| USN | | | | | | | | | | | Course Code | 2 | 1 | M | E | 4 | 4 |

Fourth Semester B.E. Degree Examinations, September/October 2024
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.

Q. No		*Question*	*Marks*	*(RBTL:CO:PI)*
		MODULE – 1		
1.	**a.**	List the different types of work transfer other than P-dv work? Write the sign convention of work and heat transfer.	**06**	(2 :1 : 1.6.1)
	b.	With neat P-V diagram , derive an expression for work done in following cases (i) Isothermal process (ii) Polytropic Process	**06**	(2 :1 : 1.6.1)
	c.	Determine the total work done by a gas system following an expansion process as shown in Figure 1(c).	**08**	(2 :1 : 1.7.1)

Fig. 1(c)

OR

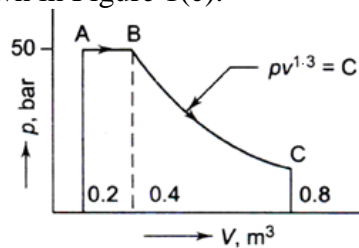|				
2.	**a.**	With neat sketch explain Joule's experiment and state first law of thermodynamics.	**06**	(2 :1 : 1.6.1)
	b.	Stating the assumptions, derive the steady flow energy equation (SFEE) for an open system	**08**	(2 :1 : 1.6.1)
	c.	A fluid system undergoes a non-flow frictionless process following the pressure-volume relation as $p = 5 V + 1.5$ where p is in bar and V is in m^3. During the process, the volume changes from 0.15 m^3 to 0.05 m^3 and the system rejects 45 kJ of heat. Determine: (i) Change in internal energy (ii) Change in enthalpy.	**06**	(2 :1 : 1.7.1)
		MODULE – 2		
3.	**a.**	Briefly explain (i) Heat engine (ii) Heat Pump (iii) Refrigerator (iv) Kelvin Planck statement of 2nd law of thermodynamics (v) Clausius statement of 2nd law of thermodynamics	**10**	(2 :2 : 1.6.1)
	b.	List the limitations of 1st law of thermodynamics.	**04**	(1 :2 : 1.6.1)
	c.	A reversible engine operates between T_1 and T. The energy rejected by this engine is received by second reversible engine and heat is rejected to sink T_2. Show that for same work T is arithmetic mean of T_1 and T_2.	**06**	(2 :2 : 1.7.1)
		OR		
4.	**a.**	State and prove the Clausius inequality.	**10**	(2 :2 : 1.6.1)
	b.	3 kg of water at 80°C is mixed with 4 kg of water at 15°C in an isolated system. Calculate the change of entropy due to mixing process. Given C_p of water=4.187 kJ/Kg K.	**10**	(2 :2 : 1.7.1)

Note: (**RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI - Performance Indicator**)

MODULE – 3

5. **a.** Explain (i) Willan's line method (ii) Knocking (iii) Heat balance sheet — **12** — (2 :3 : 1.6.1)

b. The following data refer to a 2- stroke oil engine Bore = 20 cm, Stroke = 30 cm, Speed = 350 RPM, P_m = 275 kPa, Net brake load = 610 N, Diameter of brake drum = 1 m, oil consumption = 4.25 kg/hr, CV of fuel = 44 MJ/kg, Determine (i) IP (ii) BP (iii) η_{mech} (iv) Indicated thermal efficiency (v) Brake thermal efficiency. — **08** — (3 :3 : 1.7.1)

OR

6. **a.** Define (i) Stoichiometric Air fuel ratio (ii) Enthalpy formation (iii) Internal energy of combustion (iv) Combustion Efficiency — **10** — (2 :3 : 1.6.1)

b. Methane (CH_4) is burned with atmospheric air. The analysis of the products on a dry basis is as follows: CO_2 = 10 %, O_2 = 2.37 %, CO = 0.53% and N_2 = 87.10 %. Calculate the air fuel ratio, the percent of theoretical air and write down the combustion equation. — **10** — (3 :3 : 1.7.1)

MODULE – 4

7. **a.** With a neat sketch, explain P-T phase equilibrium diagram for pure substance. — **06** — (2 :4 : 1.6.1)

b. Sketch and explain combined separating and throttling calorimeter to find the dryness fraction of pure substance. — **06** — (3 :4 : 1.6.1)

c. Superheated steam initially at a pressure of 5 bar and 300°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. — **08** — (3 :4 : 1.7.1)

OR

8. **a.** Derive an expression for thermal efficiency of regenerative Rankine cycle with single feed water heater. — **10** — (2 :4 : 1.6.1)

b. In a thermal power station with reheat cycle, The steam at boiler outlet is 15 MPa and 550°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. — **10** — (3 :4 : 1.7.1)

MODULE – 5

9. **a.** With a help of P-V and T-S diagram, derive an expression for air standard efficiency of Otto Cycle. — **10** — (2 :5 : 1.6.1)

b. A diesel engine is working with a compression ratio of 15 and expansion ratio of 10. Calculate the air-standard efficiency of the cycle. Assume γ = 1.4. — **10** — (3 :5 : 1.7.1)

OR

10. **a.** Explain any one method of improving the thermal efficiency of gas turbine plant. — **06** — (2 :5 : 1.6.1)

b. With neat sketch explain the working of Turbo jet engine. — **06** — (2 :5 : 1.6.1)

c. Air enters the compressor of an open cycle constant pressure gas turbine at a pressure of 1 bar and temperature of 20°C. The pressure of air after compression is 4 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air to fuel ratio is 90:1. Calorific value of the fuel is 42,000 kJ/kg. If the flow rate of air is 3 kg/s, find (i) power developed (ii) thermal efficiency of the cycle. — **08** — (3 :5 : 1.7.1)

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Note: (**RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI - Performance Indicator**)