Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI EXAMINATION – SUMMER 2025

Subject Code: 3161910 Date: 20-05-2025

Subject Name: Applied Thermodynamics

Time: 10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1	**(a)**	Define (1) Thermal efficiency (2) Indicated power (3) Mechanical efficiency.	**03**
	(b)	Draw schematic diagram and p-h chart for simple vapor compression refrigeration cycle.	**04**
	(c)	Explain Thermodynamic , Physical and Chemical Properties of Refrigerants.	**07**
Q.2	**(a)**	Explain in brief about Dalton's law of partial pressure.	**03**
	(b)	Differentiate between Otto cycle and Diesel cycle.	**04**
	(c)	Explain Vander Waal's Equation of State. Derive an expression for evaluation of Constant 'a' and 'b'.	**07**
		OR	
	(c)	What are the needs of multi-staging? Derive the equation of work done on air for multi-stage reciprocating air compressor.	**07**
Q.3	**(a)**	Define: indicated power, brake power, friction power.	**03**
	(b)	Differentiate between axial flow compressor and centrifugal compressor.	**04**
	(c)	Derive an Expression for Velocity of Sound Wave in Compressible Fluid Flow and also Express in terms of Bulk Modulus.	**07**
		OR	
Q.3	**(a)**	Define: Mach waves, Mach cone and Mach angle.	**03**
	(b)	Explain in brief about heat balance sheet in context to IC Engine.	**04**
	(c)	With neat sketch, Explain Li-Br Vapor Absorption System.	**07**
Q.4	**(a)**	Explain with neat sketch Catalytic Converter used in SI Engines.	**03**
	(b)	Explain Global warming potential of refrigerants.	**04**
	(c)	What is Psychometric chart? Explain the measurement of different lines on it.	**07**
		OR	
Q.4	**(a)**	Difference between Euro norms and Bharat stage norms.	**03**
	(b)	What is Mach number? Why is this parameter so important for the study of flow of compressible fluid.	**04**
	(c)	Explain with neat Sketch Effect of Impeller Blade Shape on Performance in Centrifugal Compressor.	**07**
Q.5	**(a)**	Define the following; (i) Relative Humidity, (ii) wet bulb depression, (iii) Dew point temperature.	**03**
	(b)	Explain designation system of refrigerants.	**04**
	(c)	Explain Fundamental equations for compressible flow.	**07**
		OR	
Q.5	**(a)**	What is compressibility chart? What are the observations can be made from this chart?	**03**
	(b)	Explain the phenomenon of surging and stalling in an axial flow compressor.	**04**

(c) Explain with neat sketch flash intercooling. What are the advantages of it? **07**

Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2024

Subject Code:3161910 Date:15-05-2024

Subject Name:Applied Thermodynamics

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**
5. **Use of Refrigeration Air-Conditioning charts and Steam tables is permitted.**

			MARKS
Q.1	**(a)**	What is compressibility chart? What are the observations can be made from this chart?	**03**
	(b)	Explain the effect of compression ratio on fuel air cycle analysis.	**04**
	(c)	Explain the following terms briefly: (i) Dew point temperature (ii) Cooling and Dehumidification (iii) Comfort Air conditioning (iv) Wet bulb temperature (v) Relative humidity (vi) Degree of saturation (vii) sensible heat factor.	**07**
Q.2	**(a)**	Differentiate Between Vapour Compression System and Vapour Absorption System.	**03**
	(b)	What are desirable characteristics of ideal refrigerant? Explain how refrigerants are designated?	**04**
	(c)	A vessel of 8 m^3 capacity contains two gases A and B in proportion of 40 % and 60 % respectively at 32 ^{0}C. If the value of R for the gases is 0.29 kJ/kg K and 0.296 kJ/kg K and if the total weight of the mixture is 3 kg. Determine (1) the partial pressure (2) the total pressure (3) the mean value of R for the mixture.	**07**
		OR	
	(c)	A R-134a two stage refrigeration system operates between the pressure limits of 1.3 bar and 7.7 bar. The refrigerant leaves the condenser as a saturated liquid and is throttled to a flash chamber operating at 2.9 bar. The part of refrigerant evaporates during the flashing process and this vapour is mixed with the refrigerant leaving the low pressure compressor. Then, the mixture is compressed to the condenser pressure by the high pressure compressor. The liquid in the flash chamber is throttled to the evaporator pressure and cools the refrigerated space. The refrigerant entering lower stage compression is saturated vapour. The mass of refrigerant circulates through condenser is 8 kg/min. Calculate: (1) Mass of liquid refrigerant evaporates in flash chamber (2) Refrigerating capacity and compressor work supplied (3) COP of the system	**07**
Q.3	**(a)**	Briefly explain flash intercooling.	**03**
	(b)	Explain why the specific heats of gases increase with increases in temperature?	**04**

