University of Technology
Department of Mechanical Engineering
Final Examination 2015/2016

Subject: I.C. Engines
Division:(Auto.and General) Mech. Eng.
Examiner(s):Dr. Abdulkadom&
Dr. Mahmoud A. Mashkour

Year: 3rd
Exam Time: 3 Hrs.
Date: 1 / 6 / 2016

Note: Answer (*four*) Questions Only.

Q1. *a*) Briefly, explain the effect of variation of specific heats on pressure and temperature of Otto cycle. (*5 M*)

b) An internal combustion engine working on an ideal diesel cycle. The pressure and temperature at the beginning of compression stroke are *1 bar* and *300 K* respectively. The air-fuel ratio is *29/1* and the compression ratio is *16/1*. Find at what percentage of stroke the combustion is complete. Take the calorific value of fuel as *42000 kJ/kg*; $R=0.287$ *kJ/kg.K* and $c_v=0.709+0.000028T$ *kJ/kg.K*. (*10 M*)

Q2. *a*) Give short descriptions about the various fuels commonly used in combustion process. (*5 M*)

b) A *25%* rich mixture of butane (C_4H_{10}) and air is supplied to an industrial furnace. Find the equivalence ratio and the volumetric analysis of products. (*10 M*)

Q3. *a*) Why Morse test is not suitable for single cylinder engine? Describe the method of finding friction power using Morse test. (*5 M*)

b) In a trial of a single cylinder engine working on dual cycle, the following observations were made: Compression ratio=*15*; Fuel consumption=*10.2 kg/hr*; Calorific value of fuel=*43890 kJ/kg*; Air consumption=*3.8 kg/min*; Speed=*1900 rpm*; Torque on the brake drum=*186 N.m*; Quantity of cooling water used=*15.5 kg/min*; Temperature rise=*36* ^0C; Exhaust gas temperature=*410* ^0C; Room temperature= *20* ^0C; c_p for exhaust gases=*1.17 kJ/kg.K*; Calculate: (*i*) Brake power; (*ii*) Brake specific fuel consumption; (*iii*) Brake thermal efficiency; (*iv*) Draw the heat balance sheet.

(*10 M*)

Q4. *a*) What are the advantages of supercharging of diesel engine? (*5 M*)

b) The following data is recorded for a supercharged engine:

Number of cylinder=*6*; Engine capacity=*5 liter*; Speed=*3500 rpm*; Volumetric efficiency=*160%*.

The isentropic efficiency and the Mechanical efficiency of the supercharger are *95%* and *87%* respectively.

It is desired to deliver air to the cylinder at a certain temperature and *180 kPa* pressure, if the volumetric efficiency before supercharging is *88%*; calculate:

i. The engine power lost to run the supercharging;

ii. The increase in indicated power due to positive pump loop.

Take c_p for air =*1.005* and the ambient conditions as *296 K* temperature and *100 kPa* pressure

(*10 M*)

Q5. *a*) What are the disadvantages of a two-stroke engine? (*5 M*)

b) A two-stroke single cylinder diesel engine has a bore of *125 mm*, stroke *150 mm*, compression ratio *16/1*, runs on *2000 rpm*. The atmospheric conditions are *27* ^0C and *100 kPa*. If the delivery ratio is *120%*, the indicated thermal efficiency *40%*, the indicated mean effective pressure (*imep*)=*500 kPa*, the *air/fuel* ratio *30/1*, and the lower calorific value (*LCV*) of the fuel is *44000 kJ/kg*, Calculate:

i. Scavenging efficiency η_{sc};
ii. Scavenging ratio λ_{sc};
iii. Charging efficiency η_{ch};
iv. Trapping efficiency η_{tr};

(*10 M*)

Q.1: Answer:-

$$C_p = C_v + R = 0.996 + 0.000028T$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} \Rightarrow T_2 = 300(16)^{1.4-1} = 900\ K$$

$dQ = m C_p dT$, for unit mass

$Q = \int_2^3 C_p\, dT$, for 1 kg of mixture

$$Q = \frac{L.C.V}{A+f} = \frac{42000}{29+1} = 1400\ \frac{kJ}{kg}$$

$\therefore 1400 = \int_2^3 (0.996 + 0.000028T)\, dT$, then

$T_3 = 2244\ K$

$$V_3 = V_2 * \frac{T_3}{T_2} = 2.49 V_2$$

Stroke volume $(V_1 - V_2) = V_2\left(\frac{V_1}{V_2} - 1\right) = 15 V_2$

$$\therefore \frac{V_3 - V_2}{V_1 - V_2} = \frac{V_2(2.49-1)}{15 V_2} = 0.099 = 9\%$$

Q.2: Answer:-

$C_4H_{10} + A(O_2 + 3.76N_2) \rightarrow aCO_2 + bH_2O + dN_2$

$C_4H_{10} + 6.5(O_2 + 3.76N_2) \rightarrow 4CO_2 + 5H_2O + 24.44N_2$

25% rich = x of fuel = 0.25 ∴ mole of fuel

$= 1 + 0.25 = \phi 25$

$1.25\, C_4H_{10} + 6.5(O_2 + 3.76N_2) \rightarrow aCO_2 + bH_2O + dN_2 + fCO$

divided 1.25 then

$C_4H_{10} + 5.2(O_2 + 3.76N_2) \rightarrow a_1CO_2 + b_1H_2O + d_1N_2 + f_1CO$

$C_4H_{10} + 5.2(O_2 + 3.76N_2) \rightarrow 1.4CO_2 + 5H_2O + 19.5N_2 + 2.6CO$

$$\phi = \frac{(A/F)_{stoi}}{(A/F)_{act.}} = \frac{6.5(32 + 3.76 \times 28)/58}{5.2(32 + 3.76 \times 28)/58} = 1.25$$

$N_{p_t} = 1.4 + 5 + 19.5 + 2.6 = 28.5$

$\therefore CO_2\% = \frac{1.4}{28.5} = 4.9\%$, $H_2O\% = \frac{5}{28.5} = 17.5\%$

$N_2\% = \frac{19.5}{28.5} = 68.4\%$, $CO\% = 9.1\%$

Q3. b)

i) $B.P. = \frac{2\pi N T}{60 \times 1000} = \frac{2\pi \times 1900 \times 186}{60 \times 1000} = 37\ kW.$

ii) $b.s.f.c. = \frac{\dot{m}_f}{B.P.} \quad \frac{10.2}{37} = 0.2756 \ \frac{kg}{kW.hr}$

iii) $\eta_{th_B} = \frac{B.P.}{\dot{m}_f \times C.V.} = \frac{37}{\frac{10.2}{3600} \times 43890} = 0.2975$ or $29.75\ \%$

iv) heat balance

* heat supplied $= Q_{add} = \dot{m}_f \times C.V. = \frac{10.2}{60} \times 43890$

$= 7461\ kJ/min.$

* $B.P. = 37 \times 60 = 2220 \ \frac{kJ}{min} \Rightarrow 29.8\ \%$

* heat; $Q_{cool} = \dot{m}_w \cdot C_{p_w} (T_{w_2} - T_{w_1})$

$= 15.5 \times 4.18 \times 36 = 2332 \ \frac{kJ}{min} \Rightarrow 31.2\ \%$

* $Q_{gas} = \dot{m}_g \times C_{p_g} \times (T_g - T_R)$

$= \left(\frac{10.2}{60} + 3.8\right) \times 1.17 \times (410 - 20) = 1811 \ \frac{kJ}{min}$

