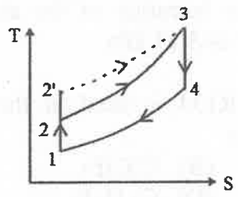
b. In a diesel Engine, ignition occurs due to high — 1 1 3 1

(A) Density of charge (B) Temperature of A/F mixture
(C) Temperature of compressed air (D) Intensity spark on spark plug

c. For the same maximum temperature and pressure, an Otto-cycle and Diesel cycle are shown on the same T-S diagram below. Which of the following is correct? — 1 2 3 1



(A) 1-2-3-4 is an Otto – Cycle and 2-3 is an Isobaric Process
(B) 1-2'-3-4 is an Otto – Cycle and 2'-3 is an Isobaric Process
(C) 1-2-3-4 is an Otto – Cycle and 2-3 is an Isobaric Process
(D) 1-2'-3-4 is an Otto – Cycle and 2'-3 is an Isobaric Process

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Reg. No.														

B.Tech. DEGREE EXAMINATION, JUNE 2023

OPEN BOOK EXAMINATION

Fourth Semester

18MEC107T – APPLIED THERMAL ENGINEERING

(For the candidates admitted from the academic year 2018-2019 to 2019-2020)

- Specific approved THREE text books (Printed or photocopy) recommended for the course
- Handwritten class notes (certified by the faculty handling the course / head of the department)

Time: 3 Hours Max. Marks: 100

Answer **FIVE** questions

(Question No 2 and 7 are compulsory)

	Marks	BL	CO	PO

1.a.i. Two engines are to operate on Otto and Diesel Cycles with the following data: Maximum temperature 1400 K, exhaust Temperature 700 K. State of air at the beginning of compression 0.1 MPa 300 K. Estimate the compression ratio, the maximum pressures, efficiencies, and rate of work outputs (For 1 kg/min of air) of the respective cycles. (Take $\gamma = 1.4$ $C_P = 1.005$ kJ/kg-K, R = 0.287 kJ/kg-K) — 18 3 1 2

b. Determine the value of expansion ratio if compression ratio and cut-off ratio are 15 and 1.4 respectively — 1 2 1 1

(A) 10.7 (B) 11.6
(C) 12.2 (D) 18.5

c. In a gas turbine cycle, the turbine output is 600 kJ/kg, the compressor work is 400 kJ/kg and the heat supplied is 1000 kJ/kg. The thermal efficiency of the cycle is _____ — 1 2 1 1

(A) 20% (B) 40%
(C) 30% (D) 50%

2.a. A Gas Turbine plant operates on the Brayton Cycle between the temperatures 27°C and 800°C. — 18 3 1 2

i. Find the pressure ratio at which cycle efficiency approaches the Carnot cycle efficiency
ii. Find the pressure ratio at which the work done per kg of air is maximum and
iii. Compare the efficiency at this pressure ratio with the Carnot efficiency for the given temperatures.

b. For the same compression ratio, the efficiency of the Brayton Cycle is — 1 1 1

(A) Equal to the Diesel Cycle (B) Equal to the Otto Cycle
(C) Equal the Dual Cycle (D) Greater than Diesel Cycle

c. Which one of the following is not a necessary assumption for the air – standard Otto cycle? 1 1 1 1

(A) All processes are both internally as well as externally reversible
(B) The combustion process is a constant volume heat addition process
(C) The combustion process is a constant volume heat addition process.
(D) The working fluid is an ideal gas with constant specific heats.

3.a. The dry products of combustion of an unknown hydrocarbon Fuel, C_xH_y have the following composition as measured by an Orsat apparatus: CO_2 - 8.0%, CO - 0.7%, O_2 - 9% and N_2 - 82.3%. Determine: 18 4 2 1

i. The composition of the Fuel
ii. The air – Fuel ratio, and
iii. The percentage excess air used

b. The adiabatic Flame temperature of a reaction is controlled by 1 2 2 1

(A) Pressure Regulation
(B) Changing the masses of reactants
(C) The amount of excess air supplied
(D) Charging the reactor volume

c. The optimum percentage of excess air for combustion depends upon the _____ of the fuel 1 2 2 1