(c) Derive an equation for the variation in air standard efficiency of Diesel cycle on account of variation in C_v. **07**

OR

Q.3 **(a)** Explain the different methods adopted to obtain variable compression ratio in I. C. engine. **03**

(b) Draw P - V diagrams of Otto and Diesel cycle and show the effect of variation of specific heat with temperature on the same. **04**

(c) Derive an Expression for Velocity of Sound Wave in Compressible Fluid Flow and also Express in terms of Bulk Modulus. **07**

Q.4 **(a)** What are the international accepted methods for measuring the NO_x, CO and HC? **03**

(b) What are the different Losses in Actual Cycle? Explain any two with neat sketch. **04**

(c) From the data given below, draw an energy balance sheet for a two stroke diesel engine run for 30 minutes at full load: **07**
RPM - 350, Mena effective pressure – 3 bar, Net brake load – 650 N, Fuel consumption – 1.8 kg, Air used – 32 kg/kg of fuel, Cylinder bore – 210 mm, Cylinder stroke – 260 mm, Brake diameter – 1 m, Cooling water supplied – 175 kg, Water input temperature – 30 ^{0}C, Water output temperature 60 ^{0}C, Room temperature – 25 ^{0}C, Exhaust gas temperature – 300 ^{0}C, Steam formed in exhaust – 1.3 kg/kg of fuel, Specific heat of steam in exhaust - 2 kJ/kg K, Specific heat of dry exhaust gas – 1.005 kJ/kg K, Calorific value of fuel – 43,000 kJ/kg

OR

Q.4 **(a)** What is Mach number? Why is this parameter so important for the study of flow of compressible fluid. **03**

(b) Explain the phenomenon of dissociation. **04**

(c) Derive an expression for the area velocity relationship for a compressible fluid in the form $\frac{dA}{A} = \frac{dV}{V}[M^2 - 1]$ **07**

Q.5 **(a)** Differentiate between positive displacement compressor and dynamic compressor. **03**

(b) Define following terms with reference to centrifugal compressor : **04**
(i) Isentropic efficiency (ii)Power input factor (iii) Slip factor (iv) Pressure co-efficient.

(c) Derive an expression for minimum work input to compress the air in two stage reciprocating compressor. **07**

OR

Q.5 **(a)** Define flow co-efficient and work co-efficient with reference to axial flow compressor **03**

(b) Explain methods of reducing compressor work done in single stage reciprocating air compressor without clearance. **04**

(c) An axial flow compressor stage has mean diameter of 60 cm and runs at 15000 rpm. If the actual temperature rise and pressure ratio developed are 30 ^{0}C and 1.35 respectively. Determine: (1) power required to drive the compressor while delivering 57 kg/s of air, if mechanical efficiency is 86 % and inlet temperature 35^{0}C (2) the stage loading co-efficient (3) the stage efficiency (4) the degree of reaction if the temperature at the rotor exit is 55 ^{0}C. **07**

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GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2023

Subject Code:3161910 Date:04-07-2023

Subject Name:Applied Thermodynamics

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**
5. **Use of steam table is allowed.**

