INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**THERMODYNAMICS**
Course Code	:	**A30306**
Class	:	II B. Tech I Semester
Branch	:	MECH
Year	:	2016 – 2017
Course Coordinator	:	Mr. SV Durga Prasad, Assistant Professor.
Course Faculty	:	Mr. SV Durga Prasad, Assistant Professor.

OBJECTIVES:

Thermodynamics is the science that deals with the relationship between heat and work and those properties of systems that bear relation to heat and work. General laws of energy transformations concerning all types of systems, mechanical, electrical and chemical may fall within the purview of this science. It is a science based on a number of empirical laws formed by experimentation from which all predictions concerning the physical behavior of the system may be deduced by logical reasoning. The findings have been formalized into certain basic laws, which are known as Zeroth, First, Second and Third laws of thermodynamics. Power cycles and refrigeration cycle based on thermodynamic system is studied.

S No	QUESTION	Blooms taxonomy level	Course Outcomes
	UNIT – I		
Part - A (Short Answer Questions)			
1	**Explain** Zeroth law of Thermodynamics.	Understand	1,2
2	**Define** System, Surroundings and Boundary?	Remember	1,2
3	**Distinguish** between macroscopic and microscopic point of view?	Evaluate	1,2
4	**Discuss** Quasi Static process, what are its characteristics?	Understand	1,2
5	**Distinguish** between different types of systems with examples.	Evaluate	1,2
6	**Explain** the features of constant volume gas thermometer.	Understand	1,2
7	**Discuss** First law of thermodynamics, explain Joule's experiment.	Understand	1,3
8	**Define** PMM 1.	Remember	1,4
9	**State** the causes of irreversibility?	Remember	1,4
10	**Derive** Steady Flow Energy Equation, when the device is an air compressor.	Apply	4,5,6
11	**State** thermodynamic system? How do you classify it?	Remember	1,2
12	**State** the closed system? Give an example	Remember	1,2
13	**Define** Intensive and Extensive properties.	Remember	1,2
14	**Define** equilibrium of a system?	Remember	1,2

S No	QUESTION	Blooms taxonomy level	Course Outcomes
15	**Define** Intensive and Extensive properties.	Remember	1,2
16	**Differentiate** closed and open system.	Analyze	1,2
17	**Define** Specific heat capacity at constant volume	Remember	1,2
18	**Define** Specific heat capacity at constant pressure.	Remember	1,2
19	**Differentiate** closed and open system.	Analyze	1,2
20	**Classify** the properties of system?	Understand	1,2
Part - B (Long Answer Questions)			
1	**Differentiate** the system, surroundings and boundary Explain in detail.	Analyze	4,5,6
2	**Classify** the types of systems, explain the energy conversion in them.	Understand	1,2
3	**Explain** in detail the macroscopic and microscopic study of thermodynamics?	Understand	1,2
4	**Explain** the importance of concept of continuum in thermodynamic approach?	Understand	1,2
5	**Explain** thermodynamic equilibrium in detail?	Understand	1,2
6	**Differentiate** thermal equilibrium and thermodynamic equilibrium, explain.	Analyze	4,5,6
7	**Explain,** the role of chemical equilibrium in thermodynamic equilibrium?	Understand	1,2
8	**Enumerate** the Isobaric process from thermodynamic point of view?	Analyze	4,5,6
9	**Enumerate** the Isochoric process from thermodynamic point of view?	Analyze	4,5,6
10	**Enumerate** the Isothermal process from thermodynamic point of view?	Analyze	4,5,6
11	**Enumerate** the Isentropic process from thermodynamic point of view?	Analyze	4,5,6
12	**Enumerate** the polytrophic process from thermodynamic point of view?	Analyze	4,5,6
13	**Explain** displacement work with neat diagram?	Understand	1,2
14	**State** Zeroth law and explain with a good example?	Understand	1,2
15	**Explain** the Joule's experiment with a neat sketch?	Understand	1,2
16	**Sketch** the constant volume gas thermometer and explain?	Apply	4,5,6
17	**List** the scales of temperature and explain in detail?	Understand	1,2
18	**Compare** the first law of thermodynamics with its corollaries?	Analyze	4,5,6
19	**Explain** how the first law of thermodynamics applied to a process?	Understand	1,2
20	**Explain** the Steady flow energy equation?	Understand	1,2
Part - C (Problem Solving and Critical Thinking Questions)			
