The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Diploma in Technology/Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX6332 Vehicle Dynamics and Design of Automotive Components**
Academic Year	:	2013/14
Date	:	04 th September 2014
Time	:	0930 hrs. – 1230 hrs.
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of two parts, A and B. Part A consists of two (02) questions and part B consists of six (06) questions. You are required to answer only five (05) questions selecting at least one (01) question from part A.
3. All questions carry equal marks.

PART A

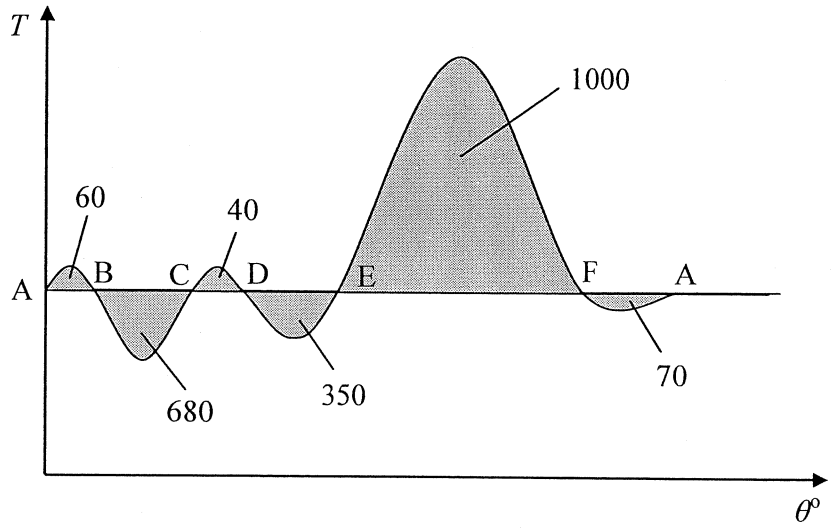
QUESTION 01

Fig. Q1 shows the turning moment diagram of a single cylinder gasoline engine running at a speed of 1800 rev/min. The turning moment diagram repeats at every two revolutions of the engine. Areas above and below the mean turning moment line are given in the figure in units of mm^2.

(a) If the moment of inertia of the effective mass on the engine crank pin is 0.7 kgm^2, determine the coefficient of fluctuation of speed of the crankshaft.

(b) Assuming that the flywheel is a solid block of diameter d and thickness t, and that the inertia of the flywheel together with the clutch is equal to 80% of the inertia of the engine rotating parts, determine the values of d and t using the following data.

Maximum peripheral velocity of the flywheel - 30 m/s
Density of the material of the flywheel - 7.8×10^3 kg/m^3



Scale : Vertical axis (Turning moment) : 1 mm = 5 Nm
Horizontal axis (Crank angle) : 1 mm = 1°

Fig. Q1

QUESTION 02

The following information are available in respect of a rear wheel driven truck and its motion.

Mass of the truck	- 4,000 kg
Maximum grade which the truck will have to negotiate	- $\tan^{-1}(0.05)$
Velocity at the maximum grade	- 40 km/h
Gear engaged, while driving at the maximum grade	- 2nd gear
Coefficient of rolling resistance	- 0.015
Aerodynamic drag coefficient	- 0.025
Total projected frontal area of the truck	- 4.8 m^2
Density of air	- 1.18 kg/m^3
Transmission efficiency in the second gear	- 80%
Transmission efficiency in the top gear	- 90%
Effective diameter of the road wheels	- 800 mm

(a) Determine the minimum power available at the engine speed of 3,600 rev/min on the second gear.

(b) Show that the maximum speed of the vehicle in the top gear on a level road at the engine speed of 3,600 rev/min is approximately equal to 158.8 km/h.

(c) Gear ratio of the second gear and the final drive (differential) gear ratio.

PART B

QUESTION 03

(a) Starting from fundamentals show that the inertia force (F_i) produced by the reciprocating parts of a crank mechanism is given by

$$F_i = mr\omega^2\left[\cos\theta + \left(\frac{r}{L}\right)\cos 2\theta\right]$$

where, m - mass of reciprocating parts
r - crank radius
L - length of the connecting rod
ω - angular speed of the crank shaft
θ - angular displacement of the crank shaft from the outer dead centre

(b) The following data are available for a vertical single cylinder engine and its crank mechanism.

Length of the connecting rod	- 825 mm
Stroke length	- 320 mm
Cylinder bore diameter	- 200 mm
Effective mass of reciprocating parts	- 125 kg
Speed of the engine	- 360 rev/min
Maximum gas pressure on the piston	- 1.2 MPa

Determine the effective turning moment on the crank shaft when the crank shaft has turned through an angle of 45° from the top dead centre position. Neglect friction and the effect of gravitational forces on the reciprocating parts.