$= 24.3\ \%$

* heat unaccounted $= 1098 \ \frac{kJ}{min} \Rightarrow 14.7\ \%$

Q.4: Answer:- (i) $P = \dfrac{\dot{m}_a C_p (T_{out} - T_{in})}{\eta_m}$

$(\dot{m}_a)_{theo.} = V_s * \dfrac{N}{120} * \rho_{air} = 5*10^{-3} * \dfrac{3500}{120} * \dfrac{100}{0.287*296}$

$= 0.17 \text{ kg/s}$

$(\dot{m}_a)_{act.} = 0.17 * 1.6 = 0.272 \text{ kg/s}$

$T_{out} = T_2 \Rightarrow \dfrac{T_2'}{T_1} = \left(\dfrac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} = T_2' = 350 \text{ K}$

$\eta_{is} = \dfrac{T_2' - T_1}{T_2 - T_1} \Rightarrow T_2 = 352.8 \text{ K}$

$\therefore P = \dfrac{0.272 * 1.005 * (352.8 - 296)}{0.87}$

$= 17.84 \text{ kW}$

(ii)

$(\dot{m})_{act.}$ befor supercharging $= 0.17 * 0.88 = 0.149 \text{ kg/s}$

$(\dot{V}_a)_{theo.} = \dfrac{(\dot{m}_a)_{theo.}}{\rho_{air}} = \dfrac{0.17}{1.17} = 0.146$

$PP = \Delta P * (\dot{V}_a)_{theo.} = (180 - 100) * 0.146$

$= 11.7 \text{ kW}$

Q5. b)

$$\dot{V}_s = \frac{\pi}{4}(0.125)^2 * (0.15) * \frac{2000}{60} = 0.061 \ \frac{m^3}{s}$$

$$V_{cyl.} = \frac{r}{r-1}\dot{V}_s = \frac{16}{15} * 0.061 = 0.0654 \ \frac{m^3}{s}$$

$$\rho_a = \frac{P}{RT} = \frac{100}{0.287 * 300} = 1.161 \ kg/m^3$$

$$I.P. = P_{im} * \dot{V}_s = 500 * 0.061 = 30.5 \ kW$$

$$\dot{m}_f = \frac{I.P.}{\eta_{ith} * LCV} = \frac{30.5}{0.4 * 44000} = 0.00173 \ \frac{kg}{s}$$

$$\dot{m}_{mt} = \dot{m}_f * \frac{A}{F} = 0.00173 * 30 = 0.052 \ kg/s$$

$$\lambda_d = \frac{\dot{m}_{mi}}{V_s \rho_a} \Rightarrow \dot{m}_{mi} = 1.2 * 0.061 * 1.161$$

$$= 0.085 \ kg/s$$

$$\dot{m}_{cyl} = V_{cyl} * \rho_a = 0.0654 * 1.161 = 0.076 \ kg/s$$

i) $\eta_{sc} = \frac{\dot{m}_{mt}}{\dot{m}_{cyl}} = \frac{0.052}{0.076} = 0.684$

ii) $\lambda_{sc} = \frac{\dot{m}_{mi}}{\dot{m}_{cyl}} = \frac{0.085}{0.076} = 1.12$

iii) $\eta_{ch} = \frac{\dot{m}_{mt}}{V_s \rho_a} = \frac{0.052}{0.061 * 1.161} = 0.734$

iv) $\eta_{tr} = \frac{\dot{m}_{mt}}{\dot{m}_{mi}} = \frac{0.052}{0.085} = 0.611$

University of Technology
Department of Mechanical Engineering
Final Examination 2014/2015

Subject: I.C. Engines
Division: (Auto. and General) Mech. Eng.
Examiner(s): Dr. Abdulkadom &
Dr. Mahmoud A. Mashkour

Year: 3rd
Exam Time: 3 Hrs.
Date: 27 /5 / 2015

Note: Answer (*four*) Questions Only.

Q1) a) An internal combustion engine working on Otto cycle uses hydrocarbon fuel has the chemical formula (C_7H_9) and lower calorific value of 40 MJ. The compression ratio of the engine is 8/1. The pressure and temperature at the beginning of compression are 1.013 bars and 35^{0}C respectively. If the equivalence ratio is 1.25, for 1 kg of the mixture, find the maximum pressure developed in the engine.

Take Cv=0.717 kJ/kg.K and n=1.35.

(10 M)

b) **With the aid of sketch, explain the effect of variation of specific heats and dissociation on the maximum pressure and temperature of fuel/air cycle.**

(5 M)

Q2) *a)* Define fuel, name the various fuels commonly used in combustion processes, and describe one of them.

(5 M)

b) **Calculate the amount of air required to completely burn 1 kg of butane (C_4H_{10}). If this amount of air is increased by 25%, calculate the equivalence ratio and the volumetric analysis of the products.**

(10 M)

Q3) *a)* Explain a method applied to test a diesel engine at constant speed and list the methods used to measure the friction power.

(5 M)

b) **A four cylinder four stroke diesel engine delivers 150 N.m torque at speed 1200 rpm. The bore and stroke of each cylinder are 10.5 cm and 12.5 cm respectively. The engine consumes a fuel of calorific value 43124 kJ/kg at a rate of 15.27×10^{-4} kg/s. The ambient pressure and temperature are 1.03 bar and 20 ^{0}C. If the air fuel ratio is 23.46/1, find:**

1. the brake thermal efficiency;

2. the brake mean effective pressure;

3. the volumetric efficiency.

(10 M)

Q4) ***a)*** **What is scavenging process? What are the methods of scavenging? Explain with the aid of sketches?** **(*5 M*)**

b) **A two-stroke spark ignition engine having a cylinder volume of 1100 cm^3 and compression ratio of 8/1 runs at 2800 rpm. The exhaust pressure is 1.07 bars and the inlet temperature to the engine is 37 ^{0}C. The scavenging efficiency is 0.5. Calculate the trapping efficiency and the scavenging ratio for a charge flow 4 kg/min. If the brake thermal efficiency of the engine is 0.25, fuel-air ratio is 0.068, calculate the brake power developed and the brake specific fuel consumption. Take calorific value of fuel as 45 MJ/kg and the atmospheric conditions as 1 bar and 25 ^{0}C.**

(*10 M*)

Q5) ***a)*** **What are the advantages of supercharging? What factors limit the pressure of supercharging?** **(*5 M*)**

b) **The average indicated power developed in a compression ignition engine is 13 kW/m^3 of free air induced per minute. The engine is a three-liter, four-stroke engine running at 3500 rev/min, and has a volumetric efficiency of 81%, referred to free air conditions of 1.013 bars and 15 ^{0}C. It is proposed to fit a blower, driven mechanically by the engine. The blower has an efficiency of 72% and works through a pressure ratio of 1.72/1. Assume that at the end of induction, the cylinders contain volume of charge equal to swept volume at the pressure and temperature of the delivery from the blower. Calculate the increase in brake power to be expected from the engine. Take all mechanical efficiencies as 78%.**

(*10 M*)

University of Technology
Department of Machines and Equipment Engineering
First Term Examination 2013/2014

Subject: Int. Comb. Engines
Division: Automobiles
Examiner(s):
Dr.Abdulkadom&Dr.Mahmoud A.

