Model Question Paper-1with effect from 2022-23 (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. M: Marks, L: Blooms Level, C: Course outcomes
03. Use of thermodynamics data hand book and steam table are permitted
04. Assume missing data suitably

		Module-1	**M**	**L**	**C**
Q.01	**a**	Derive an expression for the thermal efficiency of an air standard diesel cycle in terms of cutoff ratio and compression ratio.	**8**	**L3**	**CO1**
	b	For same state of air before compression and same maximum pressure and temperature in both the cycles, using appropriate P-V and T-S diagrams, compare the performance of air standard Otto and Diesel cycle	**4**	**L2**	**CO1**
	c	An engine 200 mm diameter and 300mm stroke length works on diesel cycle. The initial pressure and temperature are 1bar and 27^0C. The cutoff is 8% of the stroke and the compression ratio is 15. Find (i) pressure and temperature at all salient points of the cycle (ii) theoretical air standard efficiency (iii) MEP (iv) power developed if there are 400 working strokes per cycle.	**8**	**L3**	**CO1**
		OR			
Q.02	**a**	Describe how the frictional power of an engine is determined using Morse test.	**8**	**L2**	**CO1**
	b	In a test on a three cylinder 4-stroke internal combustion engine with 22cm bore and 26cm stroke, the following were the observations during a trial period of one hour: Fuel consumption = 8kg, Calorific value = 45000kJ/kg, Total revolutions of the crank shaft = 12000, MEP = 6bar, Net load on brake = 1.5kN, Brake drum diameter = 1.8m, Rope diameter = 3cm, Mass of cooling water = 550kg, Inlet temperature of water = 27^0C, Exit temperature of water = 55^0C, Air consumed = 300kg, Ambient temperature = 30^0C, Exhaust gas temperature = 310^0C, Specific heat of exhaust gases = 1.1 kJ/kgK. Calculate (i) Indicated and Brake power in kW (ii) Mechanical efficiency (iii) Indicated thermal efficiency. Also draw a heat balance sheet in kJ/min.	**12**	**L3**	**CO1**
		Module-2			
Q.03	**a**	With a neat P-V and T –S diagram, derive an expression for the efficiency of a Brayton cycle	**6**	**L3**	**CO2**
	b	With a neat sketch and T-S diagram, explain how 'regeneration' increase thermal efficiency of a gas turbine plant.	**6**	**L2**	**CO2**
	c	In a gas turbine plant, the intake temperature and pressure are 18^0C and 1 bar respectively. Air is compressed to a pressure of 4.2 bar by a compressor. The isentropic efficiency of the compressor is 84%. The gas is heated to 650^0C in the combustion chamber, where there is a pressure drop of 0.086 bar. The	**8**	**L4**	**CO2**

		expansion of gas occurs to atmospheric pressure in the turbine. The thermal efficiency of the plant is 18%. Draw the T-s diagram and find the isentropic efficiency of the turbine. Neglect the mass of the fuel and take properties of gas as that of air. Take γ=1.4.			
		OR			
Q.04	**a**	State the working difference between turbo jet and turbo propeller engines.	**6**	**L2**	**CO2**
	b	With a neat sketch explain the principle of rocket propulsion.	**6**	**L2**	**CO2**
	c	In a gas turbine plant, air pressure and temperature before compression are 1 bar and 27^0C. The maximum pressure is 3.5 bar and temperature of the gas before expansion is 700^0C. If the isentropic efficiency of compressor and turbine are 0.8 & 0.85 respectively. Determine: (i) overall efficiency (ii) percentage change in efficiency of the plant if the regenerator of 0.6 effectiveness is added to the plant.	**8**	**L3**	**CO2**
		Module-3			
Q.05	**a**	With a neat schematic and T-S diagram, derive an expression for the thermal efficiency of the Rankine cycle	**6**	**L3**	**CO3**
	b	With a neat diagram, explain the effect of boiler pressure and condenser pressure on the Rankine cycle performance	**6**	**L2**	**CO3**
	c	In a boiler house, steam from steam generator enters the turbine at 20 bar and condenser pressure of 0.2 bar. Determine Rankine cycle efficiency (i) when the steam is 85% dry at the turbine inlet (ii) when the steam is superheated at turbine inlet at 37.6^0C.	**8**	**L3**	**CO3**
		OR			
Q.06	**a**	Why is Carnot cycle not practical for steam power plant? Explain briefly	**6**	**L2**	**CO3**
	b	With a neat schematic and T-S diagram, briefly explain the regenerative vapour power cycle with single open feed water heaters. Derive an expression for its thermal efficiency.	**6**	**L3**	**CO3**
	c	The steam is a working fluid in an ideal Rankine cycle with super heat and reheat. The Steam enters the first stage turbine at 8 MPa and 480^0C and expands to 0.7MPa. It is then reheated to 440^0C before entering the second stage turbine where it expands to condenser pressure of 0.08MPa. The net power output of cycle is 100MW. Determine (i) Thermal efficiency (ii) Mass flow rate of steam (iii) Specific steam consumption (SSC).	**8**	**L4**	**CO3**

