UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION

JANUARY 2011 SESSION

SUBJECT CODE	:	FMB 11302
SUBJECT TITLE	:	MACHINE ELEMENTS
LEVEL	:	BACHELOR
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 THREE (3) questions.

6. Answer all questions in ENGLISH ONLY.

THERE ARE 5 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total : 40 marks)

INSTRUCTIONS: Answer questions.
Please use the answer booklet provided.

Question 1

a) A chain transmission is the best to be chosen in a system that require a high torque transmission. List 3 important advantages of chain transmission compared with belt drives.

(6 marks)

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

(4 marks)

Question 2

a) There are several term used to describe the gear system characteristic. Explain the term below:-

i.   Gear backlash

(5 marks)

ii.   Diametral pitch

(5 marks)

Question 3

(a)   Using belt transmission system may has several limitation. List 2 limitation of belt drives.

(5 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. Explain the reasons why the contact area is important.

(5 marks)

Question 4

a) Describe a failure and condition of parallel misalignment.

(5 marks)

b) Describe a failure and condition of angular misalignment.

(5 marks)

SECTION B (60 marks)

INSTRUCTIONS: Answer only THREE (3) questions.
Please use the answer booklet provided.

Question 5

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.

                            (4 marks)

    ii.   Find maximum permissible stress on the belt.

                            (4 marks)

    iii.   Find the belt velocity

                            (4 marks)

    iv.   Find the mass per unit length

                            (4 marks)

    v.   Find the centrifugal load

                            (4 marks)

Question 6

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 7

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

(4 marks)

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

(4 marks)

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

(4 marks)

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

(4 marks)

v.   Calculate the Selection Power

(4 marks)

Question 8

a) Connecting a servomotor to a ballscreew by coupling may generate a backlash in the positioning. Define a coupling that used for eliminating any backlash or flexibility for this shaft connection.

(5 marks)

b) List 2 flexible couplings that can be used to a shafts with minimal misalignment.

(5 marks)

c) Multiple disc clutches is design to provide a large contact area between the pressure plate and the clutch plate to transmit the torque needed. List and describe 2 advantages of using multiple disc clutch in compared with single plate (disc) clutch.

(5 marks)

d) Differentiate between friction shoe brake and friction disc brake.

(5 marks)

END OF QUESTIONS

Attachment

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

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

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

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

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

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

$$Power = (F_1 - F_2)V$$

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

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

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

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

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

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

$$C = \frac{p}{8}\left[2L - N_2 - N_1\right.$$

$$\left. + \sqrt{(2L - N_2 - N_1)^2 - \frac{\pi}{3.88}(N_2 - N_1)^2}\right.$$

Table 8.2 Service factors

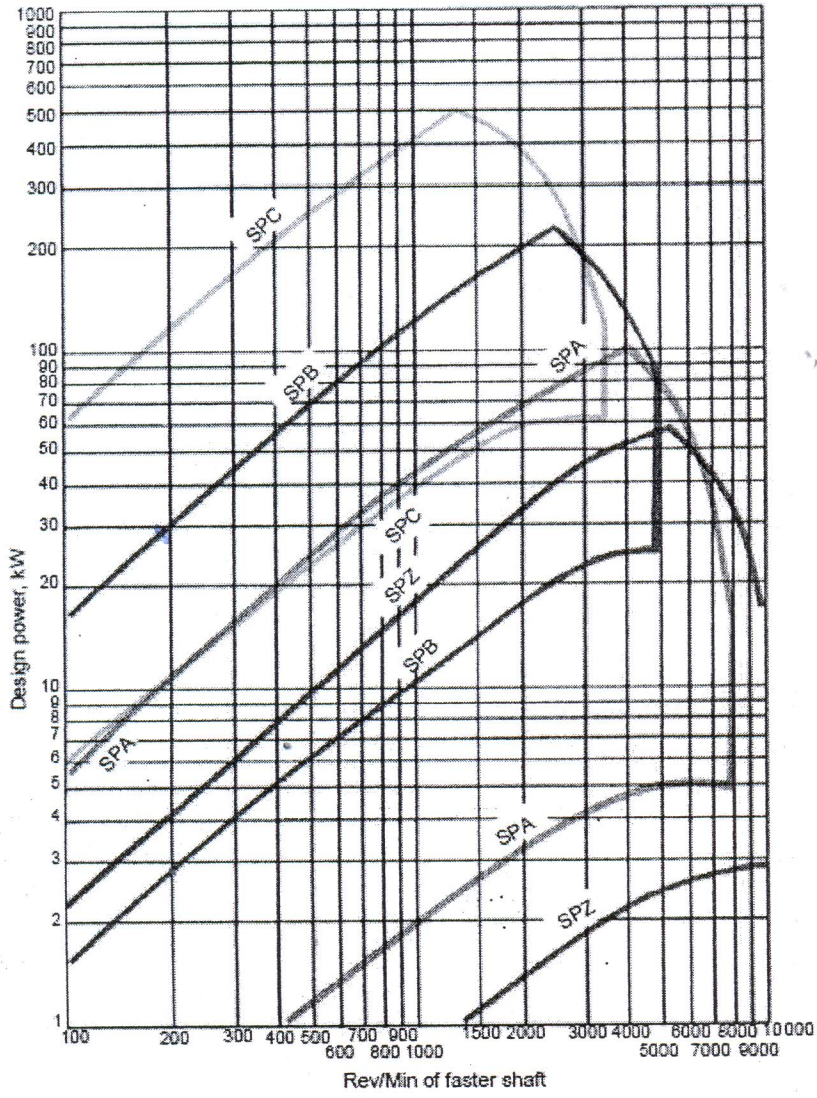| Types of driven machine	Type of prime mover					

