INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

DUNDIGAL, HYDERABAD-500043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**Thermodynamics**			
Course Code	A30306			
Regulation	**R13 - JNTUH**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	3	1	-	4
Course Coordinator	Dr. D Govardhan			
Team of Instructors	Dr. D Govardhan			

OBJECTIVES

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.

In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learner's learning process.

S.NO	QUESTIONS	BLOOMS TAXONOMY LEVEL	COURSE OUTCOMES
	UNIT-I **INTRODUCTION**		
Part - A (Short Answer Questions)			
1.	Define the term Thermodynamic system and explain	Evaluation	1
2.	Explain Quasi static process.	Evaluation	1
3.	List a few applications of thermodynamics	Evaluation	1
4.	State Zeroth law of thermodynamics	Knowledge	1
5.	Define the term system and control volume	Comprehension	1
6.	State First law of thermodynamics	Analysis	1

7.	Define the term Thermodynamic system and explain	Analysis	1
8.	Explain Quasi static process.	Application	1
9.	List a few applications of thermodynamics	Knowledge	1
10.	State Zeroth law of thermodynamics	Knowledge	1
Part - B (Long Answer Questions)			
1.	Write short notes on intensive properties of a thermodynamic system. Discuss briefly about at least three intensive properties of the system.	Application	1
2.	What is the concept of continuum? How will you define density and pressure using this concept of continuum.	Comprehension	1
3.	Write short notes on thermodynamic equilibrium.	Analysis	1
4.	In a cyclic process, heat transfers are +14.7kJ, -25.2 kJ, -3.56kJ and +31.5kJ. What is the net work for this cyclic process?	Analysis	1
5.	A stationary mass of gas is compressed without friction from an initial state of 0.3m^3 and 0.105 Mpa to a final state of 0.15m^3 and 0.105 MPa, the pressure remaining constant during the process. There is a transfer of 37.6kJ of heat from the gas during the process. How much does the internal energy of the gas change.	Evaluation	1
6.	Define enthalpy. Why does enthalpy of an ideal gas depend only on temperature?	Analysis	1
7.	Internal energy of the system is the measure of the heat of the system. Prove that internal energy is a property of a thermodynamic system.	Evaluation	1
8.	A fluid is confined in a cylinder by a spring loaded friction less piston so that the pressure in the fluid is a linear function of the volume (p=a + b V). The internal energy of the fluid is given by the following equation U = 32 + 3.15 pV .where U is in kj, pressure in kpa and V in cubic meter. If the fluid changes from an initial state of 120kpa, 0.025 m3 to a final state of 300 kpa, 0.056 m3, with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer.	Evaluation	1
9.	A reversible engine with 45% thermal efficiency discharges 1500 kJ/min at 300C to a pond. Find the temperature of the source which supplies heat to the engine and power developed by the engine.	Analysis	1
10.	Air at a pressure of 50 bar and a volume of 0.25 m3 is expanded at constant pressure until the volume is Doubled. It is then expanded according to PV$^{1.3}$=constant, until the volume is 0.85 m3. Calculate the work done in each process.	Analysis	1
Part - C (Problem Solving and Critical Thinking Questions)			
1.	A piston and cylinder machine containing a fluid system has a stirring device in the cylinder. The pistons frictionless and it is held down against the fluid due to the atmospheric pressure of 101.325 kPa. The stirring device is turned 12,000 revolutions with an average torque against the fluid of 1.5 Nm. Meanwhile the piston of 0.5 m diameter moves out 0.8 m. Find the net work transfer for the system.	Analysis	1
2.	Two vessels A and B both containing nitrogen are connected by a valve which is opened to allow the contents to mix and achieve the equilibrium temperature of 270C. Before mixing the following information is known about the gases in the two vessels Vessel A	Analysis	1