Year: 3rd
Exam Time: 3 Hrs.
Date: 2 / 6 / 2014

Answer (Four) Questions Only

Q_1 **A:** What are the assumptions made in air standard cycle analysis. (2 marks)

B: What are the types of combustion? What are the differences between them. (3 marks)

C: Calculate the amount of air required to completely burn **1** kg of fuel has the formula (C_7H_{10}). If this amount of air is increased by **12%**; calculate the equivalence ratio and the volumetric analysis of the products. (10 marks)

Q_2 **A:** Why do air-fuel cycles differs from actual cycles? (2 marks)

B: What are the components of the liquid fuel? How are they classified? List some types of liquid fuel. (3 marks)

C A petrol engine with a compression ratio of **6/1** uses a fuel of calorific value **43960** kJ/kg. The air-fuel ratio is **15/1**and the temperature and pressure of the charge at the beginning of compression are **60** °C and **1**bar respectively. Determine the maximum pressure in the cylinder if the index of compression is **1.32** and the specific heat at constant volume is expressed by the relation: $\mathbf{cv=0.717+2.08\times10^{-4}T}$, where T is the temperature in Kelvin. (10 marks)

Q_3 **A:** Define: 1-deficiency of air, 2-equivalence ratio, 3-rich mixture. (3 marks)

B: List the basic performance parameters of internal combustion engine. (2 marks)

C: A **four** cylinder **four** stroke diesel engine have a bore of **0.11**m and a stroke of **0.13**m for each cylinder. The brake torque is **153** N.m, engine speed is **2250** rpm, fuel consumption is **0.00283** kg/s, calorific value of fuel is **43000** kJ/kg, and the air/fuel ratio is **28.4/1**. If the atmospheric conditions are **15** °C and **100** kN/m^2 find 1-brake power,2-brake thermal efficiency, 3-brake mean effective pressure, 4-volumetric efficiency. (10 marks)

Q4 **A**: Explain a method applied to test a diesel engine at constant speed and list the methods used to measure the friction power. (5 marks)

B: A **six** cylinder, **4.8** liter supercharged diesel engine operates at **3500** rpm and has an overall volumetric efficiency of **158%**. The supercharger has an isentropic efficiency of **95%** and the mechanical efficiency with its link with engine is **87%**. It is desired that air be delivered to the cylinder at **65** °C and **98** kPa. Calculate 1-the amount of after cooling energy needed, 2-the engine power lost to run the supercharger. (10 marks)

Q5:**A**: Name with schemes the methods of scavenging and describe the advantages of two stroke engines. (5 marks)

B: A **two** stoke spark ignition engine with a cylinder volume of **1100** cm^3 and a compression ratio of **7/1** runs at **2800** rpm. The exhaust pressure is **1.1** bars and the inlet temperature is **40** °C. The scavenging efficiency is **0.5**, the air flow rate to the engine is **3.75** kg/min, the brake thermal efficiency is **0.25**, and the air/fuel ratio is **14.7/1**. If the calorific value of the fuel is **44100** kJ/kg. Find: 1-the trapping efficiency, 2-the scavenging ratio, 3- the brake power developed, and 4-the fuel lost through exhaust.

(10 marks)

Note: For all questions, take R=**0.287** kJ/kg K

University of Technology
Department of Machines and Equipment Engineering
First Term Examination 2012/2013

Subject: Int. Comb. Engines
Division: Automobiles
Examiner(s): Dr. M.A. Abdulhadi & Dr.Abdulkadom

Year: 3rd
Exam Time: 3 Hrs.
Date: 26 / 6 / 2013

Answer (Four) Questions Only

Q_1 A: What is the difference between external combustion engine and internal combustion engine? (2 marks)

B: What are the types of internal combustion engines? (4 marks)

C: Calculate the amount of air required to completely burn **1** kg of butane (C_4H_{10}). If this amount of air is increased by **25%**; calculate the equivalence ratio and the volumetric analysis of the products. (9 marks)

Q_2 A: Why do the air standard cycles is introduced before studying the actual cycles? (2 marks)

B: What are the components of the gaseous fuel? How are they classified? List the types of the manufactured gases. (4 marks)

C: An engine working on Otto cycle has compression ratio of **6/1** and uses a mixture of air and hydrocarbon fuel of calorific value **43950** kJ/kg. The air/fuel ratio is **15/1**. The pressure and temperature of the mixture at the beginning of compression are **1** bar and **60** °C respectively. The index of compression is **1.32**. If the specific heat at constant volume is expressed by $C_v=0.71+19\times10^{-5}T$ kJ/kg K, where T is the temperature in K; determine the maximum pressure and temperature in the cylinder. (9 marks)

Q_3 A: Define: 1-deficiency of air, 2-equivalence ratio, 3-rich mixture. (3 marks)

B: List the basic performance parameters of internal combustion engine. (3 marks)

C: A **four** cylinder **four** stroke diesel engine delivers **150** Nm torque at a speed of **1200** rpm. The bore and stroke of each cylinder are **10.5** cm and **12.5** cm respectively. The engine consumes a fuel of calorific value **43124** kJ/kg at a rate of $\mathbf{15.27 \times 10^{-4}}$ kg/s. The ambient pressure and temperature are **1.03** bar and **20** °C . If the air fuel ratio is **23.46/1**; find: 1-the brake thermal efficiency, 2-the brake mean effective pressure, 3-the volumetric efficiency. (9 marks)

Q4 **A:** Explain a method applied to test a diesel engine at constant speed and list the methods used to measure the friction power. (5 marks)

B: A **four** stroke diesel engine of **3000** cm^3 capacity runs at **3500** rpm and develops **13.42** kW per m^3 of free air induced per minute. It has a volumetric efficiency of **80%** referred to free air conditions of **1.03** bars and **27** °C. The engine is supercharged by a blower of pressure ratio **1.7** and isentropic efficiency of **75%**. Assuming that at the end of induction the cylinders contains a volume of mixture equal to the swept volume, at the pressure and temperature of the delivery from the blower, estimate the increase in brake power to be expected from the engine. Take overall mechanical efficiency as **80%**. (10 marks)

Q5: A **two** stoke spark ignition engine with a cylinder volume of **1100** cm^3 and a compression ratio of **7/1** runs at **2800** rpm. The exhaust pressure is **1.1** bars and the inlet temperature is **40** °C. The scavenging efficiency is **0.5**, the air flow rate to the engine is **3.75** kg/min, the brake thermal efficiency is **0.25**, and the air/fuel ratio is **14.7/1**. The calorific value of the fuel is **44100** kJ/kg. Find: 1-the trapping efficiency, 2-the scavenging ratio, 3- the brake power developed, and 4-the fuel lost through exhaust. (15 marks)

Note: For all questions, take R=**0.287** kJ/kg K

University of Technology
Department of Machines and Equipment Engineering
First Term Examination 2012/2013

Subject: Int. Comb. Engines
Division: Automobiles
Examiner(s): Dr. M.A. Abdulhadi & Dr.Abdulkadom

Year: 3rd
Exam Time: 1.5 Hrs.
Date: 17 / 1 / 2013

Answer (Two) Questions Only

Q1 **A:** Define heat engines, how are they classified? (1.5 marks)

B: The bore and stroke of a single cylinder **SI** engine that operates on a four stroke cycle are **8**cm and **9** cm respectively. The speed of the engine is **2400** rpm. The compression ratio is **9** and the length of the connecting rod is **16** cm. If the combustion ends at **18°** after **TDC**. Calculate: 1-average piston speed, 2-clearance volume of the engine, 3-volume in the combustion chamber at the end of combustion. (3.5 marks)

Q2 **A:** Draw the dual cycle on P-V and T-S diagrams and give brief explanation about its processes. (1.5 marks)

B: For an ideal air standard Otto cycle the maximum volume is **0.5** liter and the compression ratio is **8**. The maximum temperature in the cycle is **1900** °C. The minimum cycle pressure and temperature are **0.9** bar and **90** °C respectively. Determine: 1-the heat transfer to the cycle in kJ ,2-the thermal efficiency, 3- the net work per cycle. Take: cv=**0.718** kJ/kg K, R=**0.287** kJ/kg K, γ=**1.4**

(3.5 marks)

Q3 **A:** Define: 1-enthalpy of formation, 2-adiabatic flame temperature, 3-equilibrium constant. (1.5 marks)