			MARKS
Q.1	**(a)**	State the assumptions to be made for fuel-air cycle analysis.	**03**
	(b)	Define the following (i) Relative Humidity (ii) wet bulb depression (iii) Dew point temperature (iv) saturated air	**04**
	(c)	What are the needs of multi-staging? Derive the equation of work done on air for multi-stage reciprocating air compressor.	**07**
Q.2	**(a)**	Define engine. What are the main objectives of IC engine testing?	**03**
	(b)	Explain designation system of refrigerants.	**04**
	(c)	Explain Vander Waal's Equation of State. Derive an expression for Evaluation of Constant 'a' and 'b'.	**07**
		OR	
	(c)	1 kg of oxygen occupies a volume of 0.25 m^3/kg at 330 K is subjected to isothermal expansion process tillit's volume becomes 0.75 m^3/kg. Assuming that the gas obey Vanderwall's gas equation, find the final pressure of the gas and the work done during the process. Assume Vanderwall's gas constant as : a = 138000 $Nm^4/(kg_{mol})^2$, b = 0.0318 m^3/kg_{mol}	**07**
Q.3	**(a)**	Explain sensible cooling process.	**03**
	(b)	In an absorption system heating cooling and refrigeration takes place at temperature of 115 ºC 30 ºC and -20 ºC respectively find theoretical COP of the system. If the generator temperature increased to 200 ºC and evaporator temperature decreased to -40 ºC, find the % change in COP of system.	**04**
	(c)	Explain working of two stage compression with liquid intercooler with neat sketch and p-h diagram.	**07**
		OR	
Q.3	**(a)**	Explain Global warming potential of refrigerants.	**03**
	(b)	What are secondary refrigerants? State advantages of secondary refrigerants.	**04**
	(c)	Atmospheric air at 101.325 kPa has 30º C DBT and 15ºC DPT. Without using psychrometric chart calculate partial pressure of air and vapour, specific humidity, relative humidity,vapour density and enthalpy of moist air.	**07**

Q.4	**(a)**	Differentiate Centrifugal and Axial Flow Compressor	**03**
	(b)	Explain dissociation loss and its effect on maximum temperature and pressure of the cycle.	**04**
	(c)	Derive an Expression for Velocity of Sound Wave in Compressible Fluid Flow and also Express in terms of Bulk Modulus.	**07**
		OR	
Q.4	**(a)**	Define zone of action, zone of silence and mach cone.	**03**
	(b)	Explain time loss, spark timing loss and heat loss in actual cycle.	**04**
	(c)	In a diesel cycle, air at the beginning of compression is 1 bar and 50°C. The air-fuel ratio is 25:1 and compression ratio is 15. Assuming $Cv = 0.71 + 21 \times 10^{-5}T$ and law of compression is $pv^{1.35}$ = constant. Calculate the % stroke at which combustion is completed. Take calorific value of fuel as 44000 kJ/kg and R= 287 J/kg-K.	**07**
Q.5	**(a)**	Explain working of catalytic converter.	**03**
	(b)	Write short note on variable compression ratio engine.	**04**
	(c)	The following observations were recorded from test on a single cylinder four stroke oil engine having following parameters : cylinder bore = 150 mm, engine stroke = 250 mm, engine speed = 420 rpm, brake torque = 217 N-m, fuel consumption = 2.95 kg/h, calorific value of fuel = 44000 kJ/kg, cooling water flow rate = 0.068 kg/s, cooling water temperature rise = 45 K, specific heat capacity of cooling water = 4.18 kJ/ kg-K, mean effective pressure = 7.5 bar, calculate (i) mechanical efficiency (ii) brake thermal efficiency (iii) specific fuel consumption (iv) draw heat balance sheet.	**07**
		OR	
Q.5	**(a)**	What are the major pollutants emitted from diesel engine?	**03**
	(b)	State and explain losses in centrifugal compressor.	**04**
	(c)	For a multistage axial flow compressor, initial state of air is 1 bar, 30°C and final state is 6 bar, 300 °C. Calculate the overall isentropic and polytropic efficiencies.When the actual temperature rise per stage is 16 °C, calculate the number of stages required , assuming polytropic efficiency as the stage efficiency.	**07**

