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UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2010 SESSION

SUBJECT CODE : FMB 20202
SUBJECT TITLE : MECHANICS OF MACHINES
LEVEL : BACHELOR
TIME / DURATION : 4.00 pm – 6.00 pm
(2 HOURS)
DATE : 26 APRIL 2010

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. Answer four (4) questions only.
 6. Answer should be written in ENGLISH only.
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THERE ARE 5 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

INSTRUCTION: Answer FOUR (4) questions only

Please use the answer booklet provided.

Question 1

The three buffers at one end of a trailer each require a force of 1.5 MN/m of compression and engage with a truck having two similar buffers which travels on a straight horizontal track. The trailer has a mass of 25 tonnes and its speed is 3.5 m/s, while the truck has a mass of 10 tonnes with initial speed 1.5 m/s, in the same direction. Find,

- (a) the common speed when moving together during impact, (5 marks)
- (b) the kinetic energy then lost to the system and the compression of each buffer spring to store this, and (10 marks)
- (c) the velocity of each truck on separation if only 25% of the energy stored in the springs is returned. (10 marks)

Question 2

With reference to Figure 1, **E** is the engine flywheel, having moment of inertia 125 kg.m^2 . It is geared to pinion **D** so that the speed of **E** is $\frac{1}{5}$ of the speed of **D**. Pinion **D** is connected to the plate **C** of a dog clutch by a torsion spring which requires 200Nm torque to twist **C** through 1 radian relative to **D**. The flywheel **A**, having moment of inertia 0.6 kg.m^2 , is made to rotate at 1500 rev/min and then the dog clutch is engaged. The clutch can transmit torque from **B** to **C** only in the direction in which **A** is initially rotating or from **C** to **B** in the opposite direction.

Neglecting all losses and the inertia of parts **B**, **C** and **D**, and neglecting also any additional energy supplied by the motor used to give **A** its initial velocity, find

- (a) the final angular velocities of **D** and of **E**, and (15 marks)
- (b) the maximum torque transmitted by the clutch. (10 marks)

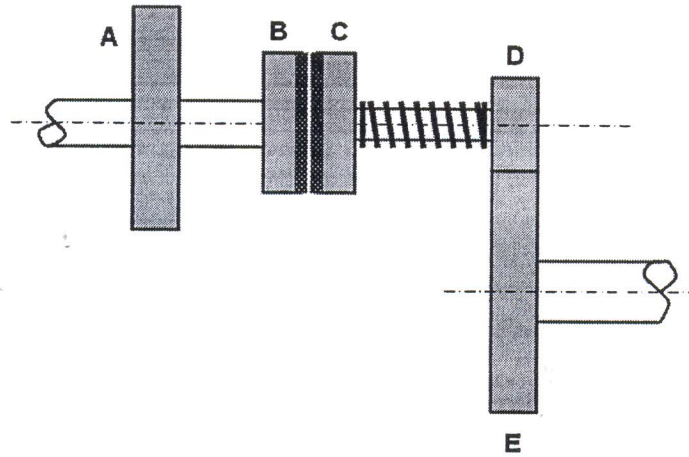


Figure 1. Inertia Starter for an Internal Combustion Engine.

Question 3

With reference to Figure 2, attached to a uniformly rotating shaft are four discs **A**, **B**, **C** and **D**, spaced at equal intervals along the shaft, of mass 7.5kg, 12.5kg, 7kg and 6kg respectively; the mass centres of the discs are at 4mm, 3mm, 5mm and 8mm respectively from the axis of rotation. An additional mass **M** may be attached to **D** at an effective radius of 60mm from the axis of rotation. Find

- (a) the minimum value of the mass of **M**, and (12.5 marks)
- (b) the relative angular positions of the mass centres of all the masses to ensure complete dynamic balance for the rotating shaft. (12.5 marks)