B: A **10%** rich mixture of benzene (C_6H_6) and air is supplied to an industrial heater. The mixture is ignited and combustion occurs. Find the wet analysis of the products of combustion and the equivalence ratio. (3.5 marks)

University of Technology
Mechanical Engineering Department
Final Examination 2011/2012- 1st Attempt
Subject:**Internal Comb. Eng.,3rdYear** Exam Time:**3 Hours**
Examiner(s):**Dr. M.Ali& Dr. A.Kadom** **Date: 23/5/2012**

Answer Four Questions Only

Q1A: Compare between reciprocating, rotary, and gas turbine engines? (3 marks)

B:What are the advantages of internal combustion engines over external combustion engines? (2 mark)

C:The indicated mean effective pressure of a four stroke engine is **750**kN/m^2 when it runs at **750** rpm and produces **28** kW brake power. The mechanical efficiency is **0.8** and the ratio of bore to stroke is **0.6**. The inlet valve opens **9**^{o} before TDC and closes**38**^{o} after BDC. If it takes **0.0033** second after ignition for the charge to gain maximum pressure, find: 1- the crank angle when the spark occurs for the maximum pressure to be at TDC, 2- the time period in second of inlet valve opening during one cycle, 3- the diameter of the engine, and 4- the average piston speed. (10 marks)

Q2A: Prove that the efficiency of Otto cycle is: $1-\frac{1}{r^{\gamma-1}}$(3 marks)

B:What are the main components of the heat balance of an engine?

(2 marks)

C:A mixture of butane (**C_4H_{10}**) and **10%** deficiency air is supplied to an industrial furnace. The mixture is ignited and combustion occurs. If the products of combustion are at a pressure of **1**atm and a certain temperature and the analysis of the products shows that **0.58**kmol of each kmol of **CO_2** is dissociated, find 1- the equilibrium constant, 2- the volumetric analysis of the products, and 3- the equivalence ratio.

(10 marks)

Q3A: Define:air/fuel, combustion, and stoichiometric mixture (3 marks)

B:How does knock occurs in S.I engine? (2 marks)

C: The air-fuel ratio of a Diesel engine is **29/1**. If the compression ratio is **16/1** and the temperature at the end of compression is **900** K, find at what cylinder volume the combustion is complete. Assume that the combustion begins at TDCand takes place at constant pressure. Take calorific value of fuel as **42000** kJ/kg, R=**0.287**kJ/kgK, and cv=**0.709+0.000028T**kJ/kg K.(10 marks)

Q4 A:What are the effects of variation of specific heats and dissociation on the work deliver from fuel-air cycle?(3 marks)

B:Define: octane number, cetane number, abnormal combustion.

(2 marks)

C:A Diesel engine is fitted with a turbocharger, which consists of radial compressor driven by radial exhaust gas turbine. The air is drawn into the compressor at a pressure of **0.95** bar and at a temperature of **15**^{o}C, and is delivered to the engine at a pressure of **2**bar. The engine is operating at an air-fuel ratio of **18/1**, and the exhaust leaves the engine at a temperature of **600**^{o}C and a pressure of **1.8**bar, while the turbine exhausts at **1.05** bar. The isentropic efficiencies of the compressor and turbine are **70%** and **80%** respectively. Calculate: 1- the temperature of the air leaving the compressor, 2- the temperature of the gases leaving the turbine, and 3- the mechanical power lost in the turbocharger expressed as a percentage of the power generated in the turbine. Take: cp_{air}=**1.01**kJ/kg K, γ_{air}=**1.4**, $cp_{exh.}$=**1.15**kJ/kg K, and$\gamma_{exh.}$=**1.33**(10 marks)

Q5 **A:** How does supercharging affect the power output of internal combustion engine?(2 marks)

B: Explain the cycle of events of two stroke engine.(3 marks)

C: A two stroke petrol engine having bore **10** cm and stroke **14** cm runs at **2000** rpm. Its compression ratio is **7/1**. The indicated power output of the engine is **27.5** kW when the air-fuel ratio is **13.5/1**. The engine consumes **3.7×10**$^{-3}$ kg/s fuel which has lower calorific value **42000** kJ/kg. If the brake specific fuel consumption is **0.605** kg/kW hr, and the trapped efficiency is **0.57**, find 1- the scavenging effigiency, 2- the scavenging ratio, and 3- the mechanical efficiency. (10 marks)

University of Technology
Mechanical Engineering Department
Mid. Term exam 2011-2012

Subject: **I. C. E. 3rd Year** Exam Time: **2 Hours**
Examiner(s): **Dr. M.A. Abdulhadi & Dr.Abdulkadom** Date: **6 / 2 /2012**

Thermodynamic Tables are allowed **Answer Three Questions Only**

Q_1 **A:** What are the types of internal combustion engines? (1.5 marks)

B: The compression ratio of an ideal cycle is **6** and the pressure and temperature at the beginning of compression stroke are **1**bar and **100** ^oC respectively. The maximum pressure in the cycle is **34.3** bar. For **1** kg of air flow calculate the ratio of heat supplied to heat rejected.

Take R=**0.287** kJ/kg K and γ=**1.4** (3.5 marks)

Q_2 **A:** What are the conditions that must be fulfilled for combustion of fuel to take place with high efficiency? (1.5 marks)

B: Find the stoichiometric A/F ratio for the combustion of octane (C_8H_{18}) in an I.C.E. engine. Calculate the A/F ratios for **0.9** and **1.2** equivalence ratios (Ø). Determine the wet analysis by volume of the exhaust gases for **1.2** equivalence ratio. (3.5 marks)

Q_3 **A:** What are the meanings of: 1-enthalpy of formation, 2-mixture strength, 3-adiabatic flame temperature? (1.5 marks)

B: A mixture of benzene (C_6H_6) and**25%** excess air is supplied to an industrial heater at a temperature of **300** K. The products leave at **400** K. Find the heat transfer occurring in the heater. (3.5 marks)

Q_4: **A:** What are the modern developments of I.C.E. engines? (1.5 marks)

B: The bore and stroke of an internal combustion engine working on Otto cycle are **17** cm and **30** cm respectively. If the total volume is **8.825** cm^3, find the air standard efficiency. Take γ=**1.4**

(3.5 marks)

University of Technology
Mechanical Engineering Department
Final Examination 2009/2010- 2nd Attempt

Subject: **Internal Comb. Eng.**, **3rd Year** Exam Time: **1.5 Hours**
Examiner(s): **Dr. M.Ali & Dr. A.Kadom** **Date: 9 / 2 /2011**

Thermodynamic Tables Allowed **Answer Two Questions Only**

Q1 **A:** How do real cycles deviate from air-standard cycles? (1 mark)

B: What is the effect of advancing and retarding of spark on the power developed by S.I.engine? (1 mark)

C: The analysis of dry products of combustion of hydrocarbon fuel is **7%**CO2; **9.9%** O2; **1.5%** CO, and the remainder is nitrogen. Find: The percentage of carbon to hydrogen and the percent of air to fuel

(3 marks)

Q2 **A:** What are the physical differences between S.I. and C.I. engines?

(1 mark)

B: List the relative merits and demerits of 2-stroke engine over 4- stroke engine. (1 mark)

C: Benzene (C_6H_6) at **27** ^oC and **19.58%** excess air at **27** ^oC are burned in a steady flow process. The products of combustion leave at **1400** K. Find the heat transfer per kmol of fuel during the combustion process.

(3 marks)

Q3 **A:** Compare Otto, dual, and Diesel cycles on P-V and T-S diagram.

(1 mark)

B: What are the assumptions of fuel-air cycles?