1	When a stationary mass of gas was compressed without friction at constant pressure, its initial state of 0.4m^3 and 0.105MPa was found to change to final state of 0.20m^3 and 0.105MPa. There was a transfer of 42.5kJ of heat from the gas during the process. **Determine** the change in internal energy of the gas?	Apply	4,5,6
2	0.44kg of air at 180^{0}C, expands adiabatically to 3times its original volume and during the process there is a fall in temperature to 15^{0}C. The work done during the process is 52.5kJ. **Calculate** Cp and Cv ?	Understand	1,2
3	Two thermometers one centigrade and other Fahrenheit are immersed in a fluid, after the thermometers reached equilibrium with the fluid, it is noted that both the thermometers indicate the same numerical values. Find that the identical numerical values shown by the thermometers? Determine the corresponding temperature of the fluid, express in degrees Kelvin and degrees Rankine?	Apply	4,5,6
4	**Derive** the steady flow energy equation.	Apply	4,5,6
5	**Derive** the expression for work done in	Apply	4,5,6

<table>
<tr><th>S No</th><th>QUESTION</th><th>Blooms taxonomy level</th><th>Course Outcomes</th></tr>
<tr><td></td><td>i) Isothermal process
ii) Polytropic process</td><td></td><td></td></tr>
<tr><td>6</td><td>A piston cylinder device operates 1kg of fluid at 20atm pressure with initial volume is 0.04m^3. Fluid is allowed to expand reversibly following $pV^{1.45}$=C. So that the volume becomes double. The fluid is cooled at constant pressure until the piston comes back. Determine the work done in each process?</td><td>Apply</td><td>4,5,6</td></tr>
<tr><td>7</td><td>A fluid contain in a horizontal cylinder with a frictionless leak proof piston is continuously agitated by a stirrer passing through the cylinder cover. The diameter of the cylinder is 50cm and the piston is held against the fluid due to atmospheric pressure equal to 100kPa. The stirrer turns 8000 revolutions with an average torque of 1.5Nm. If the piston slowly moves outwards by 60cm. Determine the net work transfer to the system?</td><td>Apply</td><td>4,5,6</td></tr>
<tr><td>8</td><td>A Piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle the sum of all heat transfers is -170kJ. The system completes 100cycles/minute. Complete the following table showing the method for each item and compute net rate of work output in kW.
<table>
<tr><th>Process</th><th>Q(kJ/min)</th><th>W(kJ/min)</th><th>ΔE(kJ/min)</th></tr>
<tr><td>a-b</td><td>0</td><td>2170</td><td>----</td></tr>
<tr><td>b-c</td><td>21000</td><td>0</td><td>----</td></tr>
<tr><td>c-d</td><td>-2100</td><td>----</td><td>-36600</td></tr>
<tr><td>d-a</td><td>----</td><td>----</td><td>----</td></tr>
</table></td><td>Analyze</td><td>4,5,6</td></tr>
<tr><td>9</td><td>A fluid is confined in a cylinder by a spring loaded friction less piston, so the pressure in the fluid is a linear function of volume (p=a+bV).The internal energy of the fluid is given by the following equation U=34+3.15pV. Where U is in kJ, p in kPa and V is in m^3. If the fluid changes from initial state of 170kPa, 0.03m^3 to a final state of 400kPa, 0.06m^3 with no work other than that done on the piston. Define the direction and magnitude of work and heat transfer.?</td><td>Remember</td><td>1,2</td></tr>
<tr><td>10</td><td>Air flows steadily at the rate of 0.5kg/sec through an air compressor, entering at 7m/sec velocity, 100kpa pressure and 0.95m^3/kg volume and leaving at 5m/sec, 700kpa and 0.19m^3/kg. The internal energy of air leaving is 90kJ/kg greater than that of air entering. Cooling water in the compressor jacket absorbs heat from the air at the rate of 58kw.Compute the rate of shaft work input to the air in KW.</td><td>Analyze</td><td>4,5,6</td></tr>
<tr><td colspan="4">UNIT - II</td></tr>
<tr><td colspan="4">Part – A (Short Answer Questions)</td></tr>
<tr><td>1</td><td>State the limitations of first law of thermodynamics?</td><td>Remember</td><td>1,2</td></tr>
<tr><td>2</td><td>Define second law of thermodynamics?</td><td>Remember</td><td>1,2</td></tr>
<tr><td>3</td><td>State PMM 2?</td><td>Remember</td><td>1,2</td></tr>
<tr><td>4</td><td>State the Carnot Cycle?</td><td>Remember</td><td>2,4,6</td></tr>
<tr><td>5</td><td>State the Clausius inequality?</td><td>Remember</td><td>1,2</td></tr>
<tr><td>6</td><td>Define the absolute temperature scale?</td><td>Remember</td><td>1,2,4</td></tr>