	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)					
	<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	13.22
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	10.06	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	12.58	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
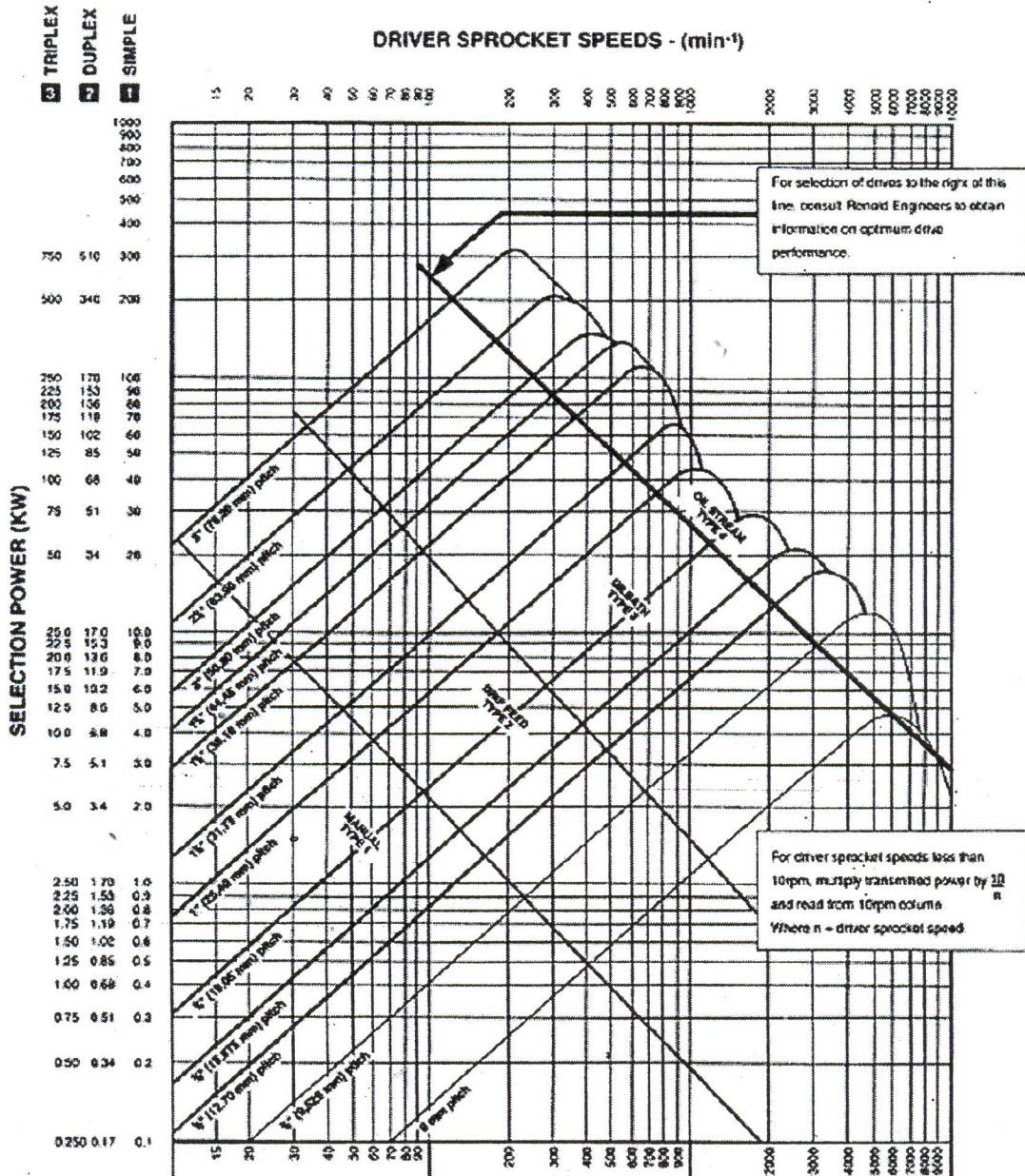
Figure 8.15 British Standard chain drives rating chart using 19 tooth drive sprocket (courtesy of Renold Chain).

1 Kilowatt = 1.34 hp.