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Course Code

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Fourth Semester B.E. Degree Examinations, Sep/Oct 2023
ENGINEERING THERMODYNAMICS

Duration: 3 hrs

Max. Marks: 100

- Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
 2. Missing data, if any, may be suitably assumed

| <u>Q. No</u> | <u>Question</u> | <u>Marks</u> | <u>(RBTL:CO: PI)</u> |
|-------------------|---|--------------|----------------------|
| MODULE – 1 | | | |
| 1. | a. What are the different types of work transfer. Explain flow work | 04 | (1 :1: 1.6.1) |
| | b. Derive the expression for displacement work in Polytrophic Process | 06 | (2 :1: 1.6.1) |
| | c. A fluid in a horizontal cylinder fitted with a frictionless leak proof piston is continuously agitated by means of stirrer passing through the cylinder cover. The cylinder diameter is 400 mm. During a stirring process of 10 minutes, the piston moves slowly outwards to a distance of 485 mm against the atmospheric pressure. The net work done by the fluid during this process is 2000 Nm. Given that the speed of electric motor driving the stirrer is 840 rpm, estimate the torque required in driving the shaft and shaft output of the motor. | 10 | (3 :1: 1.7.1) |
| OR | | | |
| 2. | a. Stating the assumptions. Derive the steady flow energy equation (SFEE) for an open system. | 10 | (2 :1: 1.6.1) |
| | b. The working fluid in a steady flow process flow at the rate of 220 Kg/min. the fluid rejects 100 KJ of heat passing through the system. the fluid enters a velocity 320 m/sec pressure of 6 bar, internal energy 2000 KJ/Kg, specific volume of 0.36 m ³ /Kg and leaves system at a velocity of 140 m/sec, pressure of 1.2 bar, internal energy 1400 KJ/Kg, specific volume 1.3 m ³ /Kg. determine the power output in MW. Neglect change in potential energy. | 10 | (3 :1: 1.7.1) |
| MODULE – 2 | | | |
| 3. | a. Define the following i) Source ii) Heat engine | 4 | (1 :2: 1.6.1) |
| | b. Establish the Equivalence of Kelvin-Plank and Clausius statement | 8 | (2 :2: 1.6.1) |
| | c. A Carnot heat engine operates between source temperatures T ₁ °K and sink temperature T ₂ °K, difference between source and sink temperature is 240. If the work developed by Carnot engine is 0.74 times the heat rejected by Carnot engine to the sink. Find the efficiency of Carnot engine, source temperature and sink temperature. | 8 | (3 :2: 1.7.1) |
| OR | | | |
| 4. | a. Show that Entropy as a property of a system | 6 | (2 :2: 1.6.1) |
| | b. Derive the Entropy change for an Ideal gas using TDS relation | 8 | (2 :2: 1.6.1) |
| | 2 kg of water at 100°C is mixed with 3 kg of water at 50°C in an isolated system calculate the change in Entropy during the mixing process. | 6 | (3 :2: 1.7.1) |

MODULE – 3

5. a. Define i) Stoichiometric Air fuel ratio ii) Enthalpy formation iii) Internal energy of combustion iv) Combustion Efficiency 8 (1 :3: 1.6.1)
- b. The products of combustion of an unknown Hydrocarbon C_xH_y have the following composition measured by Orsat apparatus. $CO_2 = 8\%$, $CO = 0.9\%$, $O_2 = 8.8\%$, $N_2 = 82.3\%$. Determine i) Composition of fuel ii) Air fuel ratio iii) Percentage of Excess air iv) Dew point temperature of products if total pressure is 1 atmospheric. 12 (3 :3: 1.7.1)

OR

6. a. What are the factors affecting Detonation or Knocking 4 (1 :3: 1.6.1)
- b. Explain the different methods to determine Frictional power of an IC Engine 6 (2 :3: 1.6.1)
- c. A 4 - cylinder petrol engine has a rated output of 52 kW at 2000 RPM. A Morse test is carried out and the brake torque readings are 177, 170, 168 and 174 N-m respectively. For normal running at this speed, the BSFC is 0.25 kg/kW-hr and CV of fuel used is 42500 kJ/kg. Calculate i) Mechanical efficiency ii) Brake thermal efficiency 10 (3 :3: 1.7.1)

MODULE – 4

7. a. Define the following i) Triple point ii) critical point iii) Dryness fraction 6 (1 :4: 1.6.1)
- b. Sketch and explain combined separating and throttling calorimeter to find out the dryness fraction of pure substance 8 (2 :4: 1.7.1)
- c. Superheated steam initially at a pressure of 5 bar and $300^\circ C$ is expanded isentropically to a pressure of 0.5 bar. Calculate i) Final condition of steam ii) Change in enthalpy iii) Change in internal energy per kg of steam. 8 (3 :4: 1.7.1)

OR

8. a. With the help of T-S diagram discuss the effect of Boiler pressure, condenser pressure and super heat on the performance of Rankin cycle? 6 (2 :4: 1.6.1)
- b. With line and T-S diagram derive the expression for efficiency of a reheat Rankine cycle? 6 (2 :4: 1.7.1)
- c. In a thermal power station with reheat cycle, The steam at boiler outlet is 15 MPa and $550^\circ C$. The reheating takes place at 4 MPa and the temperature at the end of reheat is same as boiler outlet temperature. If the condenser pressure is 10 kPa for ideal process calculate i) Quality of steam at turbine exhaust ii) work done by turbine iii) work done by pump iv) cycle efficiency 8 (3 :4: 1.7.1)

MODULE – 5

9. a. With P-V and T-S diagram, derive the expression for air standard efficiency of Dual Cycle. 10 (2 :5: 1.6.1)
- b. The pressure and temperature of fluid working on a diesel cycle are 1 bar and $30^\circ C$ before compression if the compression ratio is 18 and cut off ratio is 2 and the cycle peak temperature is $1999^\circ C$ calculate i) Efficiency ii) Pressure and Temperature at all points 10 (3 :5: 1.7.1)

OR

10. a. With line and T-S diagram explain Intercooler and Reheat methods to improve the efficiency of a Gas Turbine 6 (2 :5: 1.6.1)
- b. With a neat sketch explain Rocket propulsion 6 (2 :5: 1.6.1)

- c. Find the air fuel ratio in a gas turbine where the efficiency of turbine and compressor are 85% and 80% respectively air enters the compressor at 1 bar and 27°C and max cycle temperature is 875°C. The pressure ratio is 4 Take the CV of fuel 42000 kJ/kg there is loss of 10% of CV in the combustion chamber. 8 (3 :5: 1.7.1)

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MODEL QUESTION PAPER