

II B. Tech II Semester Supplementary Examinations January – 2014

THERMAL ENGINEERING - I

(Com. to ME, AME)

Time: 3 hours

Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks

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- Compare the actual and fuel air cycles of a gasoline engine.
 - Explain the ideal and actual port timing diagrams of a 2-stroke S.I. engine.
 - With neat sketches explain the working principle of simple carburetor.
 - Discuss the important qualities of an S.I and C.I engine fuel.
 - Describe the phenomenon of pre-ignition in S.I. engines and discuss its effect on the performance.
 - What are the various types of combustion chambers used in S.I. engines? Explain them briefly.
 - Explain the various factors that influence the delay period in a C.I engine.
 - Explain the stages of combustion in C.I engine.
 - What is the purpose of engine testing?
 - The following data were recorded during a test on a 4-stroke cycle gas engine.
Area of indicator diagram= 90 cm²,
Length of indicator diagram= 7 cm,
Spring scale= 0.3 bar/mm,
Diameter of piston = 20 cm,
Length of stroke = 25 cm,
Speed= 300 rpm.
Determine: i) Indicated mean effective pressure. ii) Indicated power
 - Explain the following as referred to air compressors.
i) Isothermal efficiency. ii) Volumetric efficiency
 - Prove the following relationship

$$\eta_{\square} = \frac{P_1 T_a}{P_a T_1} \left(1 + \frac{\kappa - 1}{\kappa} \right) - \frac{P_1}{P_a} \left(\frac{P_a}{P_1} \right)^{\frac{1}{\kappa}}$$
 - What do you mean by multistage compression? State its advantages and disadvantages.
 - A single acting two stage compressor with complete inter cooling delivers 10.5 Kg/min of air at 16 bar. The suction occurs at 1 bar and 25° C. The compression and expansion process are reversible, polytropic index = 1.3. Calculate:
i) Power required to drive the compressor ii) Isothermal efficiency
iii) Volumetric efficiency of both the compressors; If the clearance ratios for LP and HP cylinder are 0.04 and 0.06 respectively.
 - Describe with a neat sketch the working of roots blower.
 - A Roots blower compresses 0.08 m³ of air from 1.0 bar to 1.5 bar for revolution, calculate compressor efficiency.

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1. a) Draw the neat sketch of fuel pump for C.I. engine and explain.
b) Explain ideal and actual port timing diagrams of 2-stroke S.I. engine.
2. a) What is the difference between air standard cycle and fuel air cycle analysis? Explain significance of fuel air cycle.
b) What is meant by crank case ventilation? Explain the details.
3. a) Briefly explain the stages of combustion in S.I. engines elaborating the flame front propagation.
b) Explain with a neat sketch the battery ignition system.
4. a) Explain the phenomenon of knock in C.I engines.
b) Explain the working of Ricardo swirl chamber.
5. a) What is the purpose of engine testing?
b) The following data was recorded during testing of a 4-stroke cycle gas engine.
Diameter= 10 cm,
Stroke= 15 cm,
Speed= 1600 rpm,
Area of the positive loop of the indicator diagram= 5.75 cm^2 ,
Area of the negative loop of the indicator diagram= 0.25 cm^2 ,
Length of the indicator diagram= 55 mm,
Spring constant= 3.5 bar/cm.
Find the indicated power of the engine.
6. a) Compare centrifugal and axial flow compressors.
b) A roots blower compresses 0.06 m^3 of air from 1.0 bar to 1.45 bar per revolution. Calculate compressor efficiency.
7. a) Explain the working of an axial flow compressor with a neat sketch.
b) An 8 stage axial flow compressor takes in air at 20°C at the rate of 180 kg/min. The pressure ratio is 6 and isentropic efficiency is 0.9. Determine the power required.
8. a) Explain with a neat sketch the working of a centrifugal compressor.
b) A centrifugal air compressor having a pressure ratio of 5, compresses air at the rate of 10 kg/s. If the initial pressure and temperature of air is 1 bar and 20°C , calculate final temperature and power required to drive the compressor.



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1. a) Define volumetric efficiency and discuss the effect of various factors effecting the volumetric efficiency.  
b) Why do designer go for multi cylinder engine for heavy loads and name some multi cylinder engine types.
  
2. a) Explain pressure cooling system with a sketch.  
b) With neat sketch, explain the working of solex carburetor.
  
3. a) Explain the various factors that influence the flame speed of an S.I engine.  
b) What is delay period and what are the factors effecting the delay period?
  
