Menoufiya University

Faculty of Engineering Shebin El-Kom

Mechanical Power Eng. Department

First Semester Examination 2013-2014

Subject: Design of ICE Code: MPE 414C

Level: 4th year

Time Allowed: 3 hours

Total Marks : 60 marks

Date of Exam : 23 /1/2014

Solve the Following Questions

(Question Number-1) :(15 Marks)

(a) Derive mathematical relations to describe the instantaneous displacement, velocity and acceleration for central crank slider mechanism. Show also the effect of geometrical parameters on its performance.   (5 marks)

(b) Show how to eliminate the side thrust completely from the crank slider mechanism. Draw detailed sketch for this model.   (5 marks)

(c) Calculate the basic dimensions of SIE which consumes 0.18 kg/min of fuel with homogenous stoichiometric mixture and runs at 3000 rpm. The engine has compression ratio equal to 9 (Consider the thermal cycle as Otto cycle). Calculate also the mean effective pressure. If the engine uses centered crank slider mechanism, calculate the side thrust when the crank rotates 30 $^{\circ}$ ATDC during the expansion stroke.   (5 marks)

(Question Number-2) :(15 Marks)

(a) Assign the governing factors affecting piston/linear clearances and show how to assign the optimum value. Show also the effect of clearance on the engine performance.   (5 marks)

(b) Spark ignition engine has the following data:

| Cylinder diameter | : 78 mm | Piston mass | : 480 g |
| Max. speed (full load) | : 3300 rpm | Max speed (No load) | : 6200 rpm |

The mean effective pressure at full load is 10 bar. When replacing the piston by another one with the same diameter but its mass is 420 g, the engine performance changed as follows.

| Max. speed (full load) | : 4410 rpm | Max. speed (No load) | :7190 rpm |

The mean effective pressure at full load reduced to 9 bar

Compare between the two cases in terms of engine power @ full load condition and maximum inertia force applied on the piston pin.   (10 marks)

(Question Number-3) :(15 Marks)

(a) Discuss the importance of crank shaft journal bearing and show graphically the flow of lubricant through the crank shaft.   (5 marks)

(b) The dynamic analysis of crank slider mechanism shows that, the compression force transferred to the connecting rod is $F_{com} = F_g + F_i = 14505$ N at the beginning of expansion stroke. The maximum tension force is $F_t = 11500$ N at the beginning of suction stroke. Connecting rod length $L_{CR} = 136.8$ mm. Design the connecting rod shank and check the safety factor. Consider the following data:

$d = 24.4$ mm and $d_1 = 52$ mm

Draw sketch for cross section of such shank with its basic dimensions. (10 marks)

(Question Number-4) :(15 Marks)

(a) Explain why Double span design for crank shaft is not suitable for multi-cylinder diesel engines.   (5 marks)

(b) Assign the basic dimensions of crank shaft for single cylinder, 4 stroke, SIE. Technical data of this engine are summarized as follows:

Power (full load)   : 9 kW   Speed (full load)   : 3600 rpm
Mean Effective pressure   : 10.8 bar   Connecting rod mass   : 550 g.
Crank pin mass   : 90 g.   Counter weight/crank web   :180 g.
Center of gravity of the counter weight lies at 25% of stroke from the crank shaft center

Check also the mean and maximum pressure applied on both crank pin and main journals. The instantaneous pressure inside the engine cylinder during the thermal cycle is given as follows.

θ, degree	0	90	180	270	360	450	540	630	720
P_g bar	0.975	0.89	0.95	6.4	36	12.4	1.85	1.52	0.975

Assume any required data.

Draw sketch for crank shaft design. The basic dimensions must be written in separate table.   (10 marks)