

LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 5

LEFEL 5

MODULE CODE: M5X02201
MECHANICAL PRINCIPLES

PHASE TEST 2

TIME: 2 HOURS + 30 MINUTES SUBMISSION ALLOWANCE

ANSWER ALL QUESTIONS

Calculators are permitted – show your workings

THIS IS AN OPEN BOOK EXAMINATION FOR ONLINE SUBMISSION

The examination will be uploaded to Moodle at 13:00Hrs on the 11th of May 2020.

You have 2 hours to complete the paper and a further 30 minutes to prepare your submission.

Submission: You are required to take legible, clear digital photographs of your answers and workings which you must then upload these to the submission folder on Moodle.

If you have any issues with your submission you should email tim.tudor@uwtsd.ac.uk within the allotted time with a contact phone number so that I can contact you with further instructions.

Assume acceleration due to gravity 'g' = 9.81 m/s^2 .
1 Bar = 10^5 N/m^2 (Pa)

ANSWER ALL QUESTIONS

Show all your workings and state any assumptions or approximations you have made.

QUESTION ONE

Calculate:

- i) The maximum torque and power which can be transmitted at 1800 RPM by a brand new clutch if it has an outer diameter of 120mm, an inner diameter of 40mm and a coefficient of friction of 0.45. The axial force may be taken as 900N.

(5 Marks)

- ii) The reduction in torque and power which can be transmitted by the same clutch at 1800 RPM when worn by 1.55mm, if the axial force is provided by 6 springs, each with a rate of 25 N/mm.

(5 Marks)

QUESTION TWO

A belt drive must transmit 5 kW of power at 2500 rev/min. The pulley wheel is 130 mm diameter and the coefficient of friction is 0.4. The lap angle is 128° . Assuming the initial belt tension is 250 N and the belt mass may be taken to be negligible;

- a) Calculate the linear velocity of the belt

(2 Marks)

- b) Calculate the maximum and minimum belt tensions

(4 Marks)

- c) Calculate the maximum power transmitted per belt

(2 Marks)

- d) Calculate the number of belts required

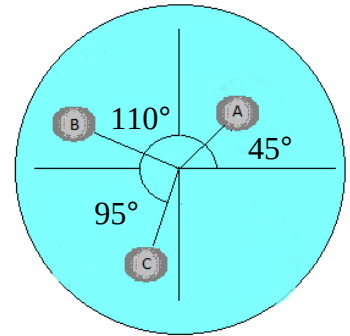
(2 Marks)

QUESTION THREE

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.

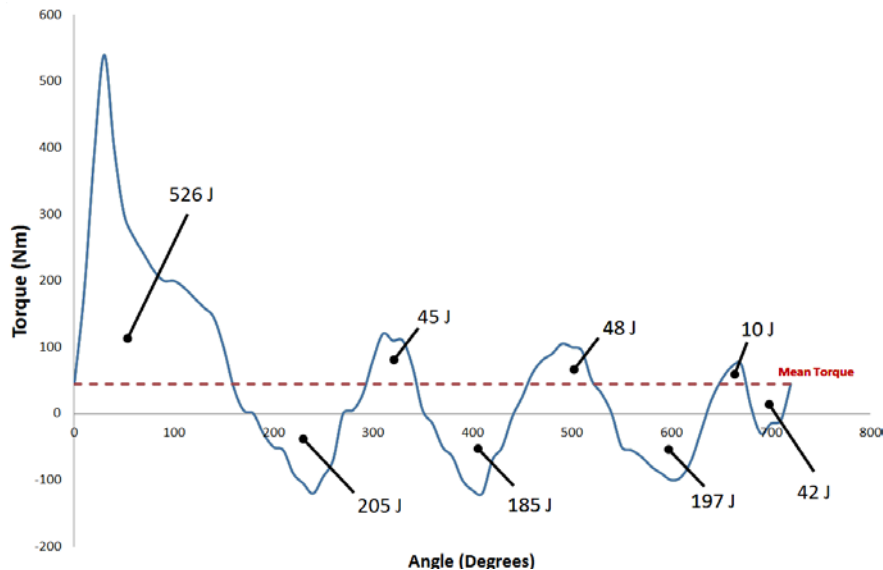
The masses are 0.87 kg, 0.55 kg and 0.58 kg respectively.

