INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**THERMODYNAMICS**				
Course Code	AMEB04				
Program	B. Tech				
Semester	THREE				
Course Type	CORE				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Course Coordinator	Ms. N. SanthiSree, Assistant Professor				

COURSE OBJECTIVES:

Students will try to learn:	
I	The fundamental knowledge on concepts of physics and chemistry for obtaining the axiomatic principles using thermodynamic co-ordinates.
II	The thermodynamic disorderness in the real time physical systems like external/internal heat engines, heat pumps to get the measure of performance characteristics.
III	The performance characteristics of open and closed systems of thermodynamic cycles for effective delineation of real time applications.
IV	The thermodynamic cycles such as power and refrigerant cycles to yield alternative solutions to conserve the environment.

COURSE OUTCOMES:

At the end of the course the students should be able to:

Course Outcomes		**Knowledge Level (Bloom's Taxonomy)**
CO 1	**Recall** the thermodynamic properties and discern the path and point functions through exact differentials.	Remember
CO 2	**Summarize** working principles of energy conversions in physical systems by fundamental laws of thermodynamics.	Understand
CO 3	**Explain** the various energy transfer mechanisms which leads to the ascertaining of properties involving thermodynamic cycles.	Understand

CO 4	**Identify** the laws of conservation of energy to yield the relationship between heat, work and change in internal energy.	Apply
CO 5	**Contrast** between various statements of purpose in heat to work conversion and notice that thermodynamic direction laws defining them are mutually complementary.	Understand
CO 6	**Relate** various relations involving pressure, temperature and volume to discern the change in entropy generation in universe.	Understand
CO 7	**Interpre**t the properties of pure substances and steam to emit relevant inlet and exit conditions of thermodynamic work bearing systems.	Understand
CO 8	**Describe** fundamental relationship between intensive properties in form of partial derivatives implemented for perfect gases.	Understand
CO 9	**Show** the significance of partial pressure and temperature to table the performance parameters of gaseous mixtures.	Understand
CO 10	**List** the properties of air-conditioning systems by practicing on psychrometry chart and gas property tables.	Analyze
CO 11	**Illustrate** the working of various air standard cycles and work out the performance characteristics.	Understand
CO 12	**Infer** the performance of power and refrigerant cycles, and their significance in real world systems.	Understand

MAPPING OF EACH CO WITH PO(s), PSO(s):

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	-	2	-	-	-	-	-	-	-	-	2	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 4	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 7	3	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 9	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 10	3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 11	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 12	3	-	3	-	-	-	-	-	-	-	-	-	2	-	-
TOTAL	36	15	10	-			-						14		
AVERAGE	**3.0**	**3.0**	**2.0**										**2.0**		

TUTORIAL QUESTION BANK

MODULE-I				
BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS				
PART – A (SHORT ANSWER QUESTIONS)				
S No	**QUESTIONS**	**Blooms Taxonomy Level**	**How does this subsume the level below**	**Course Outcomes**
1	Write Zeroth law of Thermodynamics.	Remember	----	CO 1
2	Define System, Surroundings and Boundary.	Remember	----.	CO2
3	What is the need of international practical temperature scale?	Remember	----	CO 1
4	What are adiabatic and diathermic wall boundaries?	Remember	----	CO 1
5	Define the terms-Thermodynamic process, cycle, Reversible process.	Remember	-----	CO 1
6	Explain the features of constant volume gas thermometer.	Understand	The learner to remember concept of thermometer to explain the features of thermometers.	CO 1
7	Summarize First law of thermodynamics applied to a cyclic process.	Understand	The learner to remember the law of conservation energy which describes the first law of thermodynamics.	CO 4
8	Define PMM 1 why it is not possible.	Remember	----	CO 2
9	List the causes of irreversibility?	Remember	-----	CO 2
10	Write Steady Flow Energy Equation, when the device is an air compressor.	Remember	-----	CO 4
11	When work is said to be done by system and what are positive and negative work interactions.	Remember	------.	CO 4
12	Summarize the closed system features? Give an example.	Understand	The learner to understand the closed system with practical examples by Recalling basic concepts of thermodynamics.	CO 2
13	Define Intensive and Extensive properties.	Remember	----	CO 1
14	When do you say that the system is in thermodynamically equilibrium in nature?	Remember	---	CO 2
15	Define specific Intensive and Extensive properties.	Remember	----	CO 1
16	Differentiate closed and open system.	Remember	----	CO 2
17	Define Specific heat capacity at constant volume	Remember	----	CO 1
18	Define Specific heat capacity at constant pressure.	Remember	----	CO 1
19	Give an example of closed and open system.	Understand	The learner to remember the definition of the closed system and open systems with practical examples by Recalling basic concepts of thermodynamics	CO 2
20	Why does free expansion have zero work transfer	Remember	-----	CO 2