4. a) What are the different methods used in C.I. engines to create turbulence in the mixture.  
b) Discuss the advantages and disadvantages of the two types of combustion chambers of CI engines.
  
5. a) What is the purpose of engine testing? Name the various measurements which are to be taken in a test of I.C. engine.  
b) Find the engine dimensions of a 2-cylinder, 2-stroke I.C. engine from the following data: Engine speed= 4000 rpm,  
Volume efficiency = 0.77,  
Mechanical efficiency = 0.75,  
Fuel consumption = 10Lit/hr (g = 0.73), Air fuel ratio = 18:1,  
Piston speed = 600 rpm,  
Indicated mean effective pressure = 5bar.  
Find also brake power. Take R of gas mixture as 281 J/Kg k at S.T.P.



6. a) Enumerate the application of compressed air. State how reciprocating air compressors classified.

b) Prove that the volumetric efficiency of a single stage compressor is given by

$$\eta_v = 1 + K - K \frac{P_2}{P_1} \frac{1}{n}, \text{ where } K = \frac{V_c}{V_s}$$

7. a) Derive an expression for efficiency of Roots blower in terms of pressure ratio and ratio of specific heats.

b) A rotary compressor receives air at 1 bar and  $17^\circ\text{C}$  and delivers it at a pressure of 6 bar. Determine per kg of air delivered, work done by the compressor and heat exchanged with the jacket water when the compression is isothermal, isentropic by the relation  $PV^{1.6} = \text{constant}$ .

8. a) Differentiate between centrifugal compressor and axial flow compressor.

b) An axial flow compressor, with compression ratio as 4, draws air at  $20^\circ\text{C}$  and delivers it at  $197^\circ\text{C}$ . The mean blade speed and flow velocity are constant throughout the compressor. Assuming 50% reaction blading and taking blade velocity as 180 m/s, find flow velocity and the number of stages. Take work factor = 0.82,  $\alpha = 12^\circ$ ,  $\beta = 42^\circ$  and  $C_p = 1.005 \text{ KJ/kg K}$ .



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1. a) Derive an expression for the efficiency of Otto cycle and comment on the effect of compression ratio on the efficiency with respect of ratio of specific heats by means of suitable graphs.
b) Explain exhaust blow down factor.
2. a) Mention the various parameters which affect the engine heat transfer and explain their effect.
b) Clearly explain wet sump lubrication system with a sketch.
3. a) What is meant by abnormal combustion? Explain the phenomenon of knock in S.I. engine.
b) What is ignition lag in S.I. engine and how does it affect performance.
4. a) Explain with figure various types of combustion chambers used in C.I. engine.
b) Bring out clearly the process of combustion in C.I. engine and also explain various stages of combustion.
5. The following data refer to an oil engine working on Otto 4-stroke cycle
Brake power = 14.7 kW,
Suction pressure = 0.9 bar,
Mechanical efficiency = 80%,
Index of compression curve = 1.35,
Index of expansion curve = 1.3,
Maximum explosion pressure = 24 bar,
Engine speed = 1000 rpm,
Ratio of stroke: bore = 1.5. Find the diameter and stroke of the piston.
6. a) Explain the effect of inter cooling in a multi stage reciprocating compressor.
b) Determine the size of the cylinder for a double acting air compressor of 40 kW indicated power, in which air is drawn at 1 bar and 15°C and compressed according to the law $PV^{1.2} = \text{constant}$ to 6 bar. The compressor runs at 100 rpm with average piston speed of 152.5 m/min. Neglect clearance.



7. a) What is a slip factor and pressure coefficient?
- b) The following data relate to a performance test of single acting 14 cm X 10 cm reciprocating compressor.
- Suction pressure = 1bar,
Suction temperature = 20°C,
Discharge pressure = 6bar,
Discharge temperature = 180°C,
Speed of compressor = 1200 rpm,
Shaft power = 6.25 kW,
Mass of air delivered = 1.7 kg/min.
- Calculate the following:
- The actual volumetric efficiency
 - Indicated power
 - Isentropic efficiency
 - Mechanical efficiency
 - Overall isothermal efficiency.
8. a) What do you mean by surging & choking?
- b) An axial flow compressor with an overall isentropic efficiency of 85% draws air at 20°C and compresses it in the pressure ratio of 4:1. The mean blade speed and flow velocity are constant throughout the compressor. Assuming 50% reaction blading and taking blade velocity as 180 m/s, and work input factor as 0.82. Calculate: i) Flow velocity and ii) The number of stages. Take $\alpha = 12^\circ$, $\beta = 42^\circ$ and $C_p = 1.005 \text{ KJ/kg K}$.