Module-4					
Q.07	**a**	What are the thermodynamic and thermo physical properties of good refrigerant?	**6**	**L1**	**CO4**
	b	Explain the working principle of Ammonia vapour absorption refrigeration system.	**6**	**L2**	**CO4**
	c	A 10 ton Ammonia ice plant operates between an evaporator temperature of -15^0C and condenser temperature of 35^0C. The ammonia enters the compressor as dry saturated vapour. Assuming isentropic compression, determine: i) mass flow rate of ammonia ii) COP of the plant iii) power input in KW iv) tons of ice at -10^0C produced from water at 25^0C in a day. Enthalpy of fusion of ice = 334 KJ/Kg, C_p = 4.187 KJ/KgK for water and C_p = 2.1KJ/KgK for ice.	**8**	**L3**	**CO4**
OR					
Q.08	**a**	Show the following processes on psychometric chart: (i) sensible heating (ii) sensible cooling (iii) Adiabatic humidification (iv) cooling with dehumidification	**6**	**L1**	**CO4**
	b	With a neat sketch, describe the working of summer air conditioning system for hot and dry weather.	**6**	**L2**	**CO4**
	c	Saturated air at 2^0C is required to be supplied to a room where the temperature must be held at 20^0C DBT with 55% RH. The air is heated and then the water at 10^0C is sprayed to give the required humidity. Determine: (i) the mass of spray water required per m^3 of air at room conditions (ii) the temperature to which the air must be heated. Neglect fan power. Assume that the total pressure is constant as 1.0132 bar.	**8**	**L3**	**CO4**
Module-5					
Q.09	**a**	Explain the following term as referred to an air compressor (i) Volumetric efficiency (ii) Adiabatic efficiency (iii) Mechanical efficiency	**6**	**L2**	**CO5**
	b	Derive an expression for work done in reciprocating air compressor with clearance volume.	**6**	**L3**	**CO5**
	c	Air at 1 bar and 27^0C is compressed to 7 bar by a single stage reciprocating compressor according to the law $PV^{1.3} = C$. The free air delivered was $1m^3$/min. Speed of the compressor is 300rpm. Stroke to bore ratio is 1.5:1. Mechanical efficiency is 85% and motor transmission efficiency is 90%. Determine: (i) indicated power and isothermal efficiency (ii) cylinder dimensions and power of the motor required to drive the compressor.	**8**	**L4**	**CO5**
OR					
Q.10	**a**	Discuss the various types of nozzles. Explain why nozzles are made convergent – divergent?	**6**	**L2**	**CO5**
	b	Derive an expression for critical pressure ratio which gives maximum discharge through the nozzle.	**6**	**L3**	**CO5**
	c	Calculate the throat and exit diameter of convergent and divergent nozzle. Which will discharge 820 kg of steam per hour at a pressure of 8 bar super-heated to 220^0C in to the chamber having a pressure of 1.5 bar. The friction loss in the divergent portion of nozzle may be taken as 0.15 of isentropic enthalpy drop.	**8**	**L3**	**CO5**

Model Question Paper-2with effect from 2022-23 (CBCS Scheme)

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Fourth Semester B.E. Degree Examination
APPLIED THERMODYNAMICS

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03. Use of thermodynamics data hand book and steam table are permitted
04. Assume missing data suitably

		Module-1	M	L	C
Q.01	a	Derive an expression for the air standard efficiency of a limited pressure cycle with assumptions.	10	L3	CO1
	b	An engine working on constant volume cycle has a suction pressure of 1 bar and a pressure of 13.5 bar at the end of compression. For air take =1.4, find: (i) compression ratio (ii) the percentage of clearance (iii) thermal efficiency (iv) temperature at the end of compression if initial temperature is 27^0C and (v) mean effective pressure if the pressure at the end of combustion is 23 bar.	10	L3	CO1
		OR			
Q.02	a	Explain the phenomenon of combustion in S I Engines	5	L2	CO1
	b	Explain the Willian's line method of determining the frictional power of an IC engine.	5	L2	CO1
	c	The following data were obtained from a Morse test on a 4-cylinder 4-stroke cycle SI engine coupled to a hydraulic dynamometer operating at a constant speed of 1500rpm: Brake load with all 4 cylinders firing = 296N, Brake load with cylinder1 not firing = 201N, Brake load with cylinder2 not firing = 206N, Brake load with cylinder3 not firing = 192N, Brake load with cylinder4 not firing = 200N. The brake power in kW is calculated using the equation $BP = \frac{WN}{42300}$, where W = Brake load in Newton and N = Speed of the engine in rpm. Calculate: (i) BP (ii) IP (iii) FP (iv) Mechanical efficiency.	10	L3	CO1
		Module-2			
Q.03	a	Derive an expression for the optimum pressure ratio for maximum work output in case of a Brayton cycle	10	L3	CO2
	b	In an open cycle gas turbine plant, air enters the compressor at 1 bar& 27^0C. The pressure after compression is 4 bar. The isentropic efficiency of turbine and compressor are 85% and 80% respectively. The air – fuel ratio is 80: 1. Calorific value of fuel used is 42000kJ/kg. Mass flow rate of air is 2.5kg/s. Determine the power output from the plant and the cycle efficiency. Assume that C_p and γ to be same for both air and products of combustion.	10	L3	CO2
		OR			
Q.04	a	In a regenerative gas turbine cycle, air enters the compressor at 1 bar and 15^0C. The pressure ratio is 6. The isentropic efficiencies of compressor and	10	L3	CO2