<tr><td>7</td><td>State the property of entropy?</td><td>Remember</td><td>1,2</td></tr>
<tr><td>8</td><td>Define an inversion curve?</td><td>Remember</td><td>2,3</td></tr>
<tr><td>9</td><td>Solve one T -dS equation by using Maxwell’s relations?</td><td>apply</td><td>4,5,6</td></tr>
<tr><td>10</td><td>State the Third law of Thermodynamics?</td><td>Remember</td><td>1,2,5</td></tr>
<tr><td>11</td><td>Define internal energy of a system?</td><td>Remember</td><td>1,2</td></tr>
<tr><td>12</td><td>Define the change in internal energy of a system?</td><td>Remember</td><td>2,3</td></tr>
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S No	QUESTION	Blooms taxonomy level	Course Outcomes
13	**Explain** the available energy in a system?	Understand	1,2,6
14	**State** the unavailable energy in a system?	Remember	1,6
15	**Explain** the principle of entropy increase?	Understand	1,6
16	**Explain** the exergy of a system?	Understand	2,6
17	**Explain** the Clausius statement?	Understand	3,4,5
18	**State** the Kelvin-Plank statement?	Remember	3,4,5
19	**Sketch** the PV and TS diagrams of Carnot cycle.	Apply	4,5,6
20	**Classify** the processes which constitute the cycle.	Understand	1,6
Part - B (Long Answer Questions)			
1	**Explain** the limitations of First law of thermodynamics in detail?	Understand	1,2
2	**Explain** the thermal reservoir with a neat sketch?	Understand	1,2
3	**Explain** the heat engine with a neat sketch?	Understand	1,2
4	**Explain** the heat pump with a neat sketch?	Understand	1,2
5	**List** the performance parameters of a system and explain in detail.	Understand	1,2
6	**Compare** the first law and second law of thermodynamics with suitable examples?	Analyze	4,5,6
7	**Explain** the second law of thermodynamics with suitable sketches?	Understand	1,2
8	**Write** the Kelvin-Plank statement and explain with an example?	Understand	1,2
9	**Write** the Clausius statement and explain with an example?	Understand	1,2
10	**Write** the Kelvin-Planck and Clausius statemes and explain with sketches?	Understand	1,2
11	**State** PMM1 and PMM2, in which manner both are different?	Analyze	4,5,6
12	**Compare** the relation with process and cycle? Explain.	Analyze	4,5,6
13	**State** the Carnot's principle? What is the importance of the principle, explain?	Understand	1,2,6
14	**State** the Clausius inequality? Explain.	Understand	1,2
15	**Explain** the influence of entropy on various parameters?	Analyze	4,5,6
16	**Define** Gibb's and Helmholtz's functions? Compare the importance of them?	Analyze	4,5,6
17	**State** the irreversibility and explain.	Understand	1,2
18	**Explain** the Availability in a thermodynamic system with example.	Understand	1,2
19	**Discuss** the importance of Maxwell relations ?	Understand	1,2
20	**State** the Third law of thermodynamics? Explain the importance.	Remember	1,2,3
Part – C (Problem Solving and Critical Thinking)			
1	A heat engine working on Carnot cycle converts $1/5^{th}$ of the heat input into work. When the temperature of the sink is reduced by 80^0C, the efficiency gets doubled. **Determine** the temperature of sink?	Apply	4,5,6
2	**Discuss** the equivalent of Kelvin-Plank and Clausius statements?	Understand	4,5,6
3	1kg of ice at -5^0C expose to the atmosphere which, is at 20^0C. The ice melts and comes into thermal equilibrium with the atmosphere. **Determine** the entropy increase of Universe. Cp for ice is 2.039 kJ/kgK, and the enthalpy of fusion of ice is 333.3kJ/kg.	Apply	4,5,6
4	A domestic food freezer maintains a temperature of -15^0C, the ambient air temperature is 30^0C, if heat leaks into the freezer at the continuous rate of 1.75kJ/sec. **State** the least power necessary to pump this heat out continuous?	Remember	1,2
5	A heat engine is operating between two reservoirs 1000K and 300K is used to drive a heat pump which extracts heat from the reservoir at 300K at a	Apply	4,5,6

S No	QUESTION	Blooms taxonomy level	Course Outcomes
	rate twice that at which the engine rejects the heat to it. If the efficiency of the engine is 40% of the maximum possible and COP of heat pump is 50% of the maximum possible, then **determine** the temperature of the reservoir to which the heat pump rejects heat. Also **determine** the rate of heat rejection from the heat pump, if the rate of heat supply to the heat engine is 50kW?		
