.92	11.50	13.32
720	3.95	4.53	5.11	5.69	6.26	6.82	7.39	8.06	8.73	9.39	10.16	11.79	13.65
800	4.31	4.95	5.59	6.22	6.84	7.47	8.08	8.82	9.55	10.28	11.12	12.90	14.93
900	4.75	5.46	6.16	6.86	7.56	8.25	8.93	9.75	10.56	11.36	12.29	14.25	16.47
960	5.00	5.75	6.50	7.24	7.98	8.71	9.43	10.29	11.15	11.99	12.97	15.03	17.37
1000	5.17	5.95	6.72	7.49	8.25	9.01	9.76	10.65	11.53	12.41	13.42	15.55	17.96
1100	5.58	6.42	7.27	8.10	8.93	9.75	10.56	11.52	12.48	13.43	14.52	16.80	19.39
1200	5.97	6.89	7.79	8.69	9.58	10.46	11.34	12.37	13.40	14.41	15.57	18.01	20.75
1300	6.36	7.34	8.31	9.27	10.22	11.16	12.09	13.19	14.28	15.36	16.59	19.17	22.05
1400	6.73	7.77	8.81	9.83	10.84	11.84	12.82	13.99	15.14	16.27	17.57	20.28	23.28
1440	6.88	7.95	9.00	10.05	11.08	12.10	13.11	14.30	15.47	16.63	17.96	20.70	23.75
1500	7.09	8.20	9.29	10.37	11.44	12.49	13.53	14.76	15.97	17.15	18.51	21.33	24.43
1600	7.44	8.61	9.76	10.90	12.02	13.12	14.21	15.50	16.76	18.00	19.41	22.33	25.51
1700	7.78	9.01	10.21	11.40	12.56	13.73	14.87	16.21	17.52	18.81	20.27	23.27	26.51
1800	8.11	9.39	10.65	11.90	13.12	14.32	15.50	16.89	18.25	19.58	21.08	24.15	27.43
1900	8.43	9.76	11.08	12.37	13.64	14.88	16.11	17.54	18.94	20.31	21.85	24.97	28.27
2000	8.73	10.12	11.48	12.82	14.14	15.43	16.69	18.16	19.60	20.99	22.57	25.72	29.01
2100	9.02	10.46	11.88	13.26	14.62	15.94	17.24	18.75	20.22	21.64	23.23	26.41	29.67
2200	9.31	10.79	12.25	13.68	15.07	16.44	17.76	19.31	20.80	22.24	23.85	27.03	30.22
2300	9.57	11.11	12.61	14.08	15.51	16.90	18.26	19.83	21.35	22.80	24.42	27.57	30.68
2400	9.83	11.41	12.95	14.46	15.92	17.34	18.72	20.32	21.85	23.31	24.93	28.05	31.04
2500	10.08	11.70	13.28	14.82	16.31	17.76	19.16	20.77	22.31	23.78	25.38	28.44	–
2600	10.31	11.97	13.59	15.16	16.68	18.14	19.56	21.19	22.73	24.19	25.78	28.76	–
2700	10.53	12.23	13.88	15.47	17.02	18.50	19.93	21.56	23.11	24.56	26.12	28.99	–
2800	10.73	12.47	14.15	15.77	17.33	18.83	20.27	21.90	23.44	24.87	26.40	–	–
2880	10.89	12.65	14.35	15.99	17.57	19.07	20.51	22.14	23.67	25.08	26.57	–	–
2900	10.93	12.69	14.40	16.04	17.62	19.13	20.57	22.20	23.72	25.12	26.61	–	–
3000	11.10	12.90	14.63	16.30	17.89	19.40	20.84	22.46	23.96	25.33	26.76	–	–

