Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. / B.Tech /B.Arch (Full Time) - END SEMESTER EXAMINATIONS, November/ December 2024

Mechanical Engineering

IV – Semester

ME5403 - APPLIED THERMODYNAMICS

(Regulation 2019)

Use of approved Steam Table is permitted

Time:3 hrs

Max.Marks: 100

CO1	Applying the concepts and laws of thermodynamics to predict the operation of thermodynamic cycles and performance of Internal Combustion(IC) engines and Gas Turbines.
CO2	Analyzing the performance of steam nozzle and computing critical pressure ratio.
CO3	Evaluating the performance of steam turbines.
CO4	Understanding the working of IC engines and its auxiliaries.
CO5	Determining the performance parameters of IC engines.

BL – Bloom's Taxonomy Levels
(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

PART- A(10 x 2 = 20 Marks)

(Answer all Questions)

Q.No	Questions	Marks	CO	BL
1	Compare Otto, Diesel and Dual with cycle help of p-V diagram for same compression ratio and heat addition.	2	1	L2
2	Why is the Carnot cycle not a realistic model for steam power plants?	2	1	L2
3	List the effect of friction in a nozzle.	2	2	L1
4	What is supersaturation in a steam nozzle?	2	2	L1
5	Why compounding is need for an impulse turbine?	2	3	L2
6	Draw the velocity diagram for a 50% reaction turbine.	2	3	L1
7	Draw the actual valve time diagram for a diesel engine. Indicate all the processes.	2	4	L2
8	Differentiate abnormal combustion SI and CI engine.	2	4	L1
9	Why Morse test is not suitable for single cylinder engine?	2	5	L2
10	What are the objectives of supercharging?	2	5	L1

PART- B(5 x 13 = 65 Marks)

Q.No	Questions	Marks	CO	BL
11 (a)	The compression and expansion ratios of an oil engine working on air standard dual cycle are 9 and 5 respectively. The initial pressure and temperature are 1 bar and 30°C respectively. The heat liberated at constant pressure is twice the heat liberated at constant volume. The expansion and compression follows the law $pV^{1.25}=C$. Determine: i) Pressure and temperature at all salient points; ii) The mean effective pressure of the cycle; iii) Thermal efficiency of the cycle and iv) power developed of the engine, if eight cycles complete in a second. Take bore = 250 mm and stroke = 400 mm.	13	1	L4
	OR			
11 (b)	A gas-turbine power plant operating on an ideal Brayton cycle has a pressure ratio of 8. The gas temperature is 300 K at the compressor inlet and 1300 K at the turbine inlet. Utilizing the air-standard assumptions, determine (i) the gas temperature at the exits of the compressor and the turbine, (ii) the back work ratio, and (iii) the thermal efficiency. Assuming a compressor efficiency of 80 percent and a turbine efficiency of 85 percent, determine (iv) the back work ratio, (v) the thermal efficiency, and (vi) the turbine exit temperature of the gas-turbine cycle	13	1	L4
12 (a)	Derive the expression for discharge through a nozzle, condition for maximum discharge and also find expression for maximum discharge, critical velocity.	13	2	L3
	OR			
12 (b)	The steam is supplied to a nozzle at 15 bar, 350°C and exits at 1 bar. If the divergent portion of the nozzle is 80 mm long and the throat diameter is 6 mm, determine the cone angle of the divergent portion. Assume 12% of total enthalpy drop is lost in the friction in the divergent portion. Also calculate the velocity and temperature of stream at the throat.	13	2	L4
13 (a)	The following particulars relate to a two-row velocity compounded impulse wheel: Steam velocity at nozzle outlet = 650 m/s; Mean	13	3	L4

	blade velocity = 125 m/s; Nozzle outlet angle = 16°; Outlet angle, first row of moving blades = 18°; Outlet angle, fixed guide blades = 22°; Outlet angle, second row of moving blades = 36°; Steam flow = 2.5 kg/s; The ratio of the relative velocity at outlet to that at inlet is 0.84 for all blades. Determine the following: (i) The axial thrust on the blades ; (ii) The power developed, (iii) The efficiency of the wheel.			
	OR			
13 (b)	A stage of steam turbine with Parson blading delivers dry saturated steam at 2.7 bar from the fixed blades at 90 m/s. The mean blade height is 40 mm and the moving blades exit angle is 20°. The axial velocity of steam is three quarter of the blade velocity at the mean radius. The steam is supplied to the stage at the rate of 9000 kg/h. The effect of the blade tip thickness on the annulus area can be neglected. Calculate (i) the rotational speed of the wheel; (ii) the diagram power; (iii) the diagram efficiency; (iv) the enthalpy drop of the steam in this stage.	**13**	3	L4
14 (a)	Explain working four stroke SI engine and with help p-V indicate deviation of actual cycle with that of Ideal cycle. Also compare SI and CI engines.	**13**	4	L3
	OR			
14 (b)	Explain in detail about the various stage of CI engine combustion. Also list the knocking control parameters.	**13**	4	L3
15 (a)	A four-stroke gas engine has a cylinder diameter of 25 cm and stroke 45 cm. The effective diameter of the brake is 1.6 m. The observations made in a test of the engine were as follows: Duration of test = 40 min; Total number of revolutions = 8080; Total number of explosions = 3230; Net load on the brake = 90 kg; Mean effective pressure = 5.8 bar; Volume of gas used = 7.5 m^3; Atmospheric temperature = 17°C; Calorific value of gas = 19 MJ/m^3 at NTP Rise in temperature of jacket = 45°C; cooling water Cooling water supplied = 180 kg. Draw up a heat balance sheet and estimate the indicated thermal efficiency and brake thermal efficiency.	13	5	L4
	OR			
15 (b) (i)	What are the functions of fuel injection system? With a neat	7	5	L3

	sketch explain working of Jerk type fuel injection pump.			
(ii)	With a neat sketch explain working of wet sump lubrication system.	6	5	L3

PART- C(1x 15=15Marks)

(Q.No.16 is compulsory)

Q.No	Questions	Marks	CO	BL
16.	Consider a regenerative vapor power cycle with one open feed water heater. Steam enters the turbine at 8.0 MPa, 480°C and expands to 0.7 MPa, where some of the steam is extracted and diverted to the open feed water heater operating at 0.7 MPa. The remaining steam expands through the second-stage turbine to the condenser pressure of 0.008 MPa. Saturated liquid exits the open feed water heater at 0.7 MPa. The isentropic efficiency of each turbine stage is 85% and each pump operates isentropically. If the net power output of the cycle is 100 MW, determine (i) the thermal efficiency and (ii) the mass flow rate of steam entering the first turbine stage, in kg/h.	15	5	L6