6	Three Carnot engine are arranged in series. The first engine takes 4000kJ of heat from a source at 2000K and delivers 1800kJ of work. The second and third engines deliver 1200kJ and 500kJ of work respectively. **Compare** the exhaust temperature of second and third Carnot engines?	Analyze	4,5,6
7	Two bodies of equal capacities C and T_1 and T_2 from an adiabatically closed system. **Determine** the final temperature, if the system is brought to an equilibrium state. i) Freely ii) Reversibly, Proceed to calculate the maximum work which can be obtained from the system?	Apply	4,5,6
8	A heat engine is supplied with 2512kJ/min of heat at 650^0C. Heat rejectiontakes place at 100^0C. **Distinguish** which of the following heat rejection represent a reversible, irreversible or impossible result. i)867kJ/min ii)1015kJ/min iii)1494kJ/min	Analyze	4,5,6
9	Heat flows from a hot reservoir at 800K to another reservoir at 250K.If the entropy change of overall process is 4.25kJ/K, **Compare** calculation for the heat flowing out of the high temperature reservoir?	Analyze	4,5,6
10	Air expands through a turbine from 500kPa, 520^0C to 100kPa, 300^0C. During expansion 10kJ/kg of heat is lost to the surroundings, which is at 98kPa, 20^0C. Neglecting K.E and P.E changes, **determine** per kg of air i)the decrease in availability ii)the maximum work iii)irreversibility for air take Cp=1.005kJ/kgk	Apply	4,5,6
	UNIT-III		
Part - A (Short Answer Questions)			
1	**Explain** the equation of state?	Understand	1,4
2	**Derive** the changes in internal energy during a process with variable specific heats.	Apply	4,5,6
3	**Derive** the changes in enthalpy during a process with variable specific heats.	Apply	4,5,6
4	**Explain** the process of free expansion?	Understand	1,2
5	**Explain** the process of Throttling?	Understand	1,2
6	**State** the expression for Vander Wall's equation and determine the constants?	Remember	
7	**Explain** On what coordinates compressibility charts can be drawn?	Understand	1,2
8	**List** the molar specific heats, explain?	Understand	1,2
9	**Derive** the expression for work done in a non-flow process, if the process is adiabatic?	Apply	4,5,6
10	**Discuss** briefly the reduced properties?	Apply	4,5
11	**Define** Pure Substance and what do you understand by a saturation stage?	Remember	1,2
12	**Draw** the phase diagram on p-v diagrams with water as pure substance?	Apply	4,5
13	**Explain** the concept of p-v-T surface? Represent on p-T coordinates?	Understand	1,2
14	**Explain** the critical state of water?	Understand	1,2

S No	QUESTION	Blooms taxonomy level	Course Outcomes
15	**Draw** the phase equilibrium diagram for a pure substance on T-s plot with relevant constant property line?	Apply	4,5,6
16	**Draw** the phase equilibrium diagram for a pure substance on H-s plot with relevant constant property line?	Apply	4,5,6
17	**Compare** isobar on Mollier diagram diverse from one another?	Analyze	4,5,6
18	**Explain** Mollier chart by representing all the properties on it?	Understand	1,2
19	**State** the degree of superheat and degree of sub cooling?	Remember	1,2
20	**Define** dryness fraction? What are the different methods of measurement of dryness fraction?	Remember	1,2
Part – B (Long Answer Questions)			
1	**Enumerate** the Perfect Gas Laws and analyze from thermodynamics point of view?	Evaluate	2,3,6
2	**Explain** the equation of State with variations?	Understand	1,2
3	**Explain**, how the heat and work transfer observed in perfect gas?	Understand	1,2
4	**Explain** the change in internal energy in perfect gas?	Understand	1,2
5	**State** Vander Waals equation, what is the importance of it?	Remember	1,2
6	**What** is compressibility chart, explain the procedure of usage?	Understand	1,2
7	**Explain** the phase transformation process with a diagram?	Understand	1,2
8	**Analyze** the properties at Triple point and state properties?	Analyze	4,5,6
9	**Derive** the Clausius Claperon equation?	Apply	4,5,6
10	**Analyze** the procedure adopted in Steam calorimetry ?	Analyze	4,5,6
11	Why can not a throttling calorimeter measure the quality, if the steam is wet? **Explain** how is the quality been measured?	Understand	1,2