Courtesy of Fenner Power Transmission UK

Table 8.6 Additional power increment per SPB belt

Speed of faster shaft (rpm)	Additional power (kW) per belt for speed ratio									
	1.00 to 1.01	1.02 to 1.05	1.06 to 1.11	1.12 to 1.18	1.19 to 1.26	1.27 to 1.38	1.39 to 1.57	1.58 to 1.94	1.95 to 3.38	3.39 and over
100	0.00	0.01	0.02	0.04	0.04	0.06	0.07	0.07	0.08	0.08
200	0.00	0.01	0.04	0.07	0.09	0.11	0.13	0.15	0.16	0.17
300	0.00	0.02	0.06	0.10	0.14	0.17	0.20	0.22	0.24	0.25
400	0.00	0.03	0.07	0.13	0.19	0.22	0.26	0.29	0.32	0.34
500	0.00	0.04	0.09	0.17	0.23	0.28	0.33	0.37	0.40	0.43
600	0.00	0.04	0.12	0.20	0.28	0.34	0.40	0.45	0.48	0.51
700	0.00	0.05	0.13	0.24	0.33	0.39	0.46	0.52	0.57	0.59
720	0.00	0.05	0.14	0.25	0.33	0.41	0.48	0.54	0.59	0.62
800	0.00	0.06	0.16	0.28	0.37	0.45	0.53	0.60	0.65	0.69
900	0.00	0.07	0.18	0.31	0.42	0.51	0.60	0.66	0.72	0.77
960	0.00	0.07	0.19	0.32	0.44	0.54	0.62	0.70	0.77	0.81
1000	0.00	0.07	0.19	0.34	0.46	0.56	0.66	0.74	0.81	0.86
1100	0.00	0.08	0.22	0.37	0.51	0.62	0.72	0.81	0.89	0.94
1200	0.00	0.09	0.23	0.41	0.56	0.68	0.79	0.89	0.97	1.03
1300	0.00	0.09	0.25	0.44	0.60	0.73	0.86	0.96	1.05	1.11
1400	0.00	0.10	0.28	0.48	0.65	0.79	0.93	1.04	1.13	1.20
1440	0.00	0.10	0.28	0.48	0.66	0.79	0.94	1.06	1.15	1.21
1500	0.00	0.10	0.29	0.51	0.69	0.84	0.99	1.11	1.21	1.28
1600	0.00	0.11	0.31	0.54	0.75	0.90	1.05	1.19	1.29	1.37
1700	0.00	0.12	0.34	0.58	0.79	0.95	1.12	1.26	1.37	1.45
1800	0.00	0.13	0.35	0.61	0.84	1.01	1.19	1.34	1.45	1.54
1900	0.00	0.13	0.37	0.65	0.88	1.07	1.25	1.41	1.54	1.63
2000	0.00	0.14	0.39	0.68	0.93	1.13	1.32	1.48	1.62	1.71
2100	0.00	0.15	0.41	0.72	0.98	1.18	1.39	1.56	1.69	1.79
2200	0.00	0.16	0.43	0.75	1.02	1.24	1.45	1.63	1.78	1.88
2300	0.00	0.16	0.45	0.78	1.07	1.29	1.51	1.71	1.86	1.97
2400	0.00	0.17	0.47	0.82	1.11	1.35	1.58	1.78	1.94	2.05
2500	0.00	0.18	0.49	0.85	1.16	1.41	1.65	1.86	2.02	2.14
2600	0.00	0.19	0.51	0.89	1.21	1.46	1.72	1.92	2.10	2.22
2700	0.00	0.19	0.53	0.92	1.25	1.52	1.78	1.99	2.18	2.31
2800	0.00	0.20	0.54	0.95	1.29	1.57	1.84	2.07	2.26	2.39
2880	0.00	0.20	0.56	0.97	1.32	1.60	1.88	2.11	2.31	2.44
2900	0.00	0.21	0.57	0.99	1.34	1.63	1.91	2.15	2.34	2.48
3000	0.00	0.22	0.59	1.02	1.39	1.69	1.98	2.23	2.42	2.57

Courtesy of Fenner Power Transmission UK

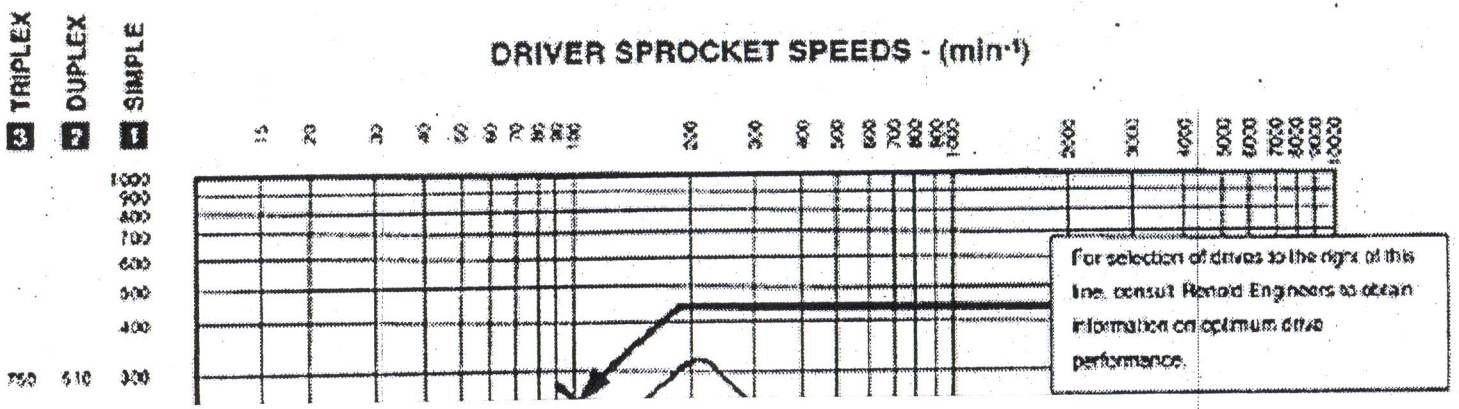
Table 8.9 Chain reduction ratios as a function of the standard sprockets available

Number of teeth in the driven sprocket N_2	Number of teeth in the drive sprocket N_1					
	15	17	19	21	23	25
25	–	–	–	–	–	1.00
38	2.53	2.23	2.00	1.80	1.65	1.52
57	3.80	3.35	3.00	2.71	2.48	2.28
76	5.07	4.47	4.00	3.62	3.30	3.04
95	6.33	5.59	5.00	4.52	4.13	3.80
114	7.60	6.70	6.00	5.43	4.96	4.56

Reproduced from Renold, 1996.

Table 8.10 Application factor

Driven machine characteristics	Driver characteristics		
	Smooth running, e.g. electric motors, IC engines with hydraulic coupling	Slight shocks, e.g. IC engines with more than six cylinders, electric motors with frequent starts	Heavy shocks, e.g. IC engines with less than six cylinders
Smooth running, e.g. fans, pumps, compressors, printing machines, uniformly loaded conveyors	1	1.1	1.3
Moderate shocks, e.g. concrete mixing machines, non-uniformly loaded conveyors, mixers	1.4	1.5	1.7
Heavy shocks, e.g. planars, presses, drilling rigs	1.8	1.9	2.1


DRIVER SPROCKET SPEEDS - (min-1)
3 TRIPLEX
2 DUPLEX
1 SIMPLE
For selection of drives to the right of this line, consult Renold Engineers to obtain information on optimum drive performance.