	vessel B Pa=1.2Mpa Pb=0.6Mpa Ta=60^0C T=20^0C Content in A = 0.6 kg mol Contents in B = 2.4 kg mol Calculate final equilibrium pressure and the amount of heat transferred to the surroundings. If vessel had been perfectly insulated calculate the final temperature and pressure which would have been reached.		
3.	What are the corollaries to the first law of Thermodynamics? Explain them..	Application	1
4.	What is PMM1 why is it impossible? Is it correct to say total heat?	Analysis	1
5.	A blower handles 1kg/s of air at 293K and consumes a power of 15kW. The inlet and out let velocities of air are 100m/s and 150m/s respectively. Find the exit air temperature, assuming adiabatic conditions. Take Cp of air as 1.005 kJ/kgK	Knowledge	1
6.	Distinguish between heat and temperature.	Knowledge	1
7.	Write short notes on thermodynamic equilibrium	Knowledge	1
8.	Internal energy of the system is the measure of the heat of the system. Prove that internal energy is a property of a thermodynamic system..	Knowledge	1
9.	A reversible engine with 45% thermal efficiency discharges 1500 kJ/min at 300C to a pond. Find the temperature of the source which supplies heat to the engine and power developed by the engine.on the cylinder. The pressure coefficient distribution along the cylindrical surface is given by Cp = 2 cos2 ϕ for $0 \leq \phi \leq \Pi/2$and $3\Pi/2 \leq \phi \leq 2\Pi$ and Cp = 0 for $\Pi/2 \leq \phi \leq 3\Pi/2$. Calculate the drag coefficient for the cylinder, based on projected frontal area of the cylinder.	Analysis	1
10.	What is the concept of continuum? How will you define density and pressure using this concept of continuum.	Analysis	1
	UNIT-II **LIMITATION OF THE FIRST LAW**		
Part - A (Short Answer Questions)			
1.	Define the term heat engine and thermal reservoir.	Comprehension	2
2.	State Kelvin Plank statement of the second law	Analysis	2
3.	State Classius statement of the second law	Analysis	2
4.	Define the term COP and write the equation for the same	Knowledge	2
5.	State the limitations of First law of thermodynamics	Knowledge	2
6.	Write the symbolic representation of a heat engine and explain.	comprehension	2
7.	Define the term heat engine and thermal reservoir.	Analysis	2
8.	State Kelvin Plank statement of the second law	Knowledge	2
9.	State Classius statement of the second law	Knowledge	2
10.	Define the term COP and write the equation for the same	Comprehension	2
Part - B (Long Answer Questions)			
1.	To produce net work in a thermodynamic cycle, a heat engine has to exchange heat with two thermal reservoirs. Explain	Comprehension	2
2.	Can you use the same plant as a heat pump in winter and as a refrigerator in summer? Explain	Application	2

3.	Show that the COP of a heat pump is greater than the COP of a refrigerator by unity.	Evaluation	2
4.	An inventor claims to have developed an engine that takes in 105 MJ at a temperature of 400K, rejects 42MJ at a temperature of 200K and delivers 15kwh of mechanical work. Would you advise investing mo ney to put this engine in the market	Evaluation	2
5.	Using an engine of 30% thermal efficiency to drive a refrigerator having a COP of 5, what is the heat input into the engine for each MJ removed from the cold body by the refrigerator?	Comprehension	2
6.	Determine the expansion for the heat transfer in a closed system isochoric process?	Evaluation	2
7.	A gas turbine receives gases from the combustion chamber at 7.5bar and 600^0C, with a velocity of 100 m/s. The gases leave the turbine at 1 bar with a velocity of 45 m/s. Calculate the work done if the expansion is isentropic.	Analysis	2
8.	Air at 150C and 1.05bar occupies a volume of 0.02 m^3. The air is heated at constant volume until the pressure is 4.2bar and then cooled at constant Pressure back to the original temperature. calculate i. The net heat flow to or from the air and ii. The net entropy change, sketch the process on T-S diagrams.	Application	2
9.	Determine an expression for the work done in a closed isothermal process?	Analysis	2
10.	State and prove Carnot theorem?	Knowledge	2
Part - C (Problem Solving and Critical Thinking Questions)			
1.	Explain the following with examples Concept of continuum, Causes of irreversibility	Application	2
2.	Determine an expression for the work done in a closed isothermal process?	Evaluation	2
3.	Derive energy equation for a closed system undergoing Isochoric proces. Isothermal process	Knowledge	2
4.	Deduce the expression for the Entropy change in terms of pressure and temperature.	Comprehension	2
5.	A gas from its initial pressure and volume and mass equal to 650 kN/m2, 0.6m3 and 0.65 kg respectively expands to its environment at and equal to 100kN/m2 and 295 K respectively though a reversible process. Calculate specific availability function if the system is a closed one. Take Cv = 0.82 kJ/Kg K, R = 0.31 kJ/Kg K.	Application	2
6.	One hundred kg of CO_2 is to be stored in a 0.5 m3 container at 100^0C. Compare the required pressure using the ideal gas law and the Van Der Waals equation of state.	Analysis	2
7.	Using an engine of 30% thermal efficiency to drive a refrigerator having a COP of 5, what is the heat input into the engine for each MJ removed from the cold body by the refrigerator?.	Knowledge	2
8.	A gas turbine receives gases from the combustion chamber at 7.5bar and 600^0C, with a velocity of 100 m/s. The gases leave the turbine at 1 bar with a velocity of 45 m/s. Calculate the work done if the expansion is isentropic.	Analysis	2
9.	Can you use the same plant as a heat pump in winter and as a refrigerator in summer? Explain	Analysis	2