(A) Type (Solid, Liquid or Gaseous)
(B) Calorific Value
(C) Sulphur Content
(D) Ignition Temperature

4.a. The following data and results refer to a test on a single cylinder, 2 stroke cycle engine: indicated mean effective pressure = 550 kPa, Bore = 20 cm, stroke = 30 cm, engine speed = 360 rpm, brake torque = 628 Nm, fuel consumption = 8.16 kg/h, calorific value of fuel = 42700 kJ/kg. Calculate: 18 4 3 1

i. Mechanical Efficiency
ii. The indicated thermal efficiency
iii. The brake thermal efficiency and
iv. Brake specific fuel consumption

b. By use of lubrication, which efficiency of an IC engine improves 1 2 3 1

(A) Volumetric Efficiency
(B) Mechanical Efficiency
(C) Charging Efficiency
(D) Indicated thermal Efficiency

c. The crank radius of a single cylinder IC engine is 60mm and diameters of the cylinder is 80mm. The stroke length of the cylinder is 1 2 3 2

(A) 30 mm
(B) 60 mm
(C) 120 mm
(D) 180 mm

5.a.i. A refrigerator based on ideal vapour compression cycle operates between the temperature limits of –20°C and 40°C. The refrigerant enters the condenser as saturated vapour and leaves as saturated liquid. The enthalpy and entropy values for satured liquid and vapour at these temperature are given below: 12 4 5 1

T°C	h_f(kJ/kg	h_g(kJ/kg)	S_f (kJ/kg-K)	S_g(kJ/kg-K)
-20	20	180	0.07	0.736
40	80	200	0.3	0.67

If refrigerant circulation rate is 0.025 kg/s, calculate the refrigeration effect and COP of the refrigerator.

ii. A room contains 35 kg of dry air and 0.5 kg of water vapour. The total pressure and temperature of air in the room are 100 kPa and 25°C respectively. Calculate the relative humidity of the air in the room, if saturation pressure of water at 25°C, is 3.17 kPa. 6 4 5 1

b. Environment Friendly refrigerant R134 is used in the new generation refrigerators. Its chemical formula is 1 1 5 1

(A) $CHClF_2$
(B) C_2ClF_3
(C) $C_2Cl_2F_4$
(D) $C_2H_2F_4$

c. If a mass of moist air in an air tight vessel is heated to a high temperature, then 1 1 5 1

(A) Specific humidity of the air increases
(B) Specific humidity of the air decreases
(C) Relative humidity of the air increases
(D) Relative humidity of the air Decreases

6.a. A single-stage air compressor delivers air at 6 bar. The pressure and temperature at the end of suction are 1 bar and 27°C. It delivers 1.5m^3 of free air per minute, when the compressor is running at 350 rpm. The clearance volume is 5% of stroke volume. The free air conditions are 1.013 bar and 15°C. The index of compression and expansion is 1.3. Find 18 4 4 2

i. The volumetric Efficiency
ii. Bore and stroke of cylinder, if both are equal
iii. The power required, if the mechanical efficiency is 80%

b. In a reciprocating compressor, the swept volume is 8/9 times the maximum volume. The clearance ratio will be equal to _____ 1 2 4 1

(A) 0.11
(B) 0.1
(C) 0.125
(D) 0.89

c. In a two-stage reciprocating compressor air enters at 1.5 bar while the delivery pressure is 54 bar. The ideal inter cooler pressure must be: 1 2 4 1

(A) 11 Bar
(B) 9 Bar
(C) 12 Bar
(D) 18 Bar

7.a. A full load test was conducted on a two-stroke engine and the following results were obtained: speed = 600rpm, brake load = 600N, indicated mean effective pressure = 4bar, oil consumption = 5 kg/h, jacket water flow rate = 7 kg/min, A/F ratio by mass = 30, atmospheric pressure = 1.2bar, cylinder diameter = 24cm, stroke = 30cm, brake diameter = 1.8m, C.V of fuel = 42000 kJ/kg, Proportion of H_2 by mass in fuel = 15%, specific heat of exhaust gas = 1.0 kJ/kg-K, specific heat of dry stream = 2.0 kJ/kg K. Calculate the volumetric efficiency based on atmospheric condition and prepare the heat balance sheet on minute and percentage basis. 18 4 3 1