12	**Explain** the saturation temperature, the changes in specific volume, enthalpy and entropy during evaporation at 1MPa.	Understand	1,2
13	**Compare** the enthalpy, entropy and volume of steam at 1.4MPa, 380^0C.	Analyze	4,5,6
14	A vessel of volume 0.04m^3 contains a mixture of saturated water and saturated steam at a temperature of 250^0C. The mass of the liquid present is 9kg.**Find** the pressure, mass, specific volume, enthalpy, entropy and internal energy?	Apply	4,5,6
15	Steam initially at 1.5MPa, 300^0C expands reversibly and adiabatically in a steam turbine to 40^0C. **Determine** the ideal work output of the Turbine per kg of steam?	Apply	4,5,6
16	Steam flows in a pipe line at 1.5MPa. After expanding to 0.1MPa in a throttling calorimeter, the temperature is found to be 120^0C.**Determine** the quality of the steam in pipe line?	Apply	4,5,6
17	The following data were obtained with a separating and throttling calorimeter. Pressure in pipe line is 1.5MPa. Condition after throttling is at 0.1MPa,110^0C, During 5minutes moisture collected in the separator 0.15lt at 70^0C steam condense after throttling during 5 min 3.24kg **Determine** the quality of steam in the pipe line?	Apply	4,5,6
18	**Determine** the enthalpy and entropy of steam and the pressure is 2MPa and the specific volume is 0.09m^3/kg.	Apply	4,5,6
19	A large insulated vessel is divided in to two chambers. One is containing 5kg of dry saturated steam at 0.2MPa and other 10kg of steam, 0.8quality at 0.5MPa. If the partition between the chambers is removed and the steam is mixed thoroughly and allow to settle. **Determine** the final pressure steam quality and entropy change in the process?	Apply	4,5,6

S No	QUESTION	Blooms taxonomy level	Course Outcomes
20	Saturated steam has entropy of 6.76kJ/kg K. **Determine** the pressure, temperature, specific volume, enthalpy and internal energy?	Apply	4,5,6
Part – C (Problem Solving and Critical Thinking)			
1	The volume of a high altitude chamber is $40m^3$.It is put into operation by reducing pressure from 1bar to 0.4bar and temperature from 25^0C to 5^0C.How many kg of air must be removed from the chamber during the process? **Express** this mass as a volume measured at 1bar and 25^0C.	Understand	1,2
2	A fluid at 200kPa and 300^0C has a volume of $0.8m^3$ in a frictionless process at constant volume, the pressure changes to 100kPa. **Calculate** the final temperature and heat transfer, if the fluid is air?	Apply	4,5,6
3	A fluid at 250^0C and 300kPa is compressed reversibly and isothermally to $1/16^{th}$ of its original volume. **Calculate** the final pressure, work done and change of internal energy per kg of fluid, if the fluid is air?	Apply	4,5,6
4	**Solve** that for an ideal gas the slope of the constant volume line on the T-S diagram is more than that of the constant pressure line.	Apply	4,5,6
5	The specific heats of a gas are given by $C_p=a+kT$ and $C_v=b+kT$ where a, b, k are constants and T is in Kelvin. **Show** that for an isentropic expansion of gas $T^b v^{(a-b)} e^{kT}$=constant.	Apply	4,5,6
6	A reversible polytropic process begins with a fluid at p_1=10bar, $T_{1=}200^0C$ and at p_2=1bar, the exponent n has the value 1.15. **Find** the final specific volume, the final temperature and the heat transfer per kg of fluid, if the fluid is air.	Apply	4,5,6
7	A certain gas has Cp=1.968 and C_v=1.507kJ/kg K. **Find** its molecular weight and the gas constant?	Apply	4,5,6
8	A constant volume of $0.3m^3$capacity contains 2kg of this gas at 5^0C. Heat is transferred to the gas until the temperature is 100^0C. **Find** the work done, the heat transfer and changes in internal energy, enthalpy and entropy?	Apply	4,5,6
9	A reversible adiabatic process begins at p_1=10bar, $T_1=300^0C$ and ends with p_2=1bar. **Find** the specific volume and the work done per kg of fluid, if the fluid is air?	Apply	4,5,6
10	**Derive** an expression for entropy change of an ideal gas from Tds equations?	Apply	4,5,6
UNIT-IV			
Part – A (Short Answer Questions)			
1	**State** Dalton's law of partial pressures?	Remember	1,2
2	**Compute** the characteristic gas constant and the molecular weight of the gas mixture?	Analyze	4,5,6
