Ref. No.: Ex/PE/PE/B/T/323C/2023

B.E. Power Engineering 3rd Year 2nd Semester Examination 2023

Full Marks: 100 **I.C.Engine and Gas Turbine** **Time: 3 hours**

Answer from all groups.

GROUP – A (Questions from CO-1)

Answer any **three** questions **(3 X 10 = 30 marks)**

1. (a) Classify the internal combustion engines based on the number of strokes and compare them on the basis of different factors. **(6)**
   (b) In case of industrial gas turbine, differentiate between an open cycle plant and a closed cycle plant? **(4)**
2. Draw the valve timing diagram of a four-stroke spark ignition engine and justify the opening and closing times of the valves. **(10)**
3. (a) Describe the working principle of a turbocharger in an internal combustion engine. **(5)**
   (b) Explain the valve opening mechanism in an internal combustion engine. **(5)**
4. (a) Describe the common rail fuel injection system in a C.I engine and state its advantages. **(8)**
   (b) What are the different types of fuel nozzles used in C.I. engine fuel injection system? **(2)**

GROUP – B (Questions from CO-2)

Answer any **three** questions **(3X10 = 30 marks)**

5. Illustrate the different fuel-air mixture quality requirements for spark ignition engines under various conditions of steady state and transient operations and justify them. **(10)**
6. (a) Substantiate the importance of flow conditions in the engine cylinder on the combustion performance of a spark ignition engine. **(5)**
   (b) Explain the principle of detonation in Spark Ignition engine. **(5)**
7. (a) Explain the significance of good atomization on the ignition delay and combustion performance of a C.I.Engine. **(4)**
   (b) What are the different phases of combustion in a C.I. Engine and explain them. **(6)**
8. (a) What are the main pollutants emitted by S.I. engines and C.I. engines? Name the sources of hydrocarbon (HC) emission from S.I. engines. **(2+2)**
   (b) What is a catalytic converter and what is its role in mitigating emission from engines? **(6)**

GROUP – C (Questions from CO-3)

Answer any **two** questions **(2X10 = 20 marks)**

9. An engine with an indicated thermal efficiency of 25% and mechanical efficiency 75% consumes 25 kg/h of fuel at a fixed speed. The brake mean effective pressure is 5 bar and the mean piston speed is

15 m/s. Assuming that the engine is a four stroke, single cylinder, square engine, determine the crank radius and crank speed in RPM. Take HV of fuel = 42 MJ/kg. **(10)**

10. A four stroke C.I. engine having a cylinder diameter of 39 cm and stroke of 28 cm has a mechanical efficiency of 80%. Assume the frictional power to be 80 kW. Its fuel consumption rate is 86 kg/h with an air-fuel ratio of 18:1. The speed of the engine is 2000 RPM. Calculate (i) IP, (ii) Heating Value of fuel, if η_{ith}=40%, (iii) p_{imep} (iv) air flow rate, (v) mean piston speed. **(10)**
11. A gasoline engine working on 4-stroke develops a brake power of 22 kW. A Morse test was conducted on this engine and the brake power (kW) obtained when each cylinder was made inoperative by short-circuiting the spark plugs are 14.9, 14.3, 14.8 and 14.5, respectively. The test was conducted at constant speed. Find the indicated power, mechanical efficiency and bmep when all the cylinders are firing. The bore of the engine is 80 mm and stroke is 90 mm. The engine is running at 3000 rpm. **(10)**

GROUP – D (Questions from CO-4)

Answer any **one** question **10 marks**

12. With a neat sketch show the components of a turbojet engine and explain the working principle. Derive the terms for thrust and propulsion efficiency for the engine. **(8+2)**
13. With a neat sketch show the construction and working of a gas turbine combustion chamber. Define pattern factor of the combustor and explain its significance. **(7+3)**

GROUP – E (Questions from CO-5)

Answer any **one** question **10 marks**

14. Considering simple air standard Brayton cycle for gas turbine, derive expressions of thermal efficiency and specific work output. In a gas turbine plant, the pressure before and after the compressor are 1 bar and 8 bar respectively, the minimum and maximum temperatures of the cycle are 25°C and 1000°C respectively. Considering the specific heat of air at constant pressure to be 1.004 kJ/kg-K, determine the thermal efficiency and specific work output of the gas turbine. Assume the plant to operate following simple air standard Brayton cycle. **(10)**
15. Why and how regeneration is done in a gas turbine plant? Show that the regeneration in a gas turbine is possible only up to a critical pressure ratio of the cycle, whose value depends on the temperature ratio. **(4+6)**