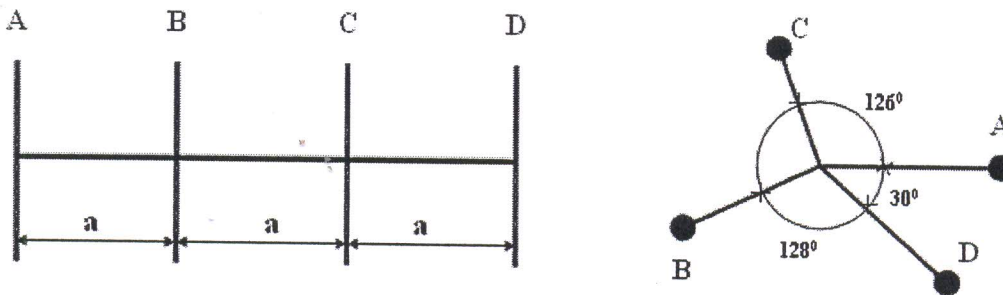


Figure 2

Question 4

With reference to Figure 3, a shaft 1.4m long carries four eccentric loads **A**, **B**, **C** and **D**, spaced at 0m, 0.45m, 0.75m and 1.4m from the end. The loads are respectively 7.5kg, 11kg, 15kg and 6kg, and eccentricities are 36mm, 48mm, 54mm and 96mm. The directions of the eccentricities of **B**, **C** and **D** relative to **A** are 60° , 200° and 270° . The shaft is carried in bearings **E** and **F**, which are 0.175m and 1.0m from **A**, **E** being between **A** and **B**.

- (a) Determine the maximum and minimum vertical forces on bearing **F**, when the shaft rotates at 90rev/min.

(20 marks)

- (b) What is the maximum speed at which the shaft may run, to ensure that the vertical component of the load on **F** is always downwards?

(5 marks)

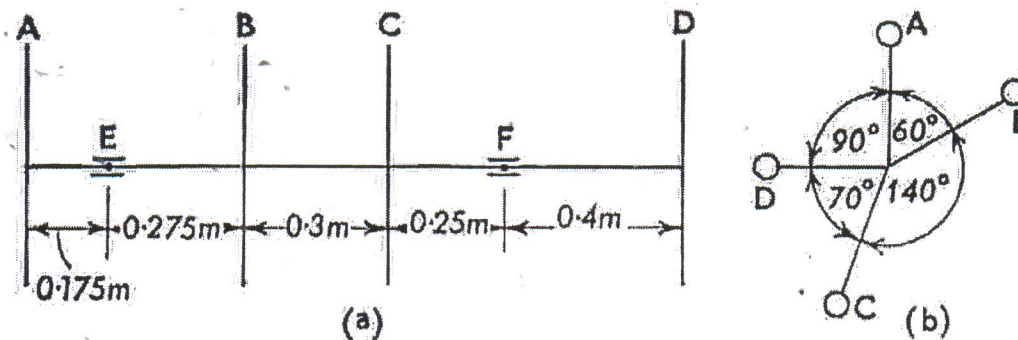


Figure 3

Question 5

With reference to Figure 4, two shafts, **A** and **B**, in the same straight line are geared together through an intermediate parallel shaft **C**. The wheel connecting **A** and **C** have a module of 2, those connecting **C** and **B** a module of 3.5. The speed of **B** is to be about, but less than, $1/5$ that of **A**. If the two pinions have each 16 teeth, find

- (a) suitable teeth for the wheels, (15 marks)
 (b) the actual ratio, and (5 marks)
 (c) the corresponding distance of shaft **C** from **A**. (5 marks)

Assuming that gears available has the following number of teeth; 30, 36, 40, 48, 54, 61, 68 and 82.

