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	:	**MEX6231 Automobile Engineering**
Academic Year	:	2014/15
Date	:	9th September 2015
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

(a) Starting from fundamentals show that the velocity of a piston in a reciprocating engine is given by

$$V_p = r\omega\left(\sin\theta + \frac{\sin 2\theta}{2n}\right)$$

where, V_p – velocity of the piston
ω – angular velocity of rotation of the crank shaft
θ – crank angle
n – ratio of connecting rod length to crank radius

(b) For an engine rotating at 1800 rev/min and having a crank radius of 50 mm and a connecting rod length of 150 mm, determine the maximum velocity of the piston and the corresponding crank angle.

QUESTION 02

(a) Starting from first principles, show that the air standard efficiency of an engine, working on the Otto cycle is given by,

$$\eta = 1 - \frac{1}{r^{\gamma-1}}$$

(b) A four cylinder four-stroke engine was tested for two minutes in a rope brake dynamomenter at a speed of 5600 rev/min. A total of 560 g of fuel was consumed. The radius of the brake pulley was 340 mm. The difference in tension on either side of the brake pulley was 400 N.

You may assume that,

Bore diameter	- 180 mm
Stroke length	- 200 mm
Clearance volume is 10% of total swept volume	
Mechanical efficiency	- 82%
Calorific value of fuel	- 45,000 kJ/kg
Ratio of specific heats	- 1.4

Determine the following.

i) Compression ratio
ii) Indicated power
iii) Brake power
iv) Indicate mean effective pressure
v) Indicated efficiency
vi) Otto cycle efficiency
vii) Specific fuel consumption

PART B

QUESTION 03

In the epicyclic gear shown in Fig. Q3, a brushh less DC motor is conencted to the sun gear, and an IC engine is connected to the planet carrier. The sun wheel has 15 teeth and the planet gear has 20 teeth. If the electric motor and the engine are rotating at 2000 rev/min and 1500 rev/min respectively in the clockwise direction. Calculate the final resultant speed of the ring gear.

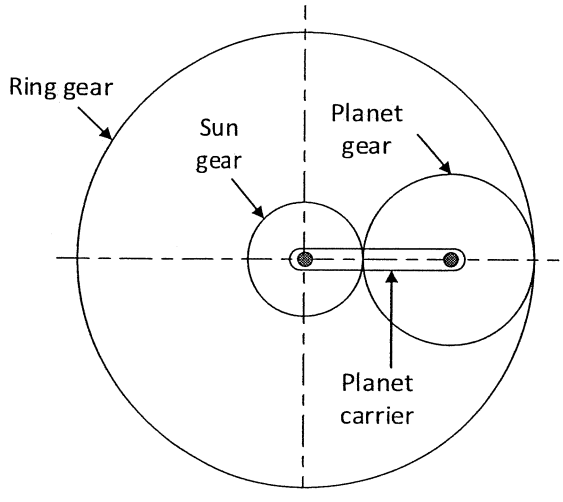


Fig. Q3

QUESTION 04

(a) From first principles derive mathematical expressions to determine the following of a disc brake system:

i) Frictional braking torque acting on the pad.
ii) Work done per minute by this torque.
iii) Amount of heat generated per second when brakes are applied.

(b) Following data of a disc brake system of an automobile is available.

Effective radius at which hydraulic force is applied	- 130 mm
Contact area of each pad	- 0.002 m^2
Coefficient of friction between pads and disc	- 0.37
Frictional braking torque to be exerted	- 135 Nm

i) Calculate the hydraulic pressure developed inside the wheel cylinder during braking.

ii) If the disc speed reduces uniformly from 15 rev/sec to 7.5 rev/sec while braking, determine the power absorbed by the brakes of an automobile fitted with two such brake assemblies.

iii) Calculate the total heat generated when brakes are applied.

QUESTION 05

(a) Derive an equation to express the maximum torque transmitted by a multi-plate clutch if:

r_1 - internal radius of the effective area
r_2 - external radius of the effective area
μ - the limiting coefficient of friction
P - axial spring pressure

Assume that the pressure is uniformly distributed over the contact area.

(b) The following information is available for a single plate clutch of an automobile. The clutch has effective clutch lining on both sides of the plate disc.