PART - B (LONG ANSWER QUESTIONS)				
1	Differentiate the system, surroundings and boundary Explain in detail.	Understand	The learner to remember the basic concepts of thermodynamics with definitions.	CO 1,CO 2
2	Compare the types of systems with examples.	Understand	The learner to remember the different types of systems by recalling basic concepts of thermodynamics.	CO 1,CO 2
3	Compare the macroscopic and microscopic study of thermo dynamics?	Understand	The learner to remember the different types of methods of thermodynamics study.	CO 1,CO 2
4	What is concept of continuum? How will you define density and pressure using this concept?	Remember	----	CO 1,CO 2
5	Explain thermodynamic equilibrium in detail?	Understand	The learner to remember the basic concepts of thermodynamics which explains the equilibrium nature of systems.	CO 1,CO 2
6	Compare thermal equilibrium and thermodynamic equilibrium, explain.	Understand	The learner to remember the basic concepts of thermodynamics which explains the thermal equilibrium nature of systems	CO 1,CO 2
7	Define path function and **Show** that work and heat are path functions?	Understand	The learner to remember the thermodynamic properties and discern the path and point functions through exact differentials.	CO 1,CO 2
8	Show the Isobaric process from thermodynamic point of view and derive its work done under p-V coordinates.	Remember	----	CO 1,CO 4
9	Show the Isochoric process from thermodynamic point of view and derive its work done under p-V coordinates.	Remember	---	CO 1,CO 4
10	Show the Isothermal process from thermodynamic point of view and derive its work done under p-V coordinates.	Remember	----	CO 1,CO 4
11	Show the adiabatic process from thermodynamic point of view and derive its work done under p-V coordinates.	Remember	----	CO 1,CO 4
12	Show the polytrophic process from thermodynamic point of view and derive its work done under p-V coordinates.	Remember	----	CO 1,CO 4
13	Develop an expression for piston displacement work with neat diagram?	Apply	The learner to remember the piston displacement work by explaining the various energy transfer mechanisms which leads to obtaining the properties involving thermodynamic cycles.	CO 1,CO 3
14	Write and explain the first law of thermodynamics undergoing a change of state.	Remember	----	CO 1,CO 2
15	Define steady flow process and Derive the Steady flow energy equation?	Remember	----	CO 1,CO 4
16	Write steady flow energy equation for turbine and obtain the work done in a device.	Remember	----	CO 1,CO 4
17	Develop expression for exit velocity of nozzle by considering steady flow energy equation.	Apply	The learner to remember the basic laws and understand the steady flow process to derive the general expression for steady	CO 1,CO 4

