Model Question Paper-1 with effect from 2019-20 (CBCS Scheme)

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Fourth Semester B.E. Degree Examination

APPLIED THERMODYNAMICS

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.
02. Use of tables of thermodynamic tables is permitted.

		Module -1	*Bloom's Taxonomy Level	Marks
Q.01	a	Derive an expression for thermal efficiency in terms of compression ratio and cutoff ratio in case of a Diesel engine cycle. Draw P-V and T-S diagrams.	2	8
	b	Compare Otto and Diesel cycles for different compression ratios but same maximum pressure and temperatures. Draw T-s diagram to explain the same.	2	4
	c	An air standard Otto cycle has a compression ratio of 10, and the heat transferred to the working fluid per cycle is 1800 kJ/kg. At the beginning of the compression process, the pressure is 100 kPa and temperature is 15^0C. Analyze various processes and determine i) The maximum pressure and temperature in the cycle ii) The thermal efficiency	3	8
		OR		
Q.02	a	With the help of schematic and T-s diagrams, explain the working of a gas turbine cycle utilizing inter-cooling, reheat and a regenerator. Explain why multistage compression with intercooling is preferred over single stage compression to the same pressure.	2	8
	b	With the help of schematic sketch and T-s diagram, explain the air standard jet propulsion cycle.	1,2	4
	c	In an air standard Brayton cycle, the air enters the compressor at 0.1 MPa and 15^oC. The pressure leaving the compressor is 1 MPa and the maximum temperature in the cycle is 900^oC. Assuming a compressor efficiency of 80% and turbine efficiency of 90%, determine: i) the pressure and temperature at each point in the cycle ii) compressor work, turbine work and cycle efficiency.	3	8
		Module-2		
Q. 03	a	With the help of schematic diagram and T-s diagram, explain the working of a reheat Rankine cycle. Write an expression for efficiency of this cycle in terms of enthalpies at various state points.	2	8
	b	List the characteristics of an ideal working fluid in Vapour power cycles.	1	4
	c	In a Rankine cycle, steam leaves the boiler and enters the turbine at 6 MPa and 550^oC. The condenser pressure is 20 kPa. Determine:	3	8

		i) Net work of the cycle ii) Heat addition in boiler iii)Thermal efficiency of the cycle iv)Mass of flow rate of steam required to produce 1000MW of power.		
		OR		
Q.04	a	With the help of schematic diagram and T-s diagram, explain the working of a regenerative Rankine cycle. Write an expression for efficiency of this cycle in terms of enthalpies at various state points.	2	8
	b	Write a note on binary vapour power cycle with the help of a suitable sketch.	1	4
	c	Consider a regenerative Rankine cycle using steam as the working fluid. Steam leaves the boiler and enters the turbine at 6 MPa, 550^{o}C. After expansion to 600 kPa, some of the steam is extracted from the turbine to heat the feed-water in an open feed-water heater. The pressure in the feed-water heater is 600 kPa, and the water leaving it is saturated liquid at 600 kPa. The steam not extracted expands to 20 kPa. Determine the thermal efficiency of the cycle.	3	8
		Module-3		
Q. 05	a	Define the following terms: i) Theoretical air ii) Excess air iii) Enthalpy of formation iv) Adiabatic flame temperature	1	8
	b	Calculate the theoretical air–fuel ratio for the combustion of methane, CH_4.	3	4
	c	An unknown fuel has the following Orsat analysis: CO_2 =12.5% CO=0.3% O_2=3.1% N_2 = 84.1% Determine, i)the air fuel ratio, ii)the fuel composition on mass basis & iii) the % theoretical air.	3	8
		OR		
Q. 06	a	With the help of a sketch, briefly explain exhaust gas analysis using Orsat apparatus.	1,2	8
	b	Define the terms: i) Combustion efficiency ii) Heat of reaction	1	4
	c	Determine the air-fuel ratio and volumetric analysis of the products of combustion when ethane (C_2H6) is burned with 150% theoretical air. Also find the dew point of the products if the total pressure of products is 0.1 MPa.	3	8
		Module-4		
Q. 07	a	With the help of a graph, briefly explain the Willan's line method of determining the friction power of an IC Engine.	2	8
	b	The following observations were made during a trail on an oil engine: Motor power to start the engine = 10 kW, speed = 1750 rpm, brake torque = 327.5 Nm, fuel consumption = 15 kg/h, CV of the fuel = 42 MJ/kg, air supplied = 4.75 kg/min, cooling water flow rate = 16 kg/min, rise in temperature of cooling water = 45 ^{o}C, room temperature = 20.8 ^{o}C, exhaust gas temperature = 400 ^{o}C (Take C_{pw} = 4.2 kJ/kg K & C_{pg} = 1.25 kJ/kg K). Determine;	3	12

		(i) Mechanical efficiency and BSFC (ii) Draw a heat balance sheet on kW & percentage basis.		
		OR		
Q. 08	a	With the help of a suitable sketch explain the air-box method of determining the air flow rate into an IC engine. Write suitable expressions for the same.	2	8
	b	A test on 2-stroke engine gave the following results at full load: speed=350 rpm, net brake load= 65 kg, IMEP=3 bar, fuel consumption=4kg/h, cooling water flow rate=500 kg/h, water temperature at inlet=20^0C, water temperature at outlet=40^0C, Test room temperature=20^0C, Temperature of exhaust gases=400^0C, Air used per kg of fuel=32 kg, cylinder diameter=22 cm, stroke length=28 cm, effective brake diameter=1 m, CV of fuel used=43 MJ/kg, proportion of hydrogen in fuel=15%, C_{eg}=1 kJ/kg-K, C_{steam}=2.1 kJ/kg-K, sensible heat of water at room temperature=62 kJ/kg, Latent heat of steam=2250 kJ/kg. Find; mechanical efficiency, thermal efficiencies, BSFC & draw up a heat balance sheet in kJ/min & in % basis	3	12
		Module-5		
Q. 09	a	With the help of a sketch, T-s and P-h diagrams, explain the working of a vapour compression refrigeration cycle.	1,2	8
	b	List desired properties of an ideal refrigerant.	1	4
	c	An ammonia ice plant operates between a condenser temperature of 35°C and an evaporator temperature of of -15°C. It produces 10 tons of ice per day from water at 30°C to ice at -5°C. Assume specific of water and ice as 4.187 kJ/kgK and 1.94 kJ/kgK respectively and latent heat of fusion for water at 0°C as 335 kJ/kg. Assuming simple vapour compression refrigeration cycle, determine: i) The capacity of the refrigeration plant in kW ii) Mass flow rate of refrigerant in kg/s iii) Power of the compressor motor iv) Theoretical C.O.P.	4	8
		OR		
Q. 10	a	Define the following terms: i) Dry Bulb Temperature ii) Dew Point Temperature iii) Specific humidity iv) Relative humidity	1	8
	b	On a psychometric chart show the following processes starting from the same point: i) Heating with humidification ii) Heating with dehumidification iii) Cooling with humidification iv) Cooling with dehumidification	2	4
	c	The air handling unit of an air-conditioning plant supplies a total of 4500 m^3/min of dry air which comprises by weight 20% fresh air at 40°C DBT and 27°C WBT, and 80% re-circulated air at 25°C DBT and 50% RH. The air leaves the cooling coil at 13°C saturated state. Calculate the total cooling load and room heat gain. Show the cycle on a schematic psychrometric chart.	4	8

*Bloom's Taxonomy Level: Indicate as L1, L2, L3, L4, etc. It is also desirable to indicate the COs and POs to be attained by every bit of questions.