C: An engine working on the constant volume cycle has a compression ratio of **6/1** and the compression follows the law $pv^{1.3}$ =c., the initial pressure and temperature being **0.97** bar and **43** ^oC. The engine runs on a mixture of gaseous fuel and air, the air-fuel ratio being **24/1**. The specific heat at constant volume is: cv = **0.71+2*10**$^{-4}$T kJ/kg K. Find the compression ratio and heat rejected during compression stroke.

Take R=**0.287** kJ/kg K. (3 marks)

University of Technology
Mechanical Eng. Department
Mid. Examination

Subject: Int. Comb. Engine — 3rd Year
Time: 1.5 Hours — Date: 19/1/2010

***Note**: Answer Two of the following Questions*

Q1 **A: What the differences between air standard cycle and air fuel cycle?**

B: What the differences between sequences of events during one cycle of a four stroke S.I. engine and C. I. engine?

C: One kmole of carbon (C) at 25 ^oC react with two kmole of oxygen (O_2) at 25 ^oC to form an equilibrium products of CO_2 , CO , and O_2 at 3000 k and 1.013 atm . Determine volumetric analysis of the products.

Q2 **A gas engine working on Otto cycle having a compression ratio of (5/1) is supplied with gas of calorific value 45000 KJ/kg. The air/fuel ratio is (15/1) . The conditions at the end of suction stroke are 98 kpa and 100 ^oC respectively compression takes place according to the law $pv^{1.35}=c$. The specific heat (cv) of products is given by : $cv = 0.715 + 2.1 \times 10^{-4}T$ where T is temperature in Kelvin . Find the work done per cycle**

Q3 **Benzene (C_6H_6) at 25 ^oC is burned with air at 500 k in a steady flow process. The air/fuel ratio of the mixture is (8.5/1) by volume. The product of combustion leave at 1400 k . Calculate the equivalence ratio and the heat transfer per kmole of fuel during the combustion using the following data:**

Substance	h_{fo}	h at 298k	h at 500k	h at 1400k
C_6H_6	82926.9	1947	24350	203930
O_2	0	731.5	6834	37730
N_2	0	728.4	6648	35700
CO_2	-393513	913.8	9231	56910
H_2O	-241826	840.5	7756	44270

Good Luck

University of Technology
Mechanical Eng. Department
Mid. Examination

Subject: **I.C. Engine** 3rd Year
Time: 1.5 Hours Date: 14/4/2010

NOTE: ANSWER TWO OF THE FOLLOWING QUESTIONS

Q1 **A:** What are the advantages of supercharging of internal combustion engine?

B: A 2.5 liter four stroke diesel engine develops 10 kW per m^3 of free air inducted per minute. The volumetric efficiency is 82% at 3000 r.p.m. referred to atmospheric conditions of 1 bar and 27 ^oC. A rotary compressor which is mechanically coupled to the engine is used to supercharge the engine. The pressure ratio and the isentropic efficiency of the compressor are 1.6 and 75% respectively. If the all mechanical efficiencies are 82%, calculate the percentage increase in brake power due to supercharging.

Assume that at the end of induction the cylinder contain a volume of charge equal to the actual volume induced at the pressure and temperature of the delivery from the blower.

Q2 **A:** Explain the types of superchargers and the methods used to supercharge the engines ?

B: A four cylinder 2 stroke racing engine of capacity 2.495 liter has a bore of 94 mm and a compression ratio of 12/1. When tested against a dynamometer with a torque arm of (0.461m) a maximum load of 622 N was obtained at 5000 r.p.m. and at the peak speed of 6750 r.p.m. the load was 547 N. The minimum fuel consumption was 17.2 cm^3 /sec. at a speed of 5000 r.p.m. I f the specific gravity of the fuel is 0.735 , and the calorific value is 44200 kJ/kg, calculate : 1- the maximum brake mean effective pressure, 2- the maximum brake power , 3- the minimum specific fuel consumption , 4- the maximum brake thermal efficiency, 5- the relative efficiency.

Q3 **A:** Explain Morse test.

B: A four cylinder petrol engine has an output power of 55kW at 2200 r.p.m. A Morse test is carried out and the brake torque reading are 180, 175, 170, 177 Nm, respectively. For normal running at this speed the specific fuel consumption is 0.4 kg/kW hr. The lower calorific value is 44000 kJ/kg, calculate the mechanical and brake thermal efficiencies of the engine.

University of Technology
Mechanical Eng. Department
Mid. Examination

Subject: **I.C. Engine** 3rd Year
Time: 1.5 Hours Date: 14/4/2009

Q1 **A:** What are the purposes of supercharging of internal combustion engine??

B: A six cylinder diesel engine have thermal efficiency of 0.25 when running at 1500 r.p.m. The fuel consumption is 8.8×10^{-3} kg/s and , L.C.V.of the fuel is 43000 Kj/kg and the mechanical efficiency is 0.85. The engine is supercharged by a turbo supercharger having compression ratio of 2 . The isentropic efficiency of the compressor is 0.65 . The $P_{i.m.e.}$ is proportional to the inlet density of the charge and the mechanical efficiency does not change due to supercharging. A water cooler is added to cool the air before it enters the engine and the temperature after the intercooler is 385 K . Calculate the brake power of the supercharged engine when air is cooled and when there is no cooling . Inlet temperature and pressure are 316 K and 1 bar.

Q2 **A:** What are the methods of scavenging ?

B: A two stroke spark ignition engine have a cylinder volume of 1.1×10^{-3} m^3 and a compression ratio of 8/1 runs at 2500 r.p.m. The inlet temperature is 315 K and the exhaust pressure 1.2 bar . The scavenging efficiency is 0.55 and the air flow is 0.0625 kg/s . Calculate the trapping efficiency and the scavenging ratio. If the air /fuel ratio is 15/1 find the fuel lost through exhaust.

University of Technology
Mechanical Eng. Department
Mid. Examination

Subject: Int. Comb. Engine — 3rd Year
Time: 1.5 Hours — Date: 19/1/2009

***Note**: Answer Two of the following Questions*

Q_1 **A: Give brief explanation about the dissociation and equilibrium constant.**

B: An engine uses a fuel of heating value 42000 Kj/kg . The air fuel ratio is 15.5/1 and the compression ratio is 7/1 . The compression takes place according to the law $pv^{1.35}=c$. The initial pressure and temperature are 98 kpa and 60 ^oC respectively . The specific heat at constant volume is given by : $cv = 0.716 + 1.68 \times 10^{-4}T$ Kj/kg K.(for the compression stroke) and $cv = 0.718 + 1.98 \times 10^{-4}T$ Kj/kg K.(for the combustion process), where T is temperature in Kelvin . Find : a- Change in entropy during compression stroke , b- The heat rejected during compression , c- The maximum pressure in the cylinder .

Q_2 **A: What are the assumptions made in air standard cycle analysis.**

B: Consider an ideal air standard diesel cycle in which the state before compression is 100 kpa pressure and 300 K temperature if the compression ratio is 20/1, what is the maximum cycle pressure required for this cycle to have a mean effective pressure of 13 bar . Calculate also the thermal efficiency.

Q_3 **A: What is the effect of engine speed on friction.**

B : A six cylinder , 4-stroke petrol engine have a compression ratio of 15/1 , bore of 130 mm and stroke of 150 mm . The indicated thermal efficiency is 0.4 and A/F = 14/1. The heating value of the fuel is 44000 kj/kg and the volumetric efficiency is %88. The friction power of the engine is equivalent to %12.5 of the indicated power. The engine operates at 950 r.p.m. and the atmospheric pressure and temperature are 100 kpa and 25 ^oC respectively. Determine:

a- Brake power , b- Brake thermal efficiency , c- Brake specific fuel consumption , c- mean piston speed.

