Question Paper

Exam Date & Time: 14-Nov-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES END SEMESTER THEORY EXAMINATIONS NOVEMBER2019 III SEMESTER B.sc. (Applied Sciences) in Engg.

THERMAL ENGINEERING [IME 231 - S2]

Marks: 100 **Duration: 180 mins.**

Answer 5 out of 8 questions.

Missing data, if any, may be suitably assumed
Use of thermodynamics data hand book and steam tables permitted.

1) A) Explain the first law of thermodynamics applied to a closed system and with the help of sketch explain Joule's experiment applied to the Ist law of thermodynamics. (6)

B) What are similarities and dissimilarities between work and heat transfer of a system. (4)

C) The initial state of air is 100 kPa and 30^0 C. After compression the fluid volume is 1/15th of its original volume and compression follows polytropic equation PV$^{1.25}$ = C. Determine pressure and temperature at the final state, work done and energy transfer as heat. (10)

2) A) Explain with assumptions the first law of thermodynamics applied to an open system executing a process. (6)

B) Explain salient features of work transfer of a system and What are similarities and dissimilarities between work and heat transfer of a system. (6)

C) In a nozzle, the ideal gas expands from a pressure of 20 bar to 3 bar and the process is reversible adiabatic. The inlet conditions are 500^0 C and 35 m/sec. determine area and velocity at the outlet section of the nozzle, If the flow rate is 5 kg/sec. Take R = 190 J/kg.K and γ = 1.35. (8)

3) A) With help of P-V diagram show that the internal energy is the property of a thermodynamic system. (4)

B) Define the two parallel statements of second law of thermodynamics and show that violation of Clausius statement equally violates the kelvin-plank statement. (6)

C) A heat engine working on Carnot cycle converts one-fifth of the heat input in to work. When the sink temperature is reduced by 70^0 C, the heat engine efficiency gets doubled. Determine temperature of source and sink. (10)

4) Show that the efficiency of a reversible heat engine is always greater than the efficiency of an irreversible heat engine. (6)

A)

B) Show that a reversible process substitute by the reversible isothermal and reversible adiabatic processes. (4)

C) In a closed system, air is at pressure of 1 bar, temperature of 300 K and volume of 0.025 m^3. The system executes the following processes during the completion of a thermodynamic cycle. Draw P-V and T-s diagram. (10)
1-2: Constant volume heat addition till pressure reaches to 3.8 bar
2-3: Constant pressure cooling of air
3-1 Isothermal heating to its initial state
Determine change in entropy in each processes and the total entropy change of the cycle.

5) Explain the working and derive expression of efficiency of an Ideal Regenerative cycle with the help of sketch and T-S diagram of the cycle. (6)

A)

B) With T-S diagram explain various factors influence the performance of a Rankine Vapour Cycle. (6)

C) In a steam power plant operating on the ideal reheat Rankine cycle, the steam at 15 bar and 250^0 C is expanded in a turbine to 4 bar and reheated at this pressure to 250^0 C and then expanded to 0.1 bar pressure before enters the condenser. Draw sketch diagram of layout and T-s diagram of the reheat cycle and find net amount of work transfer of the cycle per kg of steam and estimate the efficiency of the cycle. (8)

6) Derive an expression for Mean Effective pressure of constant volume cycle in terms of pressure ratio and compression ratio. (6)

A)

B) Explain and compare the performances of constant volume and constant pressure air standard cycles. (6)

C) The compression ratio of a compression ignition engine working on the ideal diesel cycle is 16. The temperature of air at the beginning of compression is 300 K and the temperature of air at the end of expansion is 900 K. Determine, a) Cut off ratio, b) Expansion ratio, and c) The cycle efficiency. (8)

7) Obtain an expression for Work done of Compression in a 2-Stage compressor with perfect inter cooling and also derive the condition required for minimum work supplied. (6)

A)

B) Explain Factors effecting the co-efficient of performance of Vapor compression refrigeration system. (6)

C) A single acting, single cylinder reciprocating air compressor has a cylinder diameter 200 mm and a stroke of 300 mm. Air enters the cylinder at 1 bar, 27^0C. It is then compressed polytriopically to 8 bar according to the law $PV^{1.3} = C$. If the speed of the compressor is 250 rpm, calculate the mass of air compressed per minute, and power required inn kW for driving the compressor. (8)

8) Explain briefly the different modes of heat transfer with suitable examples. (4)

A)

B) Explain the Morse and Motoring test used to determine the performance of SI Engines. (6)

C) A test on a single cylinder 4 stroke oil engine having a bore of 150 mm and stroke of 300 mm give the following results. Speed = 300 rpm, Break torque = 200 N-m, Indicated mean effective pressure = 7 bar, Fuel consumption = 2.4 kg/hr, Cooling water flow = 5 kg/min, Cooling water temperature rise = 30^0 C, Air fuel ratio = 22, Exhaust gas temperature = 410^0 C, Specific heat of exhaust gases = 1.0 kJ/kg.K, Room temperature = 20^0 C, Room pressure = 1 bar, Calorific value of the fuel = 42 MJ/kg, R = 0.2872 kJ/kg.K. Determine, a) Indicated thermal efficiency, b) Volumetric efficiency, and c) Draw a heat balance sheet in terms of kJ/min and percentage basis. (10)

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