10.	To produce net work in a thermodynamic cycle, a heat engine has to exchange heat with two thermal reservoirs. Explain	Analysis	2
UNIT-III **PERFECT GAS LAWS**			
Part - A (Short Answer Questions)			
1.	Define the terms: Saturated liquid state, Wet vapor state	Knowledge	3
2.	Draw a P-T diagram for a pure substance	Knowledge	3
3.	Explain the term dryness fraction of steam	Comprehension	3
4.	Draw a T – S diagram for a pure substance	Comprehension	3
5.	Draw a p-H diagram for a pure substance	Knowledge	3
6.	Define the term Critical point, Boiling pressure.	Analysis	3
7.	What is the use of a mollier chart	Application	3
8.	What is steam calorimetry	Analysis	3
9.	Write down the Clapeyron equation	Knowledge	3
10.	What is dryness fraction	Knowledge	3
Part - B (Long Answer Questions)			
1.	Find the saturation temperature, the changes in specific volume and entropy during evaporation and the latent heat of vapourization of steam at 1MPa.	Knowledge	3
2.	Find the enthalpy, entropy and volume of steam at 1.4MPa, 380^0C.	Analysis	3
3.	A rigid vessel of volume $0.86m^3$ contains 1 kg of steam at a pressure of 2 bar. Evaluate the specific volume, temperature, dryness fraction, internal energy, enthalpy and entropy of steam.	Application	3
4.	Why do the isobars on Mollier diagram diverge from one another? Explain with an example.	Analysis	3
5.	What is quality of steam? What are the different methods of measuring quality?	Comprehension	3
6.	What do you understand by degree of superheat and degree of sub cooling?	Comprehension	3
7.	A closed vessel of 1.5 m3 capacity contains steam at 3 bar and 0.8 dryness fraction. Steam at 10 bar and 0.9 dryness fraction is supplied until the pressure inside the vessel reaches 5 bar. Calculate the mass of steam in the vessel	Knowledge	3
8.	3 kg of steam at 18bar occupy the volume of $0.2550m^3$ during a constant volume process, the heat rejected is 1320kJ. Determine final internal energy and find initial dryness and work done.	Knowledge	3
9.	Explain briefly the formation of superheated steam with the help of T-S diagram.	Comprehension	3
10.	Using the definition of mass and mole fractions derive a relation between them	Comprehension	3
Part - C (Problem Solving and Critical Thinking Questions)			
1.	Using the definition of mass and mole fractions derive a relation between them.	Knowledge	4

