ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE, NIGERIA

DEPARTMENT OF

MECHANICAL, AUTOMOTIVE AND PRODUCTION ENGINEERING

FIRST SEMESTER EXAMINATIONS

2017/2018 ACADEMIC SESSION

HOD'S SIGNATURE

COURSE: ATE 301 – Internal Combustion Engines (3 Units)

CLASS: 300 Level Automotive Engineering

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer Question no. 1 and any other **THREE (3)** questions

Date: March, 2018

Question 1

Tominiyi's Mercedes benz G63 automobile has a four liter Spark Ignition V6 engine that operates on a four stroke air standard otto cycle at 3000 rpm. The compression ratio is 9, the length of the connecting rod is 16.6cm, and the engine is square (Bore = Stroke). At this speed, combustion ends at 20^0 at TDC. This engine is later connected to a dynamometer which gives a brake output torque reading of 205Nm at 3000 rpm. At this speed, air enters the cylinders at 85kPa and 60^0C and the mechanical efficiency of the engine is 80%. If this engine is running with an air-fuel ratio of AF = 15, a fuel heating value of 44,000 kJ/Kg and a combustion efficiency of 87%. Calculate:

a. cylinder bore and stroke length
b average piston speed
c. clearance volume of one cylinder
d. piston speed at the end of combustion
e. distance the piston has travelled from TDC at the end of combustion
f. volume in the combustion chamber at the end of combustion
g. the brake power and indicated power
h. the brake, indicated and friction mean effective pressures
i. power lost to friction
j. brake work per unit mass of gas in the cylinder
k. brake specific power and brake output per displacement
l. engine specific volume
m. rate of fuel flow into the engine

n. brake thermal, indicated thermal and volumetric efficiencies

o. brake specific fuel consumption

Take standard air density = 1.181 kg/m^3

(Hint: $V/V_c = 1 + 0.5(r_c - 1)[R + 1 - \cos\Theta - (R^2 - \sin^2\Theta)^{0.5}]$, $U_p/\bar{U}_p = (\prod/2) \sin\Theta [1 + (\cos\Theta/(R^2 - \sin^2\Theta)^{0.5}]$, $s = a \cos\Theta + \sqrt{(r^2 - a^2 \sin^2\Theta)}$)

(24 marks)

Question 2

Using question one details and by taking the start of the compression stroke in the cylinder combustion chamber to be 100kPa and 60^0C and to assume that there is a 4% exhaust left over from the previous cycle. Do a complete thermodynamic analysis of the engine. (Take k = 1.4)

(12 marks)

Question 3

(i) Describe the swirl, squish and tumble motions in a cylinder of an internal combustion engine with the aid of a suitable diagram.

(ii) Describe the crevice volume and identify the various zones where it can be found; state the effect of blowby on the crevice volume.

(iii) Identify and Describe the three broad regions of combustion process in an internal combustion engine

(iv) The crevice volume of an engine equals 2% of the total clearance volume. It can be assumed that pressure in the crevices is about the same as in the combustion chamber but the temperature stays at the cylinder wall temperature of 180^0C. Cylinder inlet conditions are 60^0C and 98K, and the compression ratio is 9.6:1. Calculate what percent of the fuel is trapped in the crevices at the end of the compression stroke and what percent of the fuel ends up in the exhaust due to being trapped in the crevice volume. It can be assumed that only 80% of fuel trapped in the crevice volume gets burned later in the power stroke (Take k = 1.4)

(12 marks)

Question 4

(i) Identify and describe the two general methods of cooling combustion chambers of an internal combustion engine

(ii) Identify three of the hottest points difficult to cool in a spark ignition engine; Explain the importance of hot spot in an intake manifold and state the three basic methods in which they can be heated.

(iii) State the material used for the piston face and why it is being used

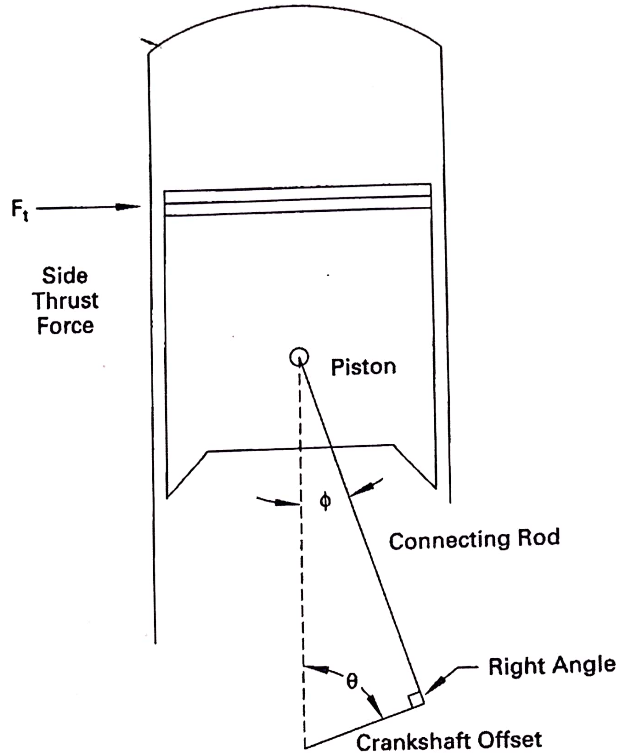
(iv) State two drawbacks of using water as a coolant fluid in an internal combustion engine and identify the appropriate coolant to be used with three advantages over water.

(12 marks)

Question 5

(i) A five-cylinder, in-line engine has a bore of 8.15cm, a 7.82-cm stroke, and a connecting rod length of 15.4 cm. Each piston has a skirt length of 6.5 cm and a mass of 0.32 kg. At a certain engine speed and crank angle, the instantaneous piston speed is 8.25 m/sec, and clearance between the piston and cylinder wall is 0.004 mm. SAE 10W-30 motor oil is used in the engine, and at the temperature of the piston-cylinder interface, the dynamic viscosity of the oil is 0.006 $N\text{-}sec/m^2$. Calculate the friction force on one piston at this condition.

Also, if the engine performs a power stroke in the cylinder described and the crank angle is as shown beside. At this point, pressure in the cylinder is 3200kPa and the compressive force in the connecting rod is 8.1kN. Calculate the thrust force on the cylinder wall at this time.



(ii) State and explain the three basic types of oil distribution systems used in an internal combustion engine. Explain the reason why some aircraft engines have dry sump systems.

(iii) Identify five major needs a lubricating oil must satisfy in an internal combustion engine.

(iv) what does it mean when a lubricating oil has a value of SAE 10W-30

(12 marks)

Question 6

(i) Explain the exhaust blowdown process, in which your explanation details out the pressure, temperature change together with the crank angle and the type of outflow velocity.

(ii) Identify five different undesirable emissions generated in the combustion process of an internal combustion engine, their major causes and the different methods of making them less harmful to the environment.

(iii) A 7-literV8 engine with a compression ratio of 9:1 operates on the air-standard cycle. The maximum cycle temperature and pressure are 2550K and 11,000kPa when operating at 3600RPM. The exhaust valve effectively opens at 60°bBDC. Calculate the time of exhaust blowdown, the percent of exhaust gas that exits the cylinder during blowdown, and the exit velocity at the start of blowdown assuming choked flow occurs.

(12 marks)