*Name :* .....

*Roll No. :* .....

*Invigilator's Signature :* .....

**CS/B.TECH/AUE/SEM-8/AUE-823/2013**

# 2013
# GAS TURBINE ENGINE

*Time Allotted :* 3 Hours *Full Marks :* 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

## GROUP – A

## ( Multiple Choice Type Questions )

1. Choose the correct answers for the following : 10 × 1 = 10

i) Thermodynamic cycle for working of gas turbine engine is

a) Diesel Engine b) Dual Cycle

c) Brayton Cycle d) Sterling Cycle.

ii) A gas turbine cycle can be operated

a) only as an open cycle arrangement

b) only as a closed cycle arrangement

c) both open and closed cycle arrangement

d) none of these.

iii) Major application of gas turbine is for

a) aircraft b) locomotive

c) IC engine d) all of these.

iv) Function of inlet duct is to

a) provide sufficient air supply to engine

b) prevent surges

c) ensure uniform pressure and velocity to compresser inlet

d) all of these.

v) Brayton cycle consists of

a) two adiabatic and two isentropic

b) two adiabatic and two isothermal

c) two isothermal and two constant pressure

d) two isentropic, one constant pressure and one constant volume.

vi) An ideal cycle with reheat, intercooling and heat exchanger will increase

a) efficiency b) work output

c) both (a) and (b) d) none of these.

vii) For the maximum specific output of any given value of $t$ , the optimum pressure ratio is given by

a) $c = t$ b) $c = t^2$

c) $c = \sqrt{t}$ d) $c = 1/t$.

viii) The efficiency of the ideal cycle is a function of

a) only the $\gamma$ of the working fluid

b) only the pressure ratio

c) both $\gamma$ and pressure ratio

d) inlet temperature of turbine.

ix) When a heat exchanger is added to an ideal cycle

a) power output decreases but the efficiency increases

b) power output increases but the efficiency decreases

c) both remain the same

d) power output remains the same but the efficiency increases.

x) The specific weight of gas turbine power plant is

a) 50 kg/kW b) 20 kg /kW

c) 100 kg/kW d) 80 kg/kW.

## GROUP – B

### ( Short Answer Type Questions )

Answer any *three* of the following. 3 × 5 = 15

2. State the assumptions made in an ideal cycle analysis of gas turbines. How are the actual cycles different from ideal cycle ?

3. Derive the expression of specific work output and the efficiency of a simple cycle.

4. Mention the various advantages and disadvantages of a Pulse jet engine.

5. Mention the advantages and disadvantages of gas turbine engine over reciprocating engines.

6. Briefly explain the process of combustion in a gas turbine combustion chamber.

## GROUP – C

**( Long Answer Type Questions )**

Answer any *three* of the following. 3 × 15 = 45

7. a) Derive the expression for specific work output and the efficiency of a simple cycle with heat exchanger. Draw their trends as a function of pressure ratio. 6 + 2

   b) Compute the indicated mean effective pressure and efficiency of a Brayton cycle if the temperature at the end of combustion is 2000 K and the temperature and pressure before compression are 350 K and 1 bar. The pressure ratio is 1·3. Assume $C_p = 1 \cdot 005$ kJ/kg K.

   $R$ = 0·287 kJ/kg-K. 7

8. a) What are the various assumptions made in practical cycle ? 5

   b) An oil gas turbine installation consists of a compressor, a combustion chamber and turbine. The air taken in at pressure of 1 bar and temperature of 30°C is compressed to 6 bars with an isentropic efficiency of 87%. Heat is added by combustion of fuel in combustion chamber to raise the temperature 700°C. The efficiency of the turbine is 85%. The calorific value of the oil used is 43·1 MJ/kg. Calculate for an air flow of 80 kg/min, neglecting the effect of fuel in the mass flow rate

   (i) the air-fuel ratio of the turbine gases

(ii) the final temperature of exhaust gases

(iii) the net power of installation

(iv) the overall thermal efficiency of the installation.

Assume $C_{pa} = 1 \cdot 005$ kJ/kg-K, $\gamma_a = 1 \cdot 4$ and $C_{pg} = 1 \cdot 147$ kJ/kg-K, $\gamma_g = 1 \cdot 33$. 10

9. What are the different types of combustors used in gas turbine engines and what are the factors affecting the performance ? Explain the various processes of combustion in combustion chamber. Describe the requirements of the combustion chamber. 4 + 6 + 5

10. What is meant by thrust ? Derive the thrust equation for a general propulsion engine. With a sketch describe the different parts of a ramjet engine. What are the advantages and disadvantages of ramjet engines ? 3 + 7 + 5

11. In a gas turbine plant air enters the compressor at 1 bar and 7°C. It is compressed to 4 bar with isentropic efficiency of 82%. The maximum temperature at the inlet to the turbine is 800°C. The isentropic efficiency of the turbine is 85%. The calorific value of the fuel used is 43·1 MJ/kg. The heat losses are 15% of the calorific value. Calculate the following :

(i) Compressor work in KJ/kg

(ii) Heat supplied in kJ/kg

(iii) Turbine work in kJ/kg

(iv) Net work in kJ/kg

(v) Thermal efficiency

(vi) Air/Fuel ratio

(vii) Specific fuel consumption in kg/kWh

(viii) Ratio of compressor work to turbine work.