2.	One kg of steam at a pressure of 700 kPa and 0.6 dry is heated at constant pressure until it becomes dry saturated. Determine change in internal energy and workdone.	Knowledge	4
3.	Prove that Partial pressure fraction = Mole fraction = Volume fraction of a constituent of a mixture of gases.	Knowledge	4
4.	A vessel of volume 1 m3 capacity contains steam at 20 bar and 0.85 dryness fraction Steam is blown off until the pressure drops to 10 bar. The valve is then closed. Determine mass of steam blown off. Assume process as throttling.	Application	4
5.	A rigid vessel of volume 0.86m^3 contains 1 kg of steam at a pressure of 2 bar. Evaluate the specific volume, temperature, dryness fraction, internal energy, enthalpy and entropy of steam.	Analysis	4
6.	Find the saturation temperature, the changes in specific volume and entropy during evaporation and the latent heat of vapourization of steam at 1MPa.	Analysis	4
7.	What is quality of steam? What are the different methods of measuring quality?	Application	4
8.	Explain briefly the formation of superheated steam with the help of T-S diagram.	Analysis	4
9.	What do you understand by degree of superheat and degree of sub cooling?	Analysis	4
10.	3 kg of steam at 18bar occupy the volume of 0.2550m^3 during a constant volume process, the heat rejected is 1320kJ. Determine final internal energy and find initial dryness and work done.	Analysis	4
UNIT-IV **MIXTURES OF PERFECT GASES**			
Part - A (Short Answer Questions)			
1.	Define Ideal gas and Mole of a gas.	Knowledge	5
2.	State Avogadro’s Hypothesis	Knowledge	5
3.	Write the equation for Change in enthalpy and entropy for an ideal gas	Knowledge	5
4.	Derive an relation between specific heats for an ideal gas,	Analysis	5
5.	State Dalton’s law of partial pressure.	Knowledge	5
6.	Define Universal gas constant and state the units.	Knowledge	5
7.	Define entropy	Analysis	5
8.	Write down the carriers equation	Analysis	5
9.	Define volume fraction	Analysis	5
10.	What is mole fraction	Application	5
Part - B (Long Answer Questions)			
1.	Why do the specific heats of an ideal gas depend only on the atomic structure of the gas?	Analysis	5
2.	How throttling helps in estimating the dryness fraction of steam. Derive $C_p - C_v = R$ for an ideal gas.	Analysis	5
3.	Show that for an ideal gas the internal energy depends only on its temperature	Analysis	5

4.	Show that the enthalpy of an ideal gas is a function of temperature only	Knowledge	5
5.	What is the mass of air contained in a room 6mx9mx4m if the pressure is 101.325 kPa and the temperature is 25^0C.	Analysis	5
6.	A certain gas has C_p = 0.913 and C_v = 0.653kJ/kg K. Find the molecular weight and the gas constant R of the gas.	Analysis	5
7.	Mathematically Dalton's Law of Partial Pressures can be written as $P_{tot} = P_1 + P_2 + P_3 + \ldots$ When we apply the ideal gas law to mixtures of gases each component gas will have its own P and n, but all of the component gases will have the same T and V. Substantiate with an example.	Evaluation	5
8.	Prove that Partial pressure fraction = Mole fraction = Volume fraction of a constituent of a mixture of gases with an example.	Knowledge	5
9.	Define mass fraction, mole fraction, volume fraction and partial pressure fraction of a constituent of a mixture of gases.	Knowledge	5
10.	Gas from a bottle of compressed helium is used to inflate an inelastic flexible balloon, originally folded completely at to a volume of 0.65 m^3. If the barometer reads 760 mm Hg, what is the amount of work done upon the atmosphere by the balloon? Sketch the system before and after the process.	Knowledge	5
Part - C (Problem Solving and Critical Thinking Questions)			
1.	Gas from a bottle of compressed helium is used to inflate an inelastic flexible balloon, originally folded completely at to a volume of 0.65 m^3. If the barometer reads 760 mm Hg, what is the amount of work done upon the atmosphere by the balloon? Sketch the system before and after the process.	Knowledge	5
2.	A closed vessel of 1.5 m^3 capacity contains steam at 3bar and 0.8 dryness fraction. Steam at 10bar and 0.9 dryness fraction is supplied until the pressure inside the vessel reaches 5bar. Calculate the mass of steam in the vessel	Application	5
3.	Define mass fraction, mole fraction, volume fraction and partial pressure fraction of a constituent of a mixture of gases.	Analysis	5
4.	Mathematically Dalton's Law of Partial Pressures can be written as $P_{tot} = P_1 + P_2 + P_3 + \ldots$ When we apply the ideal gas law to mixtures of gases each component gas will have its own P and n, but all of the component gases will have the same T and V. Substantiate with an example.	Knowledge	5
5.	Prove that Partial pressure fraction = Mole fraction = Volume fraction of a constituent of a mixture of gases with an example.	Analysis	5
6.	How throttling helps in estimating the dryness fraction of steam. Derive $C_p - C_v = R$ for an ideal gas.	Knowledge	5
7.	Why do the specific heats of an ideal gas depend only on the atomic structure of the gas?	Application	5
8.	Show that the enthalpy of an ideal gas is a function of temperature only	Evaluation	5
9.	A certain gas has C_p = 0.913 and C_v = 0.653kJ/kg K. Find the molecular weight and the gas constant R of the gas	Evaluation	5
10.	Define mass fraction, mole fraction, volume fraction and partial pressure fraction of a constituent of a mixture of gases.	Evaluation	5
UNIT-V **THERMODYNAMIC CYCLES & REFRIGERATION CYCLES**			