A fourth balancing mass, D, is to be added at a radii of 40mm to statically balance the system.



- Construct a table to calculate the magnitude of the forces created by the rotating masses
(2 Marks)
- Construct a vector diagram using a suitable scale to represent the resultant force.
(4 Marks)
- Calculate the mass of the unknown mass D
(2 Marks)
- Calculate the angular position at which the balancing mass D should be placed
(2 Marks)

QUESTION FOUR



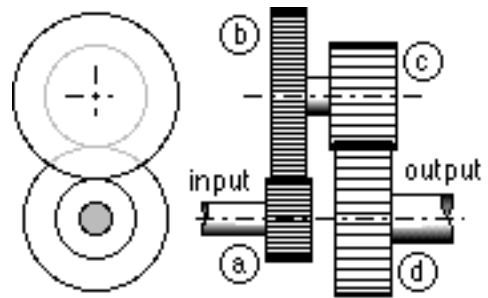
The diagram above shows a torque - angle diagram for a certain machine. If the speed of the shaft must be maintained between 2400 and 2500 rev/min, calculate

- the coefficient of fluctuation of speed
(2 Marks)
- the maximum fluctuation of energy (βW)
(3 Marks)
- the moment of inertia of a suitable flywheel.
(2 Marks)
- The mass and thickness of the flywheel if it is to take the form of a simple steel disc of radius 150 mm and density 7850Kg/m³.
(3 Marks)

QUESTION FIVE

The diagram below shows a compound gear train.

- Gear A has 32 teeth
- Gear B has 64 teeth
- Gear C has 24 teeth
- Gear D has 36 teeth



Gear A is the input gear and revolves at 2500 rev/min anticlockwise when viewed for the left end. If the input torque is 20 Nm and the gear train efficiency is 85%

- a) State which gears must have the same module/pitch (1 Mark)
- b) Calculate the output speed and direction (3 Marks)
- c) Calculate the output power (3 Marks)
- d) Calculate the holding torque required (3 Marks)

Mechanical Principles Formula Sheet 2

General

$$v = \omega r \qquad T = I\alpha \qquad W = T\theta \qquad \text{Power} = \frac{2\pi NT}{60}$$

Friction Clutches

Constant Wear

Constant Pressure

For plain disc clutches:

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

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

For conical clutches:

$$T = \frac{\mu R}{3\sin\beta} \left[\frac{D_o^3 - D_i^3}{D_o^2 - D_i^2} \right]$$

$$T = \frac{\mu W(D_o + D_i)}{4\sin\beta}$$

Belt Drives

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

Assuming negligible belt mass

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

$$P = v(F_1 - F_2)$$

Assuming belt mass per meter, m

$$F_c = mv^2$$

$$\frac{F_1 - F_c}{F_2 - F_c} = e^{\mu\theta} \qquad P = v(F_1 - F_c)\left(1 - \frac{1}{e^{\mu\theta}}\right)$$

Flywheels and inertia

$$I = \frac{\beta W}{\omega_m^2 \phi}$$

$$\phi = \frac{\omega_2 - \omega_1}{\omega_m}$$

$$\omega_m = \frac{\omega_1 + \omega_2}{2}$$

$$I = Mk^2$$

$$I = \frac{Mr^2}{2}$$

Balancing

$$F = M\omega^2 r$$

$$F = \frac{Mv^2}{r}$$

$$\text{For balance: } m_1 r_1 = m_2 r_2$$

Gear Trains

$$\text{Gear ratio} = \frac{N_1}{N_2} = \frac{t_2}{t_1}$$

$$\eta = \frac{\text{Power Out}}{\text{Power In}}$$

$$t_i + t_o + t_h = 0$$