Good Luck

University of Technology
Mechanical Eng. Department
Final Examination / Second Attempt

Subject: **Internal Comb. Engine** 3rd Year
Time: 3 Hours Date: 14/9/2009

Answer Four Questions Only

Q1 **A:** What are the advantages and disadvantages of the two stroke engines? (5 Marks)

B: A one cylinder two stroke, diesel engine has a bore of 12.5 cm and a stroke of 15 cm and a compression ratio of 15/1. The trapping efficiency is %60 at a speed of 1800 rpm and air /fuel ratio of 30/1. The lower calorific value of the fuel used is 43000 kJ/kg. The indicated mean effective pressure is 436 kN/m^2 and the indicated thermal efficiency is %35. If the engine working at atmospheric conditions of 100 kN/m^2 pressure and 300 K temperature find :

1- Scavenging ratio
2- Charging efficiency
3- Scavenging efficiency (10 Marks)

Q2 **A:** Give brief explanation about the heat balance of the engine and the distribution of the energy liberated by the fuel supplied to the engine. (4Marks)

B: What are the advantages of supercharging of diesel engine and gasoline engine? (4 Marks)

C: A mixture of Octane (C_8H_{18}) and air which is 10% weak is supplied to an industrial heater. The mixture is ignited and combustion occurs. Find the equivalence ratio and the composition of the products of combustion by mole. (7 Marks)

Q3 **A:** What are the main differences between ideal air standard cycle and ideal air-fuel cycle? (2 Marks)

B: Explain the effect of air/fuel ratio on: 1- Efficiency of the engine, 2- Maximum temperature. (3 Marks)

C: The stroke volume and compression ratio of a diesel engine working on the dual combustion cycle are 10 Liter and 15/1 respectively. The maximum pressure at the end of combustion is 6005 kN/m^2 and the temperature and pressure at the beginning of compression stroke are 95 ^oC and 100 kN/m^2 respectively . If the fuel used has calorific value of 44000 kJ/kg, calculate the work done per cycle at air fuel ratio of 20/1. Take cv = 0.718 and cp = 1.005 kJ/kg K and neglect the mass of fuel in the constant part of combustion.

(10 Marks)

Q4 **A**: Explain the four strokes that happen during one cycle of diesel engine

(3 Marks)

B: What are the main differences between gasoline engines and diesel engines?. (4 Marks)

C: Prove that the efficiency of Otto cycle can be expressed by:

$$1-1/r^{R/cv}$$

(8 Marks)

Q5: A six cylinder, 5 Liter supercharged engine has overall volumetric efficiency of %160. The engine produce 120 kW when operate at 3600 rpm and air /fuel ratio of 28/1. The isentropic efficiency of the supercharger is %90 and the mechanical efficiency with its link with engine is %85. The air delivers to the cylinder at 65 ^oC and 180 kN/m^2. If the lower calorific value of the fuel used is 43000 kJ/kg and the ambient conditions are 25 ^oC and 100 kN/m^2 find:

1- The amount of after cooling energy needed.
2- The engine power lost to run the supercharger.
3- The thermal supercharger after supercharging.

(15 Marks)

University of Technology
Mechanical Eng. Department
Final. Examination

Subject: **Internal Comb. Eng.** 3rd Year
Time: 3 Hours Date: 3/6/2009

Answer Four Questions Only

Q1 **A:** Define the following:-

1- Willan's line, 2-Displacement volume, 3- Brake mean effective pressure. (3 Marks)

B: A four stroke, internal combustion engine has a cylinder 180 mm bore and a stroke of 340 mm . During a trail, 3.2 kg/min. of cooling water were circulated through the jacket, the inlet and outlet temperature being 18 ^{o}C and 58 ^{o}C . The indicated mean effective pressure is 555 kN/m^2 at a speed of 6.5 rev./sec. while the brake torque was 288 N.m . The engine consumed fuel of calorific value 43000 kJ/kg at a rate of 0.06 kg/min. The amount of energy carried a way in the exhaust gases represented %38 of the energy input in the fuel. Draw up an energy balance in kJ/sec. and find the mechanical and thermal efficiencies. (12 Marks)

Q2 **A:** What are the effects of supercharging on the performance of the diesel engine. (3 Marks)

B: A four cylinder, four stroke diesel engine develops 600 kW per each kg of free air inducted per second. The diameter and stroke of each cylinder are 8.3 cm and 14 cm respectively. A rotary compressor has a mechanical efficiency of 0.85 is coupled to the engine and used to supercharged the engine. The pressure ratio and isentropic efficiency are 1.6 and 0.75 respectively. The volumetric efficiency before supercharging is 0.85 and 1.65 after supercharging at a speed of 3500 rpm referred to atmospheric conditions of 1 bar and 27 ^{o}C. Calculate the power lost to run the supercharger and the percentage increase in the brake power due to supercharging. (12 Marks)

Q3 **A:** What are the effect of the variable specific heat and dissociation on the pressure and the power output of ideal air-fuel cycle. (3 Marks)

B: An oil engine has a compression ratio of 14/1. The percentage of stroke at which the cut-off occurs is 0.04. Heat addition is partly at constant volume and partly at constant pressure. The maximum pressure is 4460 kN/ m^2. The pressure and temperature at the beginning of compression are 90.6 kN/ m^2 and 85 ^{o}C respectively. If the index of the working fluid during compression is 1.4. Estimate the heat supplied per kg of the working fluid,

assuming that the specific heat at constant volume (cv) is expressed by: $cv=0.713 + 3.79\times 10^{-5}\ T$ where T in K and R = 0.287 kJ/kg K.

(12 Marks)

Q₄ **A**: What are the meaning of a- Octane Number, b- Cetane Number.

(3 Marks)

B: Explain a method to determine octane number. (2 Marks)

C: A mixture of benzene (C_6H_6) and air which is 10% rich is supplied to an internal combustion engine. The mixture is ignited and combustion occurs. Find the equivalence ratio and the composition of the products of combustion by mole.

(10 Marks)

Q₅ **A:** Explain the periods of scavenging process. (3 Marks)

B: A two-cylinder diesel engine having a bore of 10.8 cm and a stroke of 12.7 cm working on two stroke cycle with a compression ratio of 17/1. The engine runs at 2000 rpm and consume 0.116 kg of air per second at rated speed. The exhaust pressure is 1.03 bar and the inlet temperature is 50 ^{o}C. The scavenging efficiency of the engine is 0.8. Calculate a- the scavenging ratio, b- the delivery ratio, c- the charging efficiency, d- the trapping efficiency. If the indicated thermal efficiency is 0.36 and the air/fuel ratio is 25/1 and the calorific value of the fuel is 42000 kJ/kg find the indicated power.

(12 Marks)

UNIVERSITY OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT
FINAL EXAMINATION

Subject: Internal Combustion Engines
Class: Third mechanical(Auto, Aircraft, General)

Date 15th June 2006
Time 3.0 Hours

Note : Answer any three questions

Q1: answer (a) or (b)

(a) Internal combustion engine can be classified in different ways, what are these ways?

(b) Explain five of the following (Displacement volume, Compression ignition, Mean effective pressure, Octane number, Ignition delay, Knock in SI engine, Turbo-charging)

(c) A gas turbine is running at 3000 rpm. The air mass flow rate is 12 kg/sec and the air inlet temperature to the compressor is 300 K , Fuel is supplied to the combustion chamber at the rate of 48 kg/min (L.C.V = 38 MJ/kg), Pressure ratio of the compressor = 8. Calculate:

1-The cycle thermal efficiency
2- the temperature and pressure at each point of the cycle
3- the power output of the turbine

Q2: answer (a) or (b)

(a) what are the advantages of two stroke engine over four stroke engines?