Part - A (Short Answer Questions)			
1.	Mention the merits of Otto cycle.	Knowledge	6
2.	State the four processes of diesel cycle.	Analysis	6
3.	Mention the demerits of Diesel cycle.	Knowledge	6
4.	L How air standard cycles can be compared?	Analysis	6
5.	What are air standard cycles?	Analysis	6
6.	Write the merits of dual combustion cycle.	Knowledge	6
7.	Explain Bell coleman cycle	Application	6
8.	Compare otto and diesel cycles.	Knowledge	6
9.	Explain vapor compression cycle	Knowledge	6
10.	Explain Atkinson cycle	Analysis	6
Part - B (Long Answer Questions)			
1.	What are cyclic and non cyclic heat engines? Explain with examples.	Comprehension	6
2.	How is the compression ratio of an SI engine fixed? Elaborate each parameter.	Comprehension	6
3.	Show that the efficiency of an Otto cycle depends only on the compression ratio.	Knowledge	6
4.	Show that the efficiency of Brayton cycle depends on pressure ratio	Knowledge	6
5.	Draw the p-v and the T-s diagram of an air standard cycle and explain.	Knowledge	6
6.	Draw the p-v and the T-s diagram of a dual combustion cycle and explain	Analysis	6
7.	Derive an expression for the mean effective pressure of an Otto cycle.	Knowledge	6
8.	A petrol engine with compression ratio of 5 develops 24 kW indicated power and consumes 8 liters of fuel per hour. The specific gravity of fuel is 0.78 and its calorific value is 45 MJ/kg. Calculate the indicated thermal efficiency and relative efficiency.	Knowledge	6
9.	Describe Otto gas power cycle with the help of P-V and T-S diagram. Derive an expression for its air standard efficiency.	Analysis	6
10.	Derive mean effective pressure of a Diesel engine cycle	Knowledge	6
Part - C (Problem Solving and Critical Thinking Questions)			
1.	An ideal Stirling engine using helium as the working fluid operates between temperature limits of 300 and 2000 K and pressure limits of 150 kPa and 3 MPa. Assuming the mass of the helium used in the cycle is 0.12 kg, determine (*a*) the thermal efficiency of the cycle, (*b*) the amount of heat transfer in the regenerator, and (*c*) the work output per cycle.	Knowledge	6
2.	Consider an ideal Ericsson cycle with air as the working fluid executed in a steady-flow system. Air is at 27°C and 120 kPa at the beginning of the isothermal compression process, during which 150 kJ/kg of heat is rejected. Heat transfer to air occurs at 1200 K. Determine (*a*) the maximum pressure in the cycle, (*b*) the net work output per unit mass of air, and (*c*) the thermal efficiency of the cycle.	Knowledge	6

3.	The compression ratio of an ideal dual cycle is 14. Air is at 100 kPa and 300 K at the beginning of the compression process and at 220^0 K at the end of the heat-addition process. Heat transfer to air takes place partly at constant volume and partly at constant pressure, and it amounts to 1520.4kJ/kg. Assuming variable specific heats for air, determine (*a*) the fraction of heat transferred at constant volume and (*b*) the thermal efficiency of the cycle.Drag reduction	Knowledge	6
4.	What are cyclic and non cyclic heat engines? Explain with examples.	Evaluation	6
5.	How is the compression ratio of an SI engine fixed? Elaborate each parameter.	Evaluation	6
6.	Show that the efficiency of an Otto cycle depends only on the compression ratio.	Application	6
7.	Draw the p-v and the T-s diagram of an air standard cycle and explain.	Analysis	6
8.	Draw the p-v and the T-s diagram of a dual combustion cycle and explain	Knowledge	6
9.	Describe Otto gas power cycle with the help of P-V and T-S diagram. Derive an expression for its air standard efficiency.	knowledge	6
10.	Derive mean effective pressure of a Diesel engine cycle.	Knowledge	6

Prepared by: Dr. D Govardhan, Professor

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