Mansoura University
Faculty of Engineering
Mech. Power Eng. Dept.
Third Year (قـديم)

Final Semester Exam
Combustion Engines - MPE4322
June 1, 2013 - Time: 3hours
Exam on 2 pages - Total Mark:100

Answer the following questions. Assume any necessary assumptions: (Mark)

1. a) Discuss briefly variables affecting volumetric efficiency for SI engines. (4) [12]
   b) Discuss briefly stages of combustion process in SI engines. (4)
   c) What are the normal ranges of the maximum average piston speeds for all reciprocating internal combustion engines? Explain why? (4)

2. a) Compare between air-cooling engines and liquid-cooling engines. Also discuss characteristics of engine liquid coolant. (5) [15]
   b) Explain briefly functions of lubricating oil in internal combustion engines, also discuss the multi-grade engine lubricating oils. (5)
   c) "Stratified air-fuel distribution is an advanced technology for good combustion process in SI engines", discuss briefly this statement and illustrate sequence events required to assure this. (5)

3 **Carefully using illustrations, discuss briefly** each of the following: [15]
   a) Air-fuel vapor zones around the inner liquid core of a Diesel engine injected fuel spray jet. (5)
   b) Flow of gases through the exhaust valve out of engine cylinder vs. crank angle degrees. (5)
   c) Distribution of energy in a typical SI engine as a function of engine speed, use suitable values in your illustration. (5)

4. A large straight six CI truck engine operates on an air-standard Diesel cycle using heavy diesel fuel (Q_{LHV} = 41,400 kJ/kg), with combustion efficiency of 98%. The engine has a compression ratio of 16.5:1. Temperature and pressure in the cylinders at the start of the compression stroke are 55°C and 102 kPa, and maximum cycle temperature is 2410°C. Calculate: [18]
   1. Temperature, pressure, and specific volume at each state of the cycle.
   2. Air-fuel ratio of the cylinder gas mixture.
   3. Cylinder temperature when the exhaust valve opens.
   4. Indicated thermal efficiency of the engine.

5. A 2.8-liter four-cylinder square engine (bore = stroke) with two intake valves per cylinder is designed to have a maximum speed of 7500RPM. Intake temperature is 60°C, calculate: [12]
   1. Intake valve area.
   2. Diameter of intake valves.
   3. Maximum valve lift.

6. A six-cylinder SI engine with a total displacement of 1.86 liters operates at 2400 RPM using gasoline direct injection (GDI) with two injections per cycle in each cylinder. The spark plug is fired at 19° bTDC, and there is an ignition delay of 0.0015 seconds before combustion is established. During combustion, there is a rich air-fuel mixture around the spark plug of AF =11:1 and a lean mixture in the rest of the combustion chamber of AF = 20:1. The rich zone can be modeled as a 2-cm-diameter hemisphere around the spark plug with a flame speed of 32 m/sec. The lean zone then fills the rest of the combustion chamber to the outer edge of the bore and a flame speed of 19 m/sec. The engine has a compression ratio of 9.8, a stroke of 7.20 cm, and a connecting rod length of 13.3 cm, with the spark plug at the center of the combustion chamber. Calculate: [14]
   1. Crank angle position at the end of combustion.
   2. Piston speed at the end of combustion.

7. A four cylinder 1.8 liter SI Engine is designed to have a maximum speed of 6000 rpm. At this speed the volumetric efficiency of the engines is 0.92. The engine will be equipped with a one-barrel carburetor. Gasoline density can be considered to be 750 kg/m^3. Assuming the height differential of the fuel capillary tube = 1.5 cm., calculate: [14]
   a) Throat diameters for the carburetor (assume discharge coefficient, C_{Dt}=0.92).
   b) Fuel capillary tube diameter (assume discharge coefficient, C_{Dt}=0.74).
   The air/fuel ratio supplied by the carburetor can be obtained by;

$$AF = \dot{m}_a / \dot{m}_f = (C_{Dt} / C_{Dc})(A_t / A_c)(\rho_a / \rho_f)^{\frac{1}{2}} \Omega \Pi$$

where $\Omega = [\Delta P_a / (\Delta P_a - \rho_f g h)]^{\frac{1}{2}}$

and $\Pi = \{[k/(k-1)][(P_t/P_0)^{2/k} - (P_t/P_0)^{(k+1)/k}]/[1-(P_t/P_0)]\}^{\frac{1}{2}}$

Good luck, Prof. Dr. S. H. El-Emam & Dr. A. A. Hassan

For required thermodynamic properties of air use:
Air gas constant R = 0.287 kJ/kg.K, and c_p as the following;

Temperature, *K*	298	300	500	850	1000	1500	2000	2500	3000
c_p, *kJ/kg.K*	1.005	1.005	1.029	1.108	1.14	1.21	1.249	1.274	1.291