



HND/C PHASE TEST RESIT SPECIFICATION

Programme:	HND Automotive Engineering / Motorsport Engineering				
Unit:	Mechanical Principles				
Phase Test No:	2	Lecturer:	T Tudor	Internal Verifier:	A Summerfield

Time and Date:	Sept 2012	Duration:	90 mins	Contribution to Overall Unit Assessment (%):	25%
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Outcomes being Assessed (from Unit Syllabus):	
Number	Description
Learning Outcome 3:	Investigate power transmission system elements
Learning Outcome 4:	Investigate the dynamics of rotating systems

For Attention of Students:

Answer **ALL** questions.

The mark allocation is as indicated – total 50 marks.

A 'formula sheet' is provided for reference.

Assume 'g' = 9.81 m/s^2 .

and $1 \text{ bar} = 10^5 \text{ N/m}^2 (\text{Pa})$

Model Answers

1. A multi-plate clutch must transmit 115 kW of power without slipping at 7000 rev/min. The coefficient of friction is 0.5. The inner and outer diameters are 40 and 200 mm respectively. The axial force applied to the plates is 400 N. Determine the number of plates required using:

- a) The uniform pressure theory.
- b) The uniform wear theory.

Assuming each side of each plate is effective.

(10 marks)

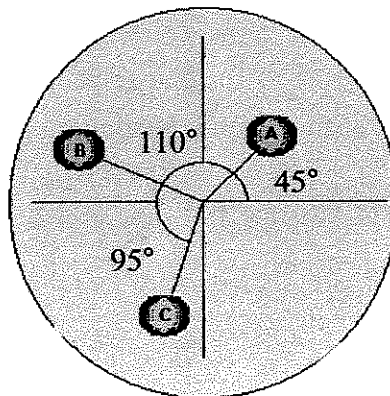
2. A belt drive must transmit 10 kW of power at 6000 rev/min. The pulley wheel is 140 mm diameter and the coefficient of friction is 0.33. The lap angle is 132° . If the initial belt tension must not exceed 140 N calculate the minimum number of belts required. Take the belt mass to be negligible.

(10 marks)

3. Three masses A, B and C are placed on a balanced disc as shown, at radii of 80 mm, 120 mm and 95 mm respectively.

The masses are 0.9 kg, 0.6 kg and 0.6 kg respectively.

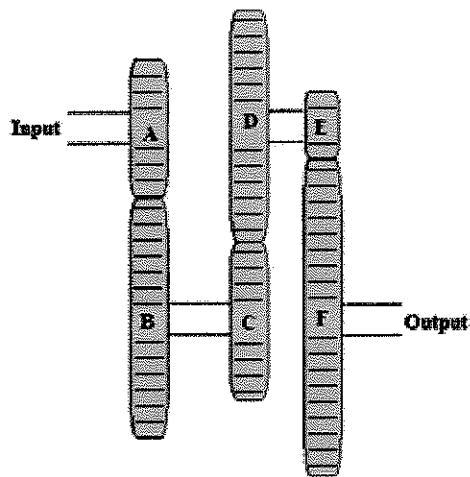
A fourth balancing mass is to be added to statically balance the system. Calculate the mass of this balancing mass, given it is to be placed at a radii of 50mm. Also determine the angular position at which it must be placed.



(10 marks)

4. The diagram below shows a compound gear train.

Gear A has 30 teeth
Gear B has 80 teeth
Gear C has 40 teeth
Gear D has 60 teeth
Gear E has 10 teeth
Gear F has 90 teeth



Gear A is the input gear and revolves at 4000 rev/min clockwise when viewed for the left end. If the input torque is 5 Nm and the gear train efficiency is 76% calculate the following;

- the output speed and direction
- the output power
- the holding torque required

(10 marks)

END OF TEST

Q1 $P = 115 \times 10^3 \text{ W}$
 $N = 7000 \text{ RPM}$
 $\mu = 0.5$
 $r_2 = 0.1$
 $r_1 = 0.02$
 $W = 400 \text{ N}$

$$\tau = \frac{P \times 60}{2\pi N} = \frac{115000 \times 60}{2\pi \times 7000} = 156.88 \text{ Nm}$$

$$T = \frac{2}{3} \mu W \frac{(r_2^3 - r_1^3)}{(r_2^2 - r_1^2)} \times 2n \quad | \quad T = \frac{\mu W (r_2 + r_1) \times 2n}{2}$$

$$n = \frac{3 \times T (r_2^2 - r_1^2)}{4 \mu W (r_2^3 - r_1^3)}$$

$$n = \frac{3 \times 156.88 \times (0.1^2 - 0.02^2)}{4 \times 0.5 \times 400 \times (0.1^3 - 0.02^3)}$$