3	**Derive** the expression for internal energy?	Apply	4,5,6
4	**Define** mole fraction?	Remember	1,2
5	**Explain** about volumetric and gravimetric analysis?	Understand	1,2
6	**Define** dry bulb temperature, wet bulb temperature, dew point temperature and degree of saturation?	Remember	1,2
7	**Explain** adiabatic saturation temperature?	Understand	1,2
8	**Explain** psychrometric charts while representing all the properties?	Understand	1,2
9	**Locate** i) sensible heating ii) sensible cooling iii) heating and humidification iv) heating and dehumidification on psychrometric chart?	Apply	4,5,6
10	**Define** bypass factors represent adiabatic mixing of two air streams on psychrometric chart?	Remember	1,2
11	**State** dry bulb temperature?	Remember	1,2
12	**State** wet bulb temperature?	Remember	1,2
13	**Define** specific humidity?	Remember	1,2

S No	QUESTION	Blooms taxonomy level	Course Outcomes
14	**Define** relative humidity?	Remember	1,2
15	**Explain** Psychrometric chart?	Understand	1,2
16	**State** adiabatic saturation?	Remember	1,2
17	**Define** degree of saturation?	Remember	1,2
18	**Obtain** the expression for enthalpy of gas mixture?	Apply	4,5,6
19	**Define** mass fraction?	Remember	1,2
20	**State** the law of additive volumes?	Remember	1,2
Part – B (Long Answer Questions)			
1	**Explain** the Mole fraction and Mass fraction in the Mixture of Perfect gas?	Understand	1,2
2	**Explain** Gravimetric Analysis of mixtures?	Understand	1,2
3	**Explain** the Volumetric Analysis of mixtures?	Understand	1,2
4	**Explain** the Dalton's law of partial pressure with an example?	Understand	1,2
5	**Explain** the Avogadro's laws of additive volumes?	Understand	1,2
6	**Compare** the Volumetric and Gravimetric Analysis of mixtures?	Analyze	4,5,6
7	**Determine** mole fraction and volume fraction in a gas mixture?	Apply	4,5,6
8	**Determine** mole fraction and partial pressure in a gas mixture?	Apply	4,5,6
9	**Explain** Equivalent gas constant of a gas mixture?	Understand	1,2
10	**Explain** Molecular internal energy of a gas mixture?	Understand	1,2
11	**Determine** enthalpy of a gas mixture?	Apply	4,5,6
12	**Determine** the entropy of a gas mixture?	Apply	4,5,6
13	**Explain** the various properties of psychrometry ?	Understand	1,2
14	**Compare** dry bulb temperature and wet bulb temperature with a sketch?	Analyze	4,5,6
15	**Explain** the concept of dew point temperature?	Understand	1,2
16	**Differentiate** the Relation between specific humidity and relative humidity?	Analyze	4,5,6
17	**Explain** the degree of saturation with an example?	Understand	1,2
18	**Explain** the adiabatic saturation,.	Understand	1,2
19	**Compare** degree of saturation and adiabatic saturation.	Analyze	4,5,6
20	**Derive** the Carrier's equation.	Apply	4,5,6
Part – C (Problem Solving and Critical Thinking)			
1	The **analysis** by weight of a perfect gas mixture at 20^0C and 1.3bar is 10%O_2, 70%N_2,15%CO_2 and 5%CO. For a reference state of 0^0C and 1bar, **determine** partial pressure of the constituent and gas constant of mixture.	Analyze	4,5,6
2	In an engine cylinder a gas has a volumetric analysis of 13%CO_2, 12.5%O_2 and 74.5%N_2. The temperature at the beginning of expansion is 950^0C and gas mixture expands reversibly through a volume ratio of 8:1. According to the law $pV^{1.2}$=constant. **Calculate** per kg of gas, the work done and the heat flow. Take Cp for CO_2=1.235kJ/kgK and O_2=1.088kJ/kgK and N_2 is 1.172kJ/kgK.	Apply	4,5,6
3	The following is the volumetric analysis of a producer gas: CO=28%,H_2=13%,CH_4=4%,CO_2=4%,N_2=51%. The values of Cp for the constituent CO,H_2, CH_4,CO_2 and N_2 are 29.27kJ/mol.K,28.89kJ/mol.K, 35.8kJ/mol.K,37.22kJ/mol.K,29.14kJ/mol.K respectively. **Calculate** the values of Cp,Cv for the mixture.	Apply	4,5,6
4	The gravimetric analysis of air and other data are as follows: Constituent | Percentage | Molecular weight	Apply	4,5,6

S No	QUESTION	Blooms taxonomy level	Course Outcomes
	<table><tr><td>Oxygen</td><td>23.14</td><td>32</td></tr><tr><td>Nitrogen</td><td>75.53</td><td>28</td></tr><tr><td>Argon</td><td>1.28</td><td>40</td></tr><tr><td>Carbon dioxide</td><td>0.05</td><td>44</td></tr></table> **Calculate** i) Gas constant for air ii)Apparent molecular weight		