		turbine are 0.8 and 0.85 respectively. The maximum temperature in the cycle is 800^0C. The regenerator efficiency is 0.78. Assume C_p = 1.1 KJ/KgK and γ = 1.32 for combustion products and find the cycle efficiency.			
	b	With a neat sketch explain the working of Ramjet and Turboprop engine.	**10**	**L2**	**CO2**
		Module-3			
Q.05	**a**	Why is Carnot cycle not a realistic model for steam power plants? Explain with appropriate T-S diagram.	**4**	**L2**	**CO3**
	b	What is the effect of following on Rankine cycle efficiency: (i) Boiler pressure (ii) Super heating (iii) Condenser pressure.	**6**	**L2**	**CO3**
	c	A Rankine cycle operates between a pressure of 80 bar and 0.1 bar. The maximum cycle temperature is 600^0C. If the steam turbine and condensate pump efficiency are 0.9 and 0.8 respectively, calculate net specific work output and thermal efficiency.	**10**	**L3**	**CO3**
		OR			
Q.06	**a**	Draw the schematic diagram and show the actual regenerative vapour power cycles. Also derive an expression for its efficiency.	**6**	**L2**	**CO3**
	b	In a reheat cycle, the initial steam pressure and maximum temperature are 150 bar and 550^0C respectively. If the condenser pressure is 0.1 bar and the moisture at the condenser inlet is 5% and assuming ideal processes, determine: (i) the reheat pressure (ii) the cycle efficiency (iii) the steam rate.	**6**	**L3**	**CO3**
		Module - 4			
Q.07	**a**	Define the following terms with respect to refrigeration: (i) Refrigerating effect (ii) Unit of refrigeration (iii) C.O.P.	**06**	**L2**	**CO4**
	b	Explain with the aid of T-S and P-h diagram, the effect of under cooling the refrigerant in a Vapour compression refrigeration cycle.	**04**	**L2**	**CO4**
	b	For a food storage purpose, a refrigeration plant of 10.5 TR is required at an evaporation temperature of -12^0C and condenser temperature of 27^0C. The refrigerant is ammonia. It is sub cooled by 6^0C before entering the expansion valve. The vapour is 0.95 dry as it leaves the evaporator coil. The compression is adiabatic. Using p-h chart, Calculate (i) Condition of vapour at outlet of the compressor (ii) condition of vapour at entrance to evaporator (iii) COP (iv)power required in kW .Neglecting throttling and clearance effect	**10**	**L3**	**CO4**
		OR			

Q.08	a	Explain the following processes by showing them on the Psychrometric chart: (i) Sensible Cooling (ii) Humidification (iii) Cooling and Dehumidification (iv) Heating and Humidifying (v) Adiabatic mixing of two streams of air	10	L2	CO4
	b	For a hall to be air conditioned, the following conditions are given: Outdoor conditions = 40^0C DBT, 20^0C WBT, Required comfort conditions =20^0C DBT and 60% RH. Seating capacity of the hall = 1500, Amount of air supplied = $0.3m^3$/ min/person. If the required condition is achieved first by adiabatic humidification and then by cooling, estimate: i) the capacity of the cooling coil in tons ii) the capacity of the humidifier in kg/hr.	10	L3	CO4
Module-5					
Q.09	a	Derive an expression for minimum work input by two stage compressor with inter cooler between the two stages	10	L3	CO5
	b	A single stage single acting reciprocating compressor has bore of 200 mm and stroke of 300 mm. It receives air at 1bar and 20^0C and delivers it at 5.5 bar .If the compression following the law $PV^{1.3}$=C and clearance volume is 5% of stoke volume, Determine (i) Mean effective pressure (ii) Power required to drive the compressor if it runs at 500 rpm	10	L3	CO5
OR					
Q.10	a	What are types of nozzles? Explain with neat sketches.	5	L2	CO5
	b	Derive an expression for condition of maximum discharge through a nozzle.	5	L3	CO5
	c	Dry saturated steam enters a steam nozzle at a pressure of 15 bar and the discharged at a pressure of 2 bar. If the dryness fraction of discharge steam is 0.96, what will be the final velocity of steam? If 10% of heat drop is lost in friction, find the percentage reduction in final velocity.	10	L3	CO5