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GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2022

Subject Code:3161910 Date:01/06/2022

Subject Name:Applied Thermodynamics

Time:10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Explain Dalton's law of partial pressure. How evaporation happens in atmosphere?	**03**
	(b)	Define the following terms: (a) Stagnation temperature (b) Stagnation velocity of sound (c) Mach number (d) Stagnation Pressure	**04**
	(c)	Briefly explain the following with *p-V* diagram (i) Time loss factor (ii) Heat loss factor (iii) Exhaust blowdown factor	**07**
Q.2	**(a)**	How ODP and GWP does affect refrigerant selection?	**03**
	(b)	Explain in brief reduced properties of gas and critical compressibility factor.	**04**
	(c)	What is the effect of compressibility on Mach number? Prove for Υ =1.4 $$\frac{P_O - P}{\frac{1}{2}\rho V^2} = 1 + \frac{M^2}{4} + \frac{M^4}{40} + \ldots\ldots\ldots..$$	**07**
		OR	
	(c)	Derive the following from one dimensional steady flow energy equation and also explain various regions of flow based on it: $$\frac{a^2}{\gamma - 1} + \frac{V^2}{2} = \frac{a_o^2}{\gamma - 1} = \frac{V_{max}^2}{2} = \frac{a^{*2}}{2}\frac{\gamma + 1}{\gamma - 1} = h_o$$	**07**
Q.3	**(a)**	Define refrigerant for Vapor Compression Refrigeration (VCR) cycle and list desirable properties of good refrigerant.	**03**
	(b)	Define the following: (i) Absolute humidity (ii) Dry bulb temperature (iii) Dew point temperature (iv) Wet bulb temperature	**04**
	(c)	Explain with neat sketch flash intercooling. What are the advantages of it?	**07**
		OR	
Q.3	**(a)**	How will you assign number to the refrigerants: Dichloro difluoro methane and dichloro tetra fluoro ethane?	**03**

	(b)	Explain humidification and dehumidification process with the help of psychrometric charts.	**04**
	(c)	Explain working of Li-Br vapour absorption refrigeration system with neat sketch.	**07**
Q.4	**(a)**	Difference between Euro norms and Bharat stage norms.	**03**
	(b)	How do the specific heat vary with temperature? What is the physical explanation for this variation?	**04**
	(c)	A four cylinder engine running at 1200 rpm delivers 20 kW. The average torque when one cylinder was cut is 110 Nm. Find the indicated thermal efficiency if the calorific value of the fuel is 43 MJ/kg and the engine uses 360 grams of gasoline per kWh.	**07**

OR

Q.4	**(a)**	Define (1) Thermal efficiency (2) Indicated power (3) Mechanical efficiency.	**03**
	(b)	What is the difference between air standard cycle and fuel-air cycle analysis?	**04**
	(c)	A six cylinder, gasoline engine operates on the four stroke cycle. The bore of each cylinder is 80mm and the stroke 100 mm. the clearance volume per cylinder is 70 cc. at a speed of 4000 rpm the fuel consumption is 20 kg/h and the torque developed is 150 Nm. Calculate (i) the brake power (ii) brake mean effective pressure (iii) brake thermal efficiency if the calorific value of the fuel is 43000 kJ/kg.	**07**
Q.5	**(a)**	Explain effect of pre- whirl in centrifugal compressor.	**03**
	(b)	Explain the phenomenon of surging and stalling in an axial flow compressor.	**04**
	(c)	Show that for a two-stage reciprocating air compressor with complete intercooling the total work of compression becomes minimum when the pressure ratio in each stage is equal.	**07**

OR

Q.5	**(a)**	What do you mean by life and drag?	**03**
	(b)	Explains the Influence of inlet and outlet blade angles on the performance of centrifugal compressor.	**04**
	(c)	With usual notations derive an expression for indicated work of reciprocating air compressor by considering clearance.	**07**

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