$$n = 5.69$$

$\therefore$ 6 plates

$$n = \frac{2T}{2\mu W (r_2 + r_1)}$$

$$n = \frac{156.88}{0.5 \times 400 \times (0.1 + 0.02)}$$

$$n = 6.54$$

$\therefore$ 7 plates

Q2 $P = 10000 \text{ W}$
 $N = 6000 \text{ RPM}$
 $D = 0.14 \text{ m}$
 $\mu = 0.33$
 $\theta = 132^\circ = 2.304 \text{ rad}$
 $F_i = 140 \text{ N}$

$$v = \omega r = \frac{2\pi \times 6000}{60} \times \frac{0.14}{2} = 43.98 \text{ m/s}$$

when stationary $F_1 = F_2 = 140 \text{ N}$

$$\text{constant} = F_1 + F_2 = 280 \text{ N}$$

$$\frac{F_1}{F_2} = e^{\mu \theta} = e^{0.33 \times 2.304} = 2.139$$

$$F_1 = 2.139 F_2$$

$$F_1 = 2.139 (280 - F_1)$$

$$F_1 = 190.795 \text{ N} \quad F_2 = 89.2 \text{ N}$$

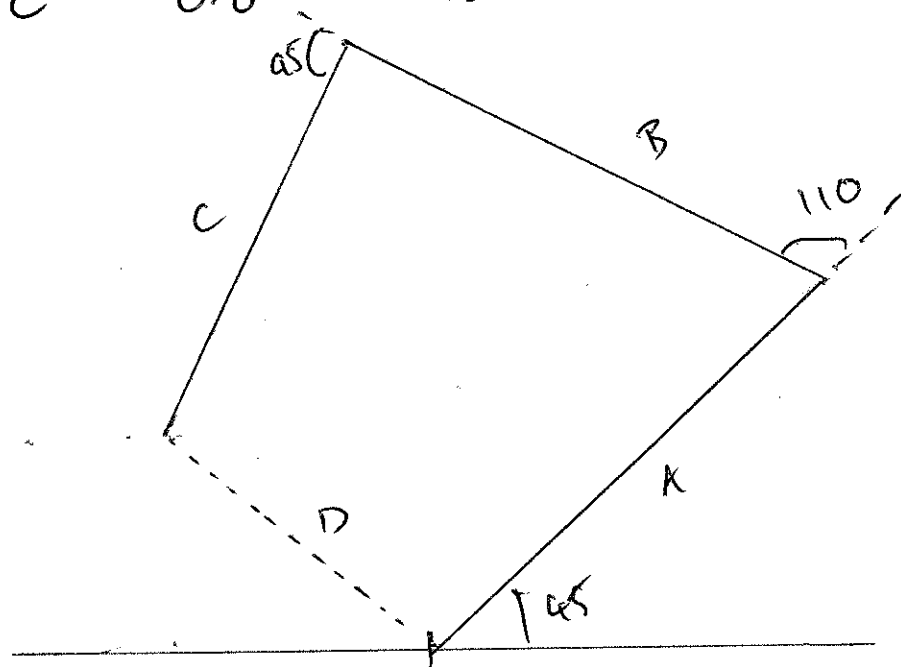
$$\begin{aligned} \text{Power per belt} &= v(F_1 - F_2) \\ &= 43.98(190.8 - 89.2) \\ &= 4468.2 \text{ W} \end{aligned}$$

$$N_o B = \frac{10000}{4468.2} = 2.24$$

$\therefore$ 3 belts

~~Q33~~

	Mass	r	Mr
A	0.9	86	72
B	0.6	120	72
C	0.6	95	57.



Approx

$$b \approx 46 \text{ mm} \quad @ \approx 330^\circ$$

$$Mr = 46 = m \times 50 \quad \text{Approx.}$$

$$m = \frac{46}{50} = 0.92 \text{ kg}$$

Q4 $\eta = 0.76$
 $N_1 = 4000 \text{ RPM}$
 $T_1 = 5 \text{ Nm}$ } Clockwise

$t_a = 30$

$t_b = 80$

$t_c = 40$

$t_d = 60$

$t_e = 10$

$t_f = 90$

$GR = \frac{80}{30} \times \frac{60}{40} \times \frac{90}{10} = 16.$

$GR = \frac{N_1}{N_2}$

$N_2 = \frac{N_1}{GR} = \frac{4000}{16} = 250 \text{ RPM}$
 anticlockwise

$P_1 = \frac{2\pi N_1}{60} \times T_1 = \frac{2\pi \times 4000}{60} \times 5 = 2094.4 \text{ W.}$

$P_2 = 0.76 \times 2094 = 1591.7 \text{ W}$

$T_2 = \frac{60 P_2}{2\pi N_2} = \frac{60 \times 1591.7}{2\pi \times 250} = 60.8 \text{ Nm (anticlock)}$

$T_1 + T_2 + T_h = 0$

$T_h = -T_1 - T_2 = -5 - (-60.8) = 55.79 \text{ Nm}$
 Clockwise.