(b) Compare the air standard cycles (Otto, Diesel, and Dual) from the point of efficiency for the same compression ratio and for the same maximum (peak) pressure.

(c) A two stroke eight(8) cylinder diesel engine runs at 120 rpm, has a bore of (0.5) meter and stroke of (0.6) meter the compression ratio is 18:1 , The engine is super-charged so that its volumetric efficiency is (110%) ,the cut-off ratio is (3) , A/F = 15:1, L.C.V of the fuel= 40MJ/kg . If the air enter the engine at 350 K .Calculate

1-the maximum temperature of the cycle
2-the mean effective pressure
3-mean piston speed
4-ISFC(Indicated specific fuel consumption .

Q3: Answer either (i) or (ii) of the following:

(i) Classify Internal combustion engines and discuss in details the following from the point of view of:
1) Basic engine design and arrangement
2) Engine cycle and its operation
3) Air supply

(ii) Discuss in details the difference between the air standard cycle (ideal cycle) and the actual engine cycle.

Q4: A small truck has a 4 cylinder , 4 liters Compression Ignition engine that operates on Air-standard dual cycle with air/fuel ratio of 16, the compression ratio is 17 and the cylinder diameter is 14.5 cm. At the start of the compression stroke Ta= 50 deg.C And Pa= 100 kPa. With 3% exhaust residual .It can be assumed the half of the heat input is added at constant volume and half at constant pressure . Calculate :

1) Temperature and Pressure at each state of the cycle.
2) Indicated thermal efficiency
3) Thermal efficiency of the cycle.

Q5:

(a) Discuss and explain the methods of super charging in piston engines.

(b) A six- cylinder 4.6 liter supercharged engine , operating at 4000 rpm. Has an overall volumetric efficiency of 99% . The supercharger has an isentropic efficiency of 92% and mechanical efficiency in its link with the engine of 87% . It is desired that air be delivered to the cylinder at T2=63 C and P2= 190 kPa , while the ambient conditions are T1=Ta=28 C and P1=Pa=99 kPa. Calculate :

1- Engine power lost to run supercharger

2- Amount of after-cooling power needed.

(ρ_{air} =1.181 kg/m3 Cp =1.005 kJ/kg.K)

UNIVERSITY OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT
FIRST TERM EXAMINATION

Subject: Internal Combustion Engines — Date: 16th march 2006
Class: All Third Year Mechanical — Time: 1.5 Hour

Note: Answer Two questions only

Q1:

1- Discuss and explain three of the following

(a) Mean effective pressure (b) equivalence ratio
(c) Indicated power (d) air standard cycle (e) Cetane number

2- explain the importance of engine performance tests at constant and variable speed .

Q2:

A single cylinder, four stroke CI engine with 12.9 cm bore and 18.0 cm stroke operating at 800 RPM. Uses 0.113 kg of fuel in four minutes (C.V= 42 Mj/kg) . the engine develops a torque of 76 N-m. calculate :

(a) Brake specific fuel consumption.
(b) Brake mean effective pressure
(c) Brake power
(d) mean piston speed

Q3:

A hydrocarbon fuel (C8 H18) in an SI engine has 10% excess air is mixed with the fuel (79% N2 and 21% O2 by volume) Find three of the following :

(e) Air/ fuel ratio ?
(f) Products of combustion?
(g) The equivalence ratio ?
(h) What will happen if 10% less air than stoichiometric is supplied?

UNIVERSITY OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT
FIRST TERM EXAMINATION

Subject: Internal Combustion Engines
Class: Automotive and Aircraft Engineering

Date 16th January 2005-01-03
Time 1.5 Hours

Q1) Answer either (a) or (b) of the following :

(i) Classify Internal combustion engines and discuss in details any four of the following from the point of view of:

1) Basic engine design and arrangement
2) Valve location
3) Fuel used
4) Cooling system
5) Engine cycle and its operation
6) Ignition.

(ii) Discuss in details the difference between the air standard cycle (ideal cycle) with the actual engine cycle.

Q2) A small truck has a 4 cylinder , 4 liters Compression Ignition engine that operates on Air-standard dual cycle with air/fuel ratio of 16, the compression ratio is 17 and the cylinder diameter is 14.5 cm. At the start of the compression stroke Ta= 50 deg.C And Pa= 100 kPa. With 3% exhaust residual .It can be assumed the half of the heat input is added at constant volume and half at constant pressure . Calculate :

1) Temperature and Pressure at each state of the cycle.
2) Indicated thermal efficiency
3) Thermal efficiency of the cycle.

Q3) An SI single cylinder engine operate on Otto cycle was used to drive electrical generator . The engine swept volume is 63 cubic centimeter , the engine uses Heptane (C_7H_{16}) as fuel mixed with chemically correct amount of air (ϕ=1) . if the engine runs at 2000 rpm and the lower calorific value of the fuel is (40000 kJ/kg) and the air is (21% O_2 and 78% N_2 by volume) calculate : $\rho_{air} = 1.0$ kg/m^3

a) the Air/ fuel ratio
b) the fuel mass flow rate $\dot{m}_f$ (kg/min)
c) the heat released by combustion in each cycle assume complete combustion

امتحان الدور الأول

الموضوع: محركات الاحتراق الداخلي

الزمن: 3 ساعات

2005/6/5

الجامعة التكنولوجية

قسم هندسة المكائن والمعدات

الصف: الثالث جميع التخصصات

Note: Answer any five Questions

For Air $\gamma = 1.4$ $C_p = 1.004$ J/kg.K

Q1: Answer either A or B

A) What are the objects of Supercharging?

B) Explain the differences between Supercharging and Turbocharging.

C)

A two stroke spark ignition single cylinder engine runs at 2000 rpm has a swept volume of 100 cubic centimeter and compression ratio of 8:1 uses fuel air mixture at a ratio of 1:12.5 (F/A) the fuel is octane (C_8H_{18}) has a calorific value of 42 MJ / kg. If the engine runs on Otto cycle and has a volumetric efficiency of 90% and the density of air at inlet is 1.1 kg/m3 calculate :

1-the indicated power of the engine

2- fuel consumption kg/hr.

Q2: Answer either A or B

A) show that the thermal efficiency of Brayton cycle is

$$\eta_{th} = 1 - T1/T2$$

B) Explain the process of scavenging in two stroke engines.

C)

An SI single cylinder four stroke engine operate on Otto cycle was used to drive electrical generator. The engine swept volume is(150) cubic centimeter, the engine uses Heptane (C_7H_{16}) as fuel mixed with chemically correct amount of air ($\phi=1$) . if the engine runs at 3000 rpm and the lower calorific value of the fuel is (40000 kJ/kg) and the air is (21% O2 and 78% N2 by volume) calculate :

1 -the Air/ fuel ratio.

2 -the fuel mass flow rate m_f .

3 -the heat released by combustion in each cycle assume complete Combustion.

Q3: Discuss and explain the meaning of five of the following parameters:

1. Ignition delay period
2. Stroke volume
3. Detonation and knocking and its effect on engine power
4. Equivalence ratio
5. Cetane and Octane numbers
6. Scavenging process
7. Brake mean effective pressure
8. Auto-ignition theory

Q4: Answer only two of the following:

1-Discuss and explain the process of combustion in a Diesel Engine.

2- Discuss engine heat balance and write down the complete equations for calculating each individual parameter.

3-Discuss the difference between ideal and actual cycle of a SI engine.

