(b) The following observations were made during a trial of a single cylinder four stroke gas engine having cylinder diameter of 180 mm and stroke of 240 mm:

Duration of trial = 30 min

Total number of revolutions = 9000

Total number of explosions = 4450

Gross imep = 5.35 bar

Pumping imep = 0.35 bar

Net load on brake wheel = 40 kg

Diameter of the brake wheel drum = 0.96 m

Diameter of the rope = 4 cm

Volume of gas used = 2.6 $m^3$

Pressure of gas = 136 mm water of gauge

Density of gas = 0.655 $kg/m^3$

Ambient temperature = 17°C

Calorific value of gas at NTP = 19 $MJ/m^3$

Total air used = 40 $m^3$

Pressure of air = 720 mm Hg

Temperature of exhaust gas = 340°C

Specific heat of exhaust gas = 1.1 kJ/(kg K)

Cooling water circulated = 80 kg

Rise in temperature of cooling water = 30°C

Draw up a heat balance sheet and estimate the mechanical and indicated thermal efficiencies of the engine. (10 + 3 + 2)





Reg. No. : | | | | | | | | | | | | |

## Question Paper Code : 80233

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fourth Semester

Mechanical Engineering

ME 8493 — THERMAL ENGINEERING — I

(Regulation 2017)

Time : Three hours Maximum : 100 marks

(Use of Steam Table is allowed)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Why does diesel cycle have high efficiency compared to Otto cycle?
2. What are the factors influencing the ideal Brayton cycle efficiency?
3. What is meant by isothermal efficiency of the compressor?
4. How is work saving possible in multi stage compressor?
5. How is cam shaft speed-related-to crank shaft speed? and Why?
6. What are the effects of rich mixtures in petrol engine?
7. What is the use of Morse Test?
8. What are the functions of lubrication system?
9. What fuel does a gas turbine use?
10. What is the effect of reheat on the Brayton cycle efficiency? and Why?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Derive the expression for the efficiency of Diesel cycle in terms of cycle parameters. (5)

(ii) In an air standard dual cycle, the pressure and temperature at the beginning of the compression are 1 bar and 57° C respectively. The heat supplied in the cycle is 1250 kJ/kg, two-third of this being added at constant volume and rest at constant pressure. If the compression ratio is 16, determine the maximum pressure and temperature in the cycle thermal efficiency and MEP. (8)

Or

(b) (i) Derive the expression for the efficiency of Brayton cycle in terms cycle parameters. (5)

(ii) Steam power plant runs on a single regenerative heating process. The steam enters the turbine at 30 bar and 400°C and steam fraction is withdrawn at 5 bar. The remaining steam exhausts at 0.10 bar, to the condenser. Calculate the efficiency and steam rate of the power plant. Neglect pump works. (8)

12. (a) A single stage, single acting air compressor running at 800 rpm delivers air at 6 bar. For this purpose, the inducted free air condition can be taken as 1.013 bar and 20°C, and air delivery as 10 $m^3$/min. The clearance volume is 5% of the swept volume and stroke bore ratio is 1.5:1. Calculate (i) the power consumed (ii) the volumetric efficiency (iii) the bore and stroke size and (iv) isothermal efficiency. The index of compression and expansion may be taken as 1.35. For air : R = 0.287 kJ/kg.K. (13)

Or

(b) (i) Present the comparison between centrifugal and reciprocating compressors. (5)

(ii) Explain the working of reciprocating compressor using relevant sketch. (8)

13. (a) (i) Draw the actual indicator diagram for a four stroke diesel engine and list the major reason for the losses. (5)

(ii) Describe the advantages and disadvantages of 2-Stroke engines. (8)

Or

(b) (i) List the desirable properties of IC Engine fuels. (5)

(ii) Write the combustion reaction for methane. Calculate the theoretical air to fuel ratio and composition of the products formed. (8)

14. (a) (i) Describe the need for firing order with examples. (5)

(ii) Describe the working of common rail direct injection systems. (8)

Or

(b) (i) Explain the working of Full pressure lubrication system. (5)

(ii) Describe how turbocharging leads to high power output and the associated effects. (8)



15. (a) (i) Show that the optimum pressure ratio for maximum work is equal to the square root of the maximum pressure ratio for the given minimum and maximum temperatures. (5)

(ii) A gas turbine works on an air standard Brayton cycle. The initial condition of the air is 25°C and 1 bar. The maximum pressure and temperature are limited to 8 bar and 650°C. Determine the cycle efficiency, heat supplied and heat rejected per kg of air, the work output per kg of air and the exhaust temperature. (8)

Or

(b) In a closed cycle gas turbine there is a two stage compressor and a two stage turbine. All the components are mounted on the same shaft. The pressure and temperature at the inlet of the first stage compressor are 1.5 bar and 20°C. The maximum cycle temperature and pressure are limited to 750°C and 6 bar. A perfect intercooler is used between the two stage compressors and a reheater is used between the two turbines at 3 bar pressure. Gases are heated in the reheater to 750°C before entering into the L.P. turbine. Assuming the compressor and turbine efficiencies as 0.82, calculate

(i) The efficiency of the cycle without regenerator

(ii) The efficiency of the cycle with a regenerator whose effectiveness is 0.70. The working fluid used in the cycle is air : For air : Specific Heat ratio = 1.4 and $c_p$ = 1.005 kJ/kg. K. (8 + 5)

PART C — (1 × 15 = 15 marks)

16. (a) The following data relate to both Otto and Diesel Cycles :

Conditions at the start of compression : 100 kPa and 300 K

Maximum temperature : 1500 K

Temperature after isentropic expansion : 700 K

Take : $c_p$ = 1.005 $c_v$ = 0.718, R = 0.287 kJ/kg.K and Specific Heat ratio = 1.4

Determine the pressure and temperature on the salient points, compression ratio, maximum pressure efficiency and mean effective pressure for

(i) Otto cycle and label the values on p-v and T-s diagram. (8)

(ii) Diesel cycle and label the values on p-v and T-s diagram. (7)

Or