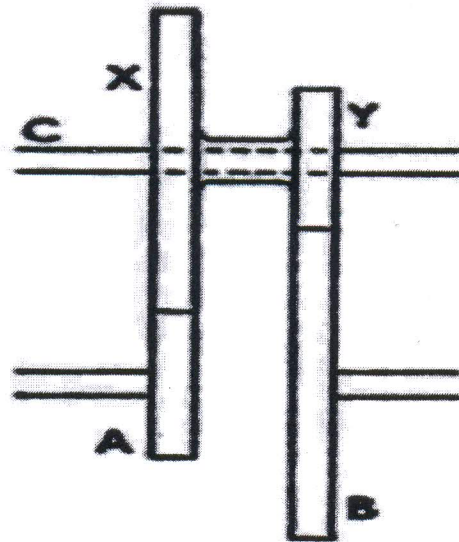


Figure 4

Question 6

In the reduction gear shown in Figure 5 below, there is an epicyclic train consisting of a sun-wheel A on the input shaft, a planet wheel B carried on an arm K on the output shaft, and an annular gear C. The latter can be held fixed, or can be connected directly to the input shaft through the spur gear drive DEFGH, as shown.

Find the speed ratio from input to output for the two cases:

- (a) with EFG disengaged, and C held against rotation; (5 marks)
- (b) with EFG engaged. (5 marks)

For case (b), determine also the torque transmitted between A and D, and between F and G, based on an input torque of 100Nm.

(15 marks)

Note:

The train EFG is not part of the epicyclic train and must therefore be treated separately.

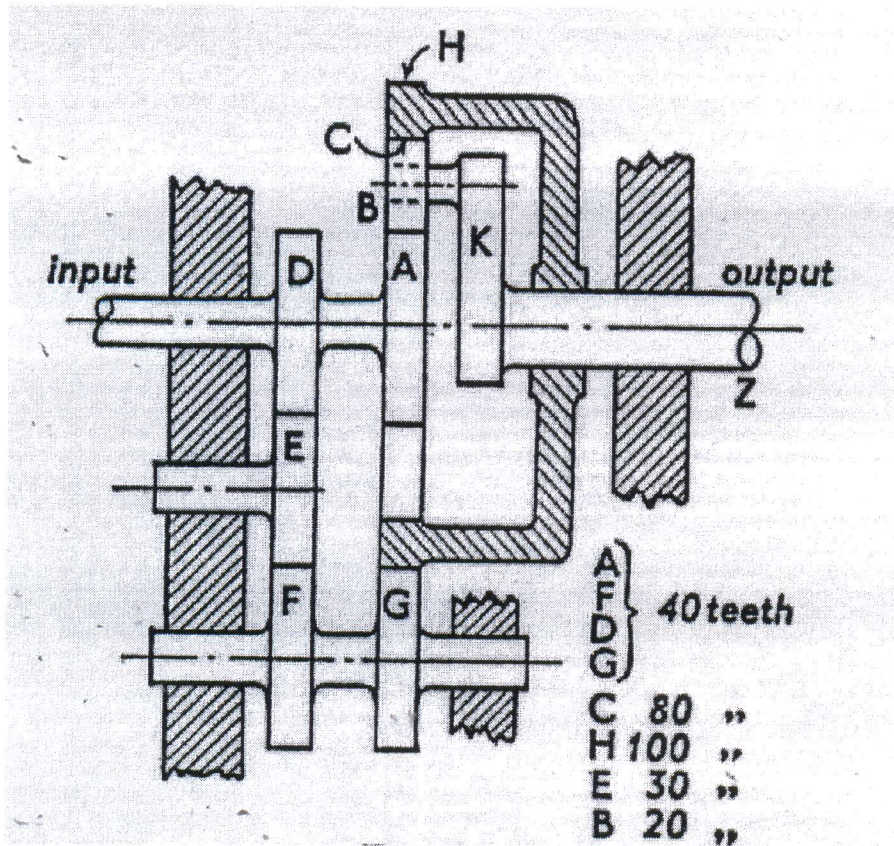


Figure 5

END OF QUESTION