QUESTION 04

(a) Show that the maximum torque (T) transmitted through a plate clutch having n pairs of contacting surfaces under uniform pressure conditions is given by

$$T = \frac{2}{3}\mu n P\left[\frac{r_1^3 - r_2^3}{r_1^2 - r_2^2}\right]$$

where μ - coefficient of friction between the plate surfaces
P - axial force
r_1 - outer radius of the plate
r_2 - inner radius of the plate

(b) A single plate clutch with one pair of contact surfaces transmits 80 kW from an engine running at 1,800 rev/min. Assuming that the pressure distribution is limited to 0.12 N/mm^2 and that the ratio of the outer radius of the clutch plate to the inner radius of the plate is 1.5, determine the outer and inner radii of the clutch plate. Assume that the coefficient of friction between the contact surfaces is 0.27.

QUESTION 05

The specifications of a motor vehicle are given in Table 5. Determine the maximum gradient uphill that this vehicle can negotiate when the vehicle is,

(a) front wheel driven
(b) rear wheel driven, separately.

Table 5

Static weight distribution on axles	1:1
Wheel base (m)	2.85
Height of the center of gravity above ground (m)	0.55
Coefficient of friction on the highway	0.75

QUESTION 06

The Gear ratios of a four speed gear box with a single lay shaft are given below.

First gear - 4.2 : 1 (approximately)
Second gear - 2.56 : 1 (approximately)
Third gear - 1.52 : 1 (approximately)
Top gear - 1 : 1 (direct coupling)

The speed of the engine shaft is 1.52 times the speed of the lay shaft approximately and the teeth of all the gears have a module of 3.25 mm. The smallest gear in the gear train must have at least 15 teeth.

Determine:
(a) Centre distance between the main shaft and the lay shaft
(b) Number of teeth in each gear wheel
(c) Actual gear ratios

QUESTION 07

(a) Fig. Q7 shows the theoretical and real P-V diagrams of a 4-stroke gasoline engine working on the Otto Cycle. Explain the following.

(i) Why point C on the real cycle does not coincide with top dead centre (TDC)?

(ii) Why pressure at point D on the real cycle is lower than the corresponding pressure of the ideal cycle?

(iii) Why points B and E on the real cycle do not coincide with bottom dead centre (BDC)?

(iv) Why pressure at point A is higher that pressure P_a?

(v) Why pressure at point F is lower than P_a?

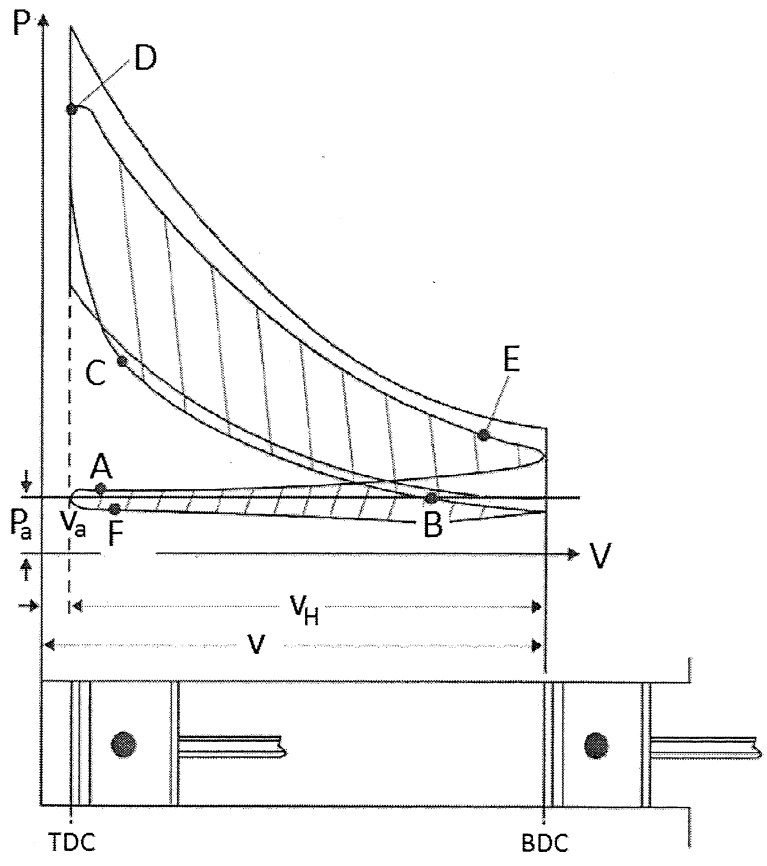


Fig. Q7

(b) What is the rolling resistance of a pneumatic tyre? Explain with the aid of a neat sketch.

(c) Discuss the effect of inflation pressure on the rolling resistance of a pneumatic tyre and list the other factors that influence the rolling resistance.

QUESTION 08

(a) Describe the boundary layer of a moving fluid by drawing its velocity gradient.

(b) Discuss the following two vehicle body improvements used in high speed vehicles to increase the aerodynamic downward force. Draw sketches where necessary.

(i) Using an inverted wing (a spoiler)

(ii) Positive rake

(c) Explain the following terms with the aid of neat sketches.

(i) Camber angle

(ii) Caster angle

(iii) Toe-in, Toe-out