			flow devices by identifying the laws of conservation of energy	
18	Define path function and Show that work and heat are path functions?	Remember	----	CO 1
19	Explain the first law of thermodynamics applied to closed system when system undergoing a change of state?	Understand	The learner to remember the basic concepts of thermodynamics by summarize working principles of energy conversions in physical systems by fundamental laws of thermodynamics.	CO 3
20	Write the characteristics of quasistatic process and explain the process with a neat diagram.	Remember	----	CO 1
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. What is the change in internal energy of the gas?	Apply	The learner to remember the various energy transfer mechanisms which leads to the understanding properties that are involving thermodynamic cycles and identifying the laws of conservation of energy to yield the relationship between heat, work and change in internal energy	CO 3,CO 4
2	0.44kg of air at 180^0 C, expands adiabatically to 3 times 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	The learner to remember the laws of conservation of energy to yield the relationship between heat, work and change in internal energy	CO 3,CO4
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 the identical numerical values shown by the thermometers? Determine the corresponding temperature of the fluid, express in degrees Kelvin and degrees Rankine?	Understand	The learner to remember the corresponding temperatures by recalling the thermodynamic properties and comparison of different temperature scales.	CO 1
4	If a gas of volume 6000 cm^3 and at pressure of 100 kPa is compressed quasi statically according to PV^2 = constant until the volume becomes 2000 cm^3, Determine the final pressure and the work transfer.	Analyze	The learner to remember The properties and understand work by explaining the various energy transfer mechanisms which leads to the obtaining properties involving thermodynamic cycles.	CO 4
5	A gas of mass 1.5 kg undergoes a quasi-static expansion which follows a relationship p = a + bV, where a and b are constants. The initial and final pressures are 1000 kPa and 200 kPa respectively and the corresponding volumes are 0.20 m^3 and 1.20 m^3. The specific internal energy of the gas is given by the relation u = l.5 p V – 85 kJ/kg .Where p is in the kPa and v is in m^3/kg. Find the net heat transfer and the maximum internal energy of the gas attained during expansion.	Apply	The learner to remember the various energy transfer mechanisms which leads to the understanding properties that are involving thermodynamic cycles and identifying the laws of conservation of energy to yield the relationship between heat, work and change in internal energy.	CO 3, CO 4
6	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	Remember	----	CO 2

<table>
<tr><td></td><td>piston comes back. What is the work done in each process?</td><td></td><td></td><td></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. Find the network transfer to the system?</td><td>Understand</td><td>The learner to remember the basics of thermodynamics by recalling the thermodynamic properties by explaining the various energy transfer mechanisms which leads to the ascertaining of properties involving thermodynamic cycles..</td><td>CO 1,CO 3</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><td>Process</td><td>Q(kJ/min)</td><td>W(kJ/min)</td><td>ΔE(kJ/min)</td></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>Understand</td><td>The learner to remember the various energy transfer mechanisms which leads to the obtaining properties involves thermodynamic cycles to determine the network output..</td><td>CO 1,CO 3</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. Interpret the direction and magnitude of work and heat transfer.</td><td>Understand</td><td>The learner to remember the various energy transfer mechanisms which leads to the obtaining properties involves thermodynamic cycles to determine the network output.</td><td>CO 1,CO 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.Find the rate of shaft work input to the air in KW.</td><td>Understand</td><td>The learner to remember the various energy transfer mechanisms which leads to the obtaining properties involves thermodynamic cycles to determine the network output</td><td>CO 4</td></tr>
<tr><td colspan="5">MODULE-II</td></tr>
<tr><td colspan="5">SECOND LAW OF THERMODYNAMICS</td></tr>
<tr><td colspan="5">PART – A (SHORT ANSWER QUESTIONS)</td></tr>
<tr><td>1</td><td>Outline the limitations of first law of thermodynamics?</td><td>Understand</td><td>The learner to remember the first law by Identifying the laws of conservation of energy to yield the relationship between heat and work.</td><td>CO 1, CO 4</td></tr>
<tr><td>2</td><td>Summarize second law of thermodynamics?</td><td>Understand</td><td>The learner to remember the working principles of energy conversions in physical systems</td><td>CO 1, CO 4</td></tr>
</table>