Maximum possible torque developed by the engine	- 35 Nm
Coefficient of friction of the clutch lining	- 0.25
Maximum axial pressure developed by the clutch	- 0.9 x 10^5 N/m^2
Ratio r_2: r_1	- 1.4:1

Design a clutch plate to suit the above conditions.

(c) If an engine drives a load through the above clutch unit, determine the time required for the rotating components of the load to reach 1500 rev/min from standstill when it transmits the maximum torque. Assume the equivalent moment of inertia of rotating components of the load to be 1.9 kgm^2.

QUESTION 06

A six cylinder, four stroke engine with a motronic fuel injection system is running at 5400 rev/min. If the discharge rate of the injector is 0.08 ml/ms, determine the fuel injection duration.

You may use the additional data given below.

Stroke	- 120 mm
Bore diameter	- 140 mm
Volumetric efficiency	- 72%
Atmospheric pressure	- 103 kN/m^2
Temperature	- 31°C
Universal gas constant for air	- 0.287 kJ/kg.K
Air fuel ratio	- 14:1
Specific gravity of fuel	- 0.8

QUESTION 07

The following parameters are given for a typical gasoline engine.

Power developed by the engine	- 90 kW
Volumetric efficiency	- 72%
Mechanical efficiency	- 85%
Calorific value of gasoline	- 45 MJ/kg
Excess air factor	- 5%
Pressure of the mixture at the end of suction stroke	- 8.24×10^4 N/m^2.
Temperature of the mixture at the end of suction stroke	- 320 K
Gas constant for air	- 0.287 kJ/kgK
Stoitiometric air/fuel ratio	- 14.5:1

Find the cylinder dimensions for a four cylinder four stroke engine if the engine is to develop 120 kW at 2200 rev/min. Assume that the stroke to bore ratio is 1.25, thermal efficiency is 26% and densitiy of petrol vapour in the mixture is twice that of air.

Determine,

i) Indicated power
ii) Theoretical air requirement
iii) Actual air requirement
iv) Total swept volume per sec
v) Bore diameter of the engine and stroke length

QUESTION 08

The position of the plunger of an inline type diesel fuel injection pump in four different positions is shown in Fig. Q8. Referring the figure,

i) explain the operation of a typical inline type diesel fuel injection pump.
ii) explain how the amount of fuel delivered is adjusted.
iii) explain the basic calibration procedure for an inline pump.

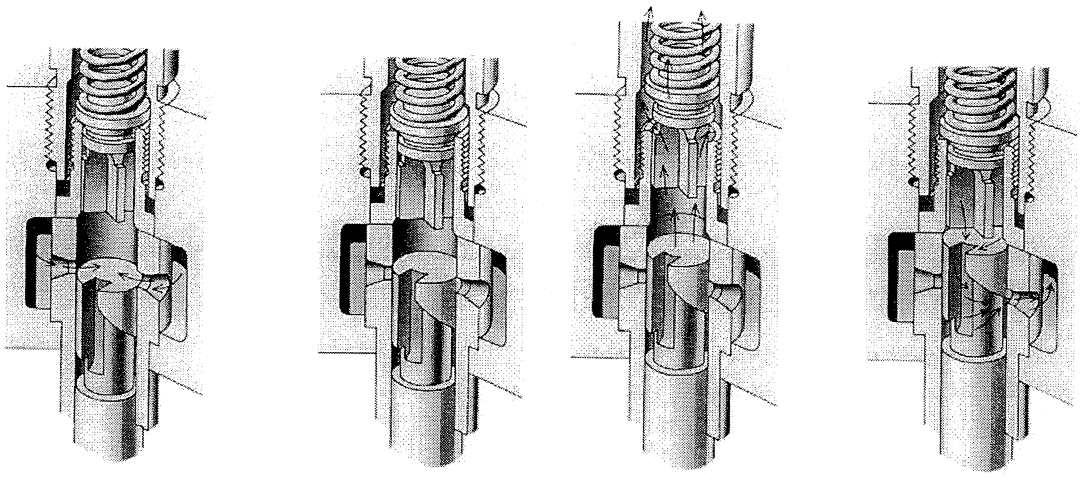


Fig. Q8

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