5	A mixture of hydrogen and oxygen is to be made, so that the ratio of H_2 to O_2 is 2:1 by volume. If the pressure and temperature are 1bar and 25^0C, respectively. **Calculate** mass of oxygen required and volume of the container?	Apply	4,5,6
6	Air at 10bar and a DBT of 40^0Cand WBT of 36^0C.**Compute** degree of saturation, dew point temperature and enthalpy of the mixture?	Analyze	4,5,6
7	Atmospheric air at 1.0132bar has DBT of 32^0C and a WBT of 26^0C. **Compute** partial pressure of the water vapor, specific humidity, dew point temperature and relative humidity?	Analyze	4,5,6
8	Air at 20^0C,40% RH is mixed adiabatically with air at 40^0C, 40%RH in the ratio of 1kg of the former with 2kg of later(on dry basis).**Find** the final condition of air?	Apply	4,5,6
9	Saturated air at 21^0C is passed through a dryer, so that its final relative humidity is 20%. The dryer uses silica gel absorbent. The air is then pass through a cooler until its final temperature is 21^0C without a change in specific humidity. **Find** out i)the temperature of air at the end of the drying process, ii) the relative humidity at the end of the cooling process, iii)The dew point temperature at the end of the drying process?	Apply	4,5,6
10	An air water vapor mixture enters an adiabatic saturator at 30^0C and leaves at20^0C, which is the adiabatic saturation temperature? The pressure remains constant at 100kPa. **Determine** the relative humidity and humidity ratio of the inlet mixture.	Analyze	4,5,6
	UNIT-V		
Part - A (Short Answer Questions)			
1	**Classify** the assumptions to be made for the analysis of all air standard cycles?	Analyze	4,5,6
2	**List** the Processes in Otto cycle and represent on P-V and T-S diagrams?	Apply	4,5,6
3	**List** the Processes in Constant pressure cycle and represent on P-V and T-S diagrams?	Apply	4,5,6
4	**List** the variable factors used for comparison of cycles?	Remember	1,2,6
5	**Draw** the Atkinson cycle? How it differs from Otto cycle?	Apply	4,5,6
6	**Derive** the air standard efficiency of Diesel cycle?	Apply	4,5,6
7	D **Define** mean effective pressure?	Remember	1,2
8	**List** functional parts of simple vapor compression system represents the processes on T-S diagram?	Remember	1,2
9	Draw the Sketch P-V and T-S diagrams of Bell-Coleman cycle while representing process and hence deduce its COP?	Apply	4,5,6
10	**Discuss** limited pressure cycle; represent the processes of it on P-V and T-S diagrams?	Understand	1,2
11	**Compare** Otto cycle with Diesel cycle?	Analyze	4,5,6
12	**Define** the unit of refrigeration?	Remember	1,2,6
13	**Define** COP of refrigeration?	Remember	1,2,6
14	**Draw** the PV and TS diagram of Atkinson Cycle?	Apply	4,5,6
15	**Draw** the PV and TS diagram of Ericsson Cycle?	Apply	4,5,6
16	**Draw** the PV and TS diagram of Lenoir Cycle?	Apply	4,5,6

S No	QUESTION	Blooms taxonomy level	Course Outcomes
17	**Draw** the PV and TS diagram of Sterling Cycle?	Apply	4,5,6
18	**Define** vapor compression cycle?	Remember	1,2,6
19	**Evaluate** the performance of refrigeration cycle?	Evaluate	4,5,6
20	**Draw** the PV and TS diagrams of dual combustion cycle?	Apply	4,5,6
Part - B (Long Answer Questions)			
1	**Differentiate** cycle and power cycle. Explain in detail with diagram.	Analyze	4,5,6
2	**Explain** the working principle of Otto cycle with a diagram.	Understand	
3	**Sketch** the Otto cycle and explain the processes in the cycle.	Apply	4,5,6
4	**State** the characteristic of power cycles?	Remember	1,2
5	**Support** diesel car have a better fuel efficiency than a gasoline car?	Evaluate	4,5
6	**Explain** the Otto cycle working principle with P-V and T-S diagram?	Understand	1,2
7	**Explain** the diesel cycle working principle with P-V and T-S diagram?	Understand	1,2
8	**Explain** the dual cycle working principle with P-V and T-S diagram?	Understand	1,2
9	**Explain** the sterling cycle working principle with P-V and T-S diagram?	Understand	1,2
10	**Explain** the Atkinson cycle working principle with P-V and T-S diagram?	Understand	1,2
11	**Explain** the Ericsson cycle working principle with P-V and T-S diagram?	Understand	1,2