			to describe fundamental 2 nd laws of heat engines.	
3	What is PMM 2? Why is it impossible?	Understand	The learner to remember the laws of thermodynamics to explain the possibility of machines.	CO 5
4	**Name** the processes of Carnot Cycle?	Remember	---	CO 5
5	State the Clausius inequality?	Remember	----	CO5
6	Define COP of refrigerator.	Remember	---.	CO5
7	What is heat pump and how it differs from refrigerator in terms of COP?	Remember	----	CO5
8	What is absolute thermodynamics temperature scale?	Remember	----	CO 3
9	**Write** Maxwell's 1 and 2 relations?	Remember	----	CO 6
10	State the Third law of Thermodynamics?	Understand	The learner to remember the working principles of energy conversions in physical systems by fundamental laws of thermodynamics to explain third law.	CO 1,CO 6
11	**Define** available energy of a system?	Remember	----	CO 1,CO 5
12	Write Maxwell's 3 and 4 relations?	Remember	----	CO 1,CO 6
13	Explain dead state of a system?	Understand	The learner to remember the state of a system by recalling the thermodynamic laws to explain about dead state of system.	CO 1,CO 6
14	Define the unavailable energy in a system?	Remember	------	CO 1,CO 5
15	Explain the principle of entropy increase?	Understand	The learner to remember the second law of thermodynamics and explain the concept of disorderness of a substance.	CO 6
16	Explain the exergy of a system?	Remember	----	CO 5
17	Explain the Claussius statement?	Remember	----	CO 5
18	Write the Kelvin-Plank statement?	Remember	----	CO 5
19	Illustrate Carnot cycle with PV and TS diagrams.	Understand	The learner to remember basic processes of carnot cycle to illustrate on thermodynamic coordinates.	CO 5
20	Classify the processes which constitute the ideal Carnot cycle.	Understand	The learner to understand the basic processes involved in standard cycle by involving heat to work conversion.	CO 5
PART - B (LONG ANSWER QUESTIONS)				
1	Explain the limitations of First law of thermodynamics in detail?	Understand	The learner to remember the first law by explaining the relation between heat and work.	CO 4
2	Define the terms thermal reservoir, source, and sink with a neat sketch?	Remember	-----	CO 5

3	Explain the heat engine with a neat sketch?	Understand	The learner to remember relation between parameters of thermal device by explaining the laws of thermodynamics.	CO 5
4	Explain the heat pump with a neat sketch?	Understand	The learner to define the performance parameters of thermal device by **Contrasting** between various statements of laws of thermodynamics.	CO 5
5	List the performance parameters of a system and explain in detail.	Remember	----	CO 5
6	Compare the first law and second law of thermodynamics by considering example.	Understand	The learner to remember the basic laws for comparison of fundamental laws of thermodynamics.	CO 4
7	Explain the statements of second law of thermodynamics with suitable ketches?	Understand	The learner to remember the basic working of thermal devices.	CO 5
8	Give Kelvin-Plank statement and explain with an example?	Understand	The learner to remember the basic working of thermal devices by stating various statements of thermodynamics.	CO 5
9	Give Claussius statement and explain with refrigerator as an example?	Understand	The learner to remember the basics of first law of thermodynamics to explain second law applicable to refrigerators.	CO 5
10	Illustrate the equivalence between Kelvin-Planck and Claussius statements with sketches?	Understand	The learner to remember the basic working of thermal devices by stating equivalence between statements of thermodynamics laws.	CO 5
11	State PMM1 and PMM2, in which manner both are different?	Understand	The learner to remember the working of devices by checking impossibility of machines in heat to work conversion and notice that thermodynamic direction laws defining them are mutually complementary.	CO 5
12	Compare the relation with process and cycle? Explain.	Remember	----	CO 1
13	Explain Carnot's principle? What is the importance of the principle, explain?	Understand	The learner to remember the basic processes of Carnot to explain the principle of Carnot heat engine.	CO 5
14	Explain the statements of second law of thermodynamics with suitable ketches?	Understand	The learner to remember the basic working of thermal devices.	CO 5
15	Give Kelvin-Plank statement and explain with an example?	Understand	The learner to remember the basic working of thermal devices by stating various statements of thermodynamics.	CO 5
16	Explain the Claussius inequality? Explain.	Understand	The learner to remember Carnot cycle processes to explain the nature of cycle stating claussius inequality.	CO 5
17	Explain the influence of entropy on various parameters?	Understand	The learner to remember the second law of thermodynamics to explain disorderness of universe.	CO 6