Q5: A construction vehicle has a diesel engine with eight cylinders of 130 mm bore and 192 mm stroke, operating on four stroke cycle. It delivers 105 kW brake power at 1000 rpm, with a mechanical efficiency of 0.72, calculate:

1. total engine displacement
2. brake mean effective pressure
3. engine torque
4. indicated power
5. friction mean effective pressure

Q6/ (A) Write down the complete equation of stoichiometric of Hexane (C_6H_{14}) in a petrol engine. If the hexane fuel enrich with 20% excess fuel , calculate the equivalence ratio for combustion and write down the complete equation.

(B) Discuss and compare the efficiency of ideal cycle of Diesel , Dual and Otto cycle of the engine with the aid of sketch for

1. If all engines have the same compression ratio
2. If all engines have the same maximum temperatures and pressures.

Calorific value of fuel=42600 kJ/kg

UNIVERSITY OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT
FIRST TERM EXAMINATION

Subject: Combustion Equipment Technology I — Date: 23rd February 2006

Class: 3rd year/r-conditioning — Time: one and a half hours

Note : Attempt all questions.

Q1. A) Classify Internal combustion engine according to:

a) Basic Design

b) Position of cylinders

c) Type of cooling .

d) Fuel type.

B) What are the important factors and efficiencies to be considered in IC Engines selection and why.

Q2. An unknown hydrocarbon fuel (CxHy)in a SI engine has a dry volumetric gas analysis in percentage as CO_2 = 10.5% O_2 = 5.3% N_2= 84.2% find.

a) is the mixture weak or rich ?

b) Fuel type.

c) The equivalence ratio.

Q3. In a refrigeration truck on roads operation of compressor is using an internal combustion engine what sort of I C engine cycle to be selected and why if :

a) They have the same compression ratio.

b) They have the same maximum pressure

امتحان الدور الأول

الموضوع:محركات الاحتراق الداخلي

الزمن: 3 ساعات

2009/6/5

الجامعة التكنولوجية

قسم هندسة المكائن والمعدات

الصف :الثالث جميع التخصصات

Note: Answer any five Questions

For Air $\gamma = 1.4$ Cp=1.004 kJ/kg.K

Q1: Answer either A or B

A) What are the objects of Supercharging?

B) Explain the differences between Supercharging and Turbocharging.

C)

A two stroke spark ignition single cylinder engine runs at 2000 rpm has a swept volume of 100 cubic centimeter and compression ratio of 8:1 uses fuel air mixture at a ratio of 1:12.5 (F/A) the fuel is octane (C_8H_{18}) has a calorific value of 42 MJ / kg . If the engine runs on Otto cycle and has a volumetric efficiency of 90% and the density of air at inlet is 1.1 kg/m3 calculate :

1-the indicated power of the engine

2- fuel consumption kg/hr.

Q2: Answer either A or B

A) show that the thermal efficiency of Brayton cycle is

$$\eta_{th} = 1 - T1/T2$$

B) Explain the process of scavenging in two stroke engines.

C)

An SI single cylinder four stroke engine operate on Otto cycle was used to drive electrical generator. The engine swept volume is(150) cubic centimeter. the engine uses Heptane (C_7H_{16}) as fuel mixed with chemically correct amount of air (ϕ=1) . if the engine runs at 3000 rpm and the lower calorific value of the fuel is (40000 kJ/kg) and the air is (21% O2 and 78% N2 by volume) calculate :

1 -the Air/ fuel ratio.

2 -the fuel mass flow rate m_f.

3 -the heat released by combustion in each cycle assume complete Combustion.

Q3: Discuss and explain the meaning of five of the following parameters:

1. Ignition delay period
2. Stroke volume
3. Detonation and knocking and its effect on engine power
4. Equivalence ratio
5. Cetane and Octane numbers
6. Scavenging process in two-stroke engines
7. Brake mean effective pressure
8. Auto-ignition theory

Q4: Answer only two of the following:

1-Discuss and explain the process of combustion in a Diesel Engine.

2- Discuss engine heat balance and write down the complete equations for calculating each individual parameter.

3-Discuss the difference between ideal and actual cycle of a SI engine.

$i = 8$

Q5: A construction vehicle has a diesel engine with eight cylinders of 130 mm bore and 192 mm stroke, operating on four stroke cycle. It delivers 105 kW brake power at 1000 rpm, with a mechanical efficiency of 0.72, calculate:

1. total engine displacement
2. brake mean effective pressure
3. engine torque
4. indicated power
5. friction mean effective pressure

$V_d = \frac{\pi}{4} D^2 * S$

$V_T = i * V_d$

$N_b = \frac{bmep * V_d * i * n_s}{z/2} \rightarrow \frac{1000}{60}$

$N_b = T * \omega$

$\eta_m = \frac{N_b}{N_i} \Rightarrow N_i$

$P_{fmep} = imep - bmep$

$\eta_m = \frac{bmep}{imep}$

Q6/ (A) Write down the complete equation of stoichiometric of Hexane (C_6H_{14}) in a petrol engine. If the hexane fuel enrich with 20% excess fuel , calculate the equivalence ratio for combustion and write down the complete equation.

(B) Discuss and compare the efficiency of ideal cycle of Diesel , Dual and Otto cycle of the engine with the aid of sketch for

1. If all engines have the same compression ratio
2. If all engines have the same maximum temperatures and pressures.

Calorific value of fuel=42600 kJ/kg

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2005/6/5

قسم هندسة المكائن والمعدات

الزمن: 3 ساعات

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Note: Answer any five Questions

For Air $\gamma = 1.4$ Cp=1.004 kJ/kg.K

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Q1: Answer either A or B

A) What are the objects of Supercharging?

B) Explain the differences between Supercharging and Turbocharging.

A two stroke spark ignition single cylinder engine runs at 2000 rpm has a swept volume of 100 cubic centimeter and compression ratio of 8:1 uses fuel air mixture at a ratio of 1:12.5 (F/A) the fuel is octane (C_8H_{18}) has a calorific value of 42 MJ / kg . If the engine runs on Otto cycle and has a volumetric efficiency of 90% and the density of air is 1.1 kg/m3 calculate :

1-the indicated power of the engine

2- fuel consumption kg/hr.

Q2: Answer either A or B

A) show that the thermal efficiency of Brayton cycle is

$$\eta_{th} = 1 - T1/T2$$

B) Explain the process of scavenging in two stroke engines.

[illegible] used to drive electrical generator. The engine swept volume is(150) cubic centimeter. The engine uses Heptane (C_7H_{16}) as fuel mixed with chemically correct amount of air (ϕ=1) , if the engine runs at 3000 rpm and the lower calorific value of the fuel is (40000 kJ/kg) and the air is (21% O2 and 78% N2 by volume) calculate :

1-the Air/ fuel ratio.

2 -the fuel mass flow rate m_f.

3 -the heat released by combustion in each cycle assume complete Combustion.

Q3: Discuss and explain the meaning of five of the following parameters:

1. Ignition delay period
2. Stroke volume
3. Detonation and knocking and its effect on engine power
4. Equivalence ratio
5. Cetane and Octane numbers
6. Scavenging process in two stroke engines
7. Brake mean effective pressure
8. Auto-ignition theory

Q4: Answer only two of the following:

1-Discuss and explain the process of combustion in a Diesel Engine.

2- Discuss engine heat balance and write down the complete equations for calculating each individual parameter.

3-Discuss the difference between ideal and actual cycle of a SI engine.

Q5: A construction vehicle has a diesel engine with eight cylinders of 130 mm bore and 192 mm stroke, operating on four stroke cycle. It delivers 105 kW brake power at 3000 rpm, with a mechanical efficiency of 0.72, calculate:

1. total engine displacement
2. brake mean effective pressure
3. engine torque
4. indicated power
5. friction mean effective pressure

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