12	**Explain** the Lenoir cycle working principle with P-V and T-S diagram?	Understand	1,2
13	**Compare** the thermal efficiency and mean effective pressure of Otto and diesel cycles?	Analyze	4,5,6
14	**Compare** the thermal efficiency and mean effective pressure of dual and diesel cycles?	Analyze	4,5,6
15	**Compare** the thermal efficiency and mean effective pressure of Otto and dual cycles?	Analyze	4,5,6
16	**List** the thermal efficiencies, mep's of otto,diesel and dual cycles? Compare their efficiencies?	Remember	1,2
17	**Examine** the performance of vapor compression cycle?	Evaluate	4,5
18	**Examine** the performance of Bell-Coleman cycle?	Evaluate	4,5
19	**Explain** the working principle of Bell-Coleman cycle with diagram?	Understand	1,2
20	**Explain** the working principle of vapor compression cycle?	Understand	1,2
Part – C (Problem Solving and Critical Thinking)			
1	**Derive** the expression for air standard efficiency of a constant volume cycle?	Apply	4,5,6
2	An engine working on Otto cycle has a volume of $0.45m^3$ pressure 1bar and temperature 30^0C at the beginning of the compression stroke. At the end of the compression stroke the pressure is 11bar. 210kJ of heat is added at constant volume. **Determine** efficiency and mean effective pressure?	Analyze	4,5,6
3	An engine with 200mm cylinder diameter and 300mm stroke working on theoretical diesel cycle. The initial pressure and temperature of air used are 1bar and 27^0C. The cut of is 8% of the stroke**. Determine** air standard efficiency, mean effective pressure and power of the engine if the working cycles per minute are 300? Assume the compression ratio is 15 and the working fluid is air.	Analyze	4,5,6
4	a)**Determine** the Compression ratio, if efficiency of an Otto cycle is 60% and $\gamma = 1.5$? b) An inventor claims that a new heat cycle will develop 0.4kw for a heat addition of 32.5kJ/min. The temperature of heat source is 1990K and that of sink is 850K. Is his claim possible?	Analyze	4,5,6

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5	A perfect gas undergoes a cycle which consists of following processes. i) heat rejection at constant pressure ii) adiabatic compression from 1bar and 27^0C to 4 bar iii) heat addition at constant volume to a final pressure of 16bar iv) adiabatic expansion to 1bar. **Calculate** work done per kg of gas and efficiency of the cycle. Take Cp = 0.92 and Cv=0.7.	Apply	4,5,6
6	The stroke and cylinder diameter of Compression Ignition engine are 250mm and 150mm respectively. If the clearance volume is 0.0004m^3 and fuel injection takes place at constant pressure for 5% of the stroke. **Determine** the efficiency of the engine. Assume the engine working on Diesel cycle?	Analyze	4,5,6
7	An engine of 250mm bore and 375mm stroke works on Otto cycle. The clearance volume is 0.00263m^3. The initial pressure and temperature are 1bar and 50^0C. The maximum pressure is limited to 25bar. **Find** the air standard efficiency and the mean effective pressure of the cycle? Assume ideal conditions?	Apply	4,5,6
8	28tonnes of ice from and at 0^0C is produced per day in an Ammonia refrigerator. The temperature range in the compressor is from 25^0C to -15^0C. The vapor is dry and saturated at the end of the compression and expansion valve is used. Assuming the C.O.P of 62% of the theoretical. **Calculate** power required to drive the compressor?	Apply	4,5,6
9	A Bell-Coleman refrigerator operates between pressure limits of 1bar and 8bar. Air is drawn from the cold chamber at 9^0C, compressed and then it is cooled to 29^0C before entering the expansion cylinder. Expansion and compression follow the law $pV^{1.35}$=C. **Calculate** theoretical C.O.P of the system. Take ɣ of air is 1.4.	Apply	4,5,6
10	The swept volume of a Diesel engine working on Dual cycle is 0.0053m^3 and clearance volume is 0.00035m^3. The maximum pressure is 65bar. Fuel injection ends at 5% of stroke. The temperature and pressure of the start of the compression are 80^0C and 0.9bar**. Determine** air standard efficiency of cycle? Take ɣ of air is 1.4.	Analyze	4,5,6

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