

TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF MECHANICAL & AUTOMOTIVE
ENGINEERING

DIPLOMA IN MARINE ENGINEERING
EMG 2314: APPLIED MECHANICS IV
END OF SEMESTER II YEAR III EXAMINATION

SERIES: APRIL 2016

TIME: 2 HOURS

DATE: Pick Date Select Month Pick Year

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES

1. You are required to have the following for this examination:
 - Examination Booklet, Examination pass and student ID.
 - Drawing instruments
 - Scientific calculator
2. This paper consists of **FIVE** Questions.
3. Answer **ANY THREE** Questions.
4. Maximum marks for each part of a question are shown.
5. Take gravitational acceleration, $g = 9.81\text{m/s}^2$ where applicable.
6. Show all your working on the answer booklet
7. **Do not write on the question paper**

QUESTION ONE

- (a) A single clutch is to have an internal and external radii, r_1 and r_2 respectively. If the limiting coefficient of friction is μ and the axial spring loading is W , show that the maximum torque transmitted by the clutch is given by:

(i) $\frac{2}{3} \mu W \left[\frac{r_2^3 - r_1^3}{r_2^2 - r_1^2} \right]$; assuming uniform pressure intensity on the contact surfaces

(ii) $\mu W \left[\frac{r_2 + r_1}{2} \right]$; assuming uniform wear of contact surfaces.

(12 arks)

- (b) A multi-plate clutch has four plates with friction surfaces on each side. Each spring used provides a spring force of 300N, and the assembly has six springs in it. The internal radius of the plates is 40mm and the external radius is 100mm. The coefficient of friction between the contact surfaces is 0.45. For both the constant pressure approach and the constant wear approach, determine the power that this clutch could transmit when running at 2400rev/min.

(8 Marks)

QUESTION TWO

- (a) A cone clutch is to be designed in order to have inner and outer radii of r_1 and r_2 respectively. If W is the axial load to be transmitted to the clutch and β is the semi-angle of the cone, show that the frictional torque transmitted by the clutch, assuming uniform wear, will be given by:

$$\mu W \left[\frac{r_2 + r_1}{2} \right] \cos ec \beta$$

Where, μ is the coefficient of friction between the contact surfaces

(8 Marks)

- (b) The mean diameter of the contact surfaces of a conical clutch is 300mm and the width of the conical surface is 60mm. The clutch is lined with a material giving a coefficient of friction of 0.3 and the semi-angle of the cone is 12.5° . If the intensity of pressure is limited to 70KN/m^2 , determine:-

- (i) The greatest power that can be transmitted at a speed of 1200rev/min.
(ii) The least axial force necessary to hold the clutch in engagement.

(12 Marks)

QUESTION THREE

- (c) With the aid of a suitable diagram, show that in a centrifugal clutch, the total frictional torque (T) transmitted by the clutch is given by:

$$T = n\mu R(F_c - F_s)$$

Where:

- n - Number of shoes in the clutch
- μ - Coefficient of friction
- R - Inside radius of rim
- F_c - Centrifugal force on each shoe
- F_s - Spring force on each shoe

(5 Marks)

- (b) A centrifugal clutch is designed with four shoes. The contact surface is 160mm radius and the friction force is μS , where S is the resultant of the normal forces on the surface and $\mu=0.25$. The centre of mass is 25mm from the contact surface. If the clutch is to commence engagement at 500rev/min, determine:

- (i) The value of S and the mass of each shoe.
- (ii) The force of the beam spring on the adjusting screw.
- (iii) The power transmitted at 750rev/min when the shoes have worn 2mm and have not been adjusted.

(15 Marks)

QUESTION FOUR

- (a) A gear box has an input speed of 1500rev/min clockwise and an output speed of 300rev/min anticlockwise. The input power is 20KW and the efficiency is 70%. Determine:
- i) The input and output torque
 - ii) The fixing torque of the casing

(5 Marks)

- (b) In a compound gear train shown in Figure Q4 (b), gear A is the input and revolves at 1200rev/min clockwise viewed from the left end. The input torque is 30Nm and the efficiency of the gear train is 70%. The number of teeth on the gears is: A=50, B=150, C=30 and D=60 teeth. Determine:

- i) The output speed and its direction
- ii) The output power and output torque

(6 Marks)

- (c) Figure Q4 (c) shows an epicyclic gear train in which wheel D is held stationary by the shaft A and arm B is rotated 200rev/min. The wheels E and F are fixed together and rotate freely on the pin carried by the arm. The wheel G is rigidly attached to the shaft C. The number of teeth on the wheels is: E=20, F=40 and G=30 teeth. If the system forms a reverted gear train and the module is common for all the gears, determine:

- (i) The number of teeth of D.
 - (ii) The speed of the shaft C and state its direction of rotation relative to that of B
- (9 Marks)

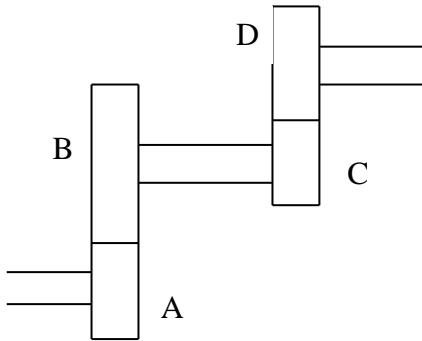


Figure Q4 (b)

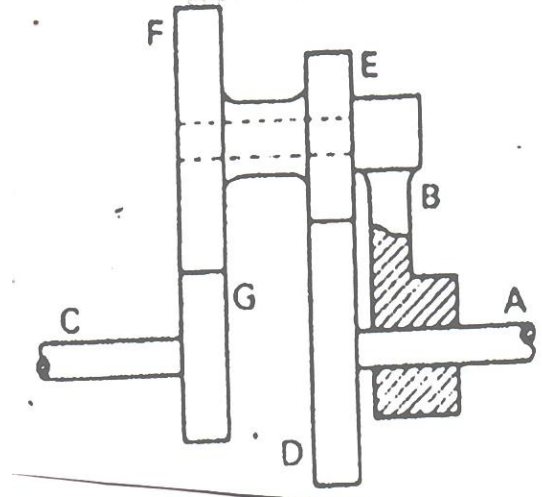


Figure Q4 (c)

QUESTION FIVE

- (a) A compressor requires 90KW in order to run at 250rev/min. The drive is by V-belt from an electric motor running at 750rev/min. The diameter of the pulley on the compressor shaft is 1m and the centre distance between the pulleys is 1.75m and the belt speed is 1600rev/min. The cross-sectional area of each belt is 375mm², the density of the belt material is 1000Kg/m³ and the allowable tensile stress in the material is 2.5MN/m². The groove angle of the pulley is 35° and the coefficient of friction between the belt and the pulley is 0.25. Determine the number of V-belts required to transmit the power.

(10 Marks)

- (b) A belt drive consists of two V-belts in parallel, on grooved pulleys of the same size. The angle of the groove is 30°. The cross-sectional area of each belt is 750mm² and the coefficient of friction between the belt and the pulley is 0.15. The density of the belt material is 1.5Mg/m³ and the maximum safe stress in the material is 7MN/m². If the diameter of the pulleys is 300mm, calculate:

- i) The power that can be transmitted between the pulleys
- ii) The shaft speed in rev/min at which the power transmitted would be a maximum.

(10 Marks)