18	Define Gibb's Helmholtz's functions? Write Maxwell relations.	Remember	----	CO 6
19	What is irreversibility and explain.	Remember	----	CO 5
20	Explain the Availability and derive an expression for it in a thermodynamic system for non-flow process.	Understand	Learner to recall the method of finding line integral in real analysis and understand the variable value along the line and apply integral concepts.	CO 5
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	A heat engine working on Carnot cycle converts 1/5th of the heat input into work. When the temperature of the sink is reduced by 80^0C, the efficiency gets doubled. What is the temperature of sink?	Remember	----	CO 5
2	A reversible heat engine is supplied with heat from two constant temperature sources at 900K and 600 K and rejects heat to a constant temperature at 300K to sink. The engine develops work equivalent to 91kJ/s and rejects heat at the rate of 56kJ/sec. Calculate (i) heat supplied by each source (ii) Thermal efficiency of engine.	Understand	The learner to remember the statements of second law of thermodynamics to calculate efficiency of heat engines	CO 5
3	A block of iron weighing 100 kg and having a temperature of 100°C is immersed in 50 kg of water at a temperature of 20°C. What will be the change of entropy of the combined system of iron and water? Specific heats of iron and water are 0.45 and 4.18 kJ/kg K respectively.	Remember	----	CO 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. What is the least power necessary to pump this heat out continuous?	Understand	The learner to remember the statements of second law of thermodynamics to calculate efficiency of heat engines.	CO 6
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 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 find the rate of heat rejection from the heat pump, if the rate of heat supply to the heat engine is 50kW?	Understand	The learner to remember the statements of second law of thermodynamics to calculate efficiency a d heat transfer rates of heat engines.	CO 5
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?	Understand	The learner to remember the statements of second law of thermodynamics to calculate efficiency a d heat transfer rates of heat engines.	CO 5
7	Two bodies of equal capacities C and T1 and T2 from an adiabatically closed system. Determine the final temperature, if the system is brought to an equilibrium state. i) Freely, ii) reversibly, Proceed to find the maximum work which can be obtained from the system?	Understand	The learner to remember the statements of second law of thermodynamics to calculate efficiency a d heat transfer rates of heat engines.	CO 6

8	A heat engine is supplied with 2512kJ/min of heat at 650^0C. Heat rejection takes place at 100^0C. Distinguish which of the following heat rejection represent a reversible, irreversible or impossible result. i) 867 kJ/min ii) 1015 kJ/min iii) 1494 kJ/min	Understand	The learner to remember the statements of second law of thermodynamics to explain the existence of system.	CO 5
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?	Understand	The learner to remember the statements of second law of thermodynamics to calculate heat transfer rates of heat engines.	CO 5
10	5 kg of air heated from a temperature of 100^0 C at constant volume till its pressure becomes three times its original pressure. For this process Solve:(i)heat transfer(ii)change in internal energy (iii)Change in enthalpy (iv)change in entropy for air take Cp=1.005kJ/kg k	Apply	The learner to remember the second law of thermodynamics and understand various processes to discern the change in entropy generation in universe.	CO 4,CO 6
MODULE-III				
PROPERTIES OF PURE SUBSTANCES				
PART – A (SHORT ANSWER QUESTIONS)				
1	Define Pure Substance and what do you understand by a saturation stage?	Remember	----	CO 1,CO 7
2	Show the phase diagram on p-v diagrams with water as pure substance?	Remember	----	CO 1,CO 7
3	Explain the concept of p-v-T surface? Represent on p-T coordinates?	Understand	The learner to remember the basic properties and **Interpret** the properties of pure substances by illustrating on thermodynamic coordinates.	CO 1,CO 7
4	Explain the critical state of water?	Remember	------	CO 1,CO 7
5	Show the phase equilibrium diagram for a pure substance on T-s plot with relevant constant property line?	Remember	-----	CO 1,CO 7
6	Show the phase equilibrium diagram for a pure substance on h-s plot with relevant constant property line?	Understand	The learner to remember the basic properties and **Interpret** the properties of pure substances by illustrating on thermodynamic coordinates.	CO 1,CO 7
7	Why isobar lines on Mollier diagram diverse from one another?	Remember	----	CO 1,CO 7
8	Explain Mollier chart by representing all the properties on it?	Remember	----	CO 1,CO 7
9	Explain the degree of superheat and degree of sub cooling?	Understand	The learner to understand the basic properties and **Interpret** the properties of pure substances and steam with help of mollier chart.	CO 1,CO 7
10	Define dryness fraction? What are the different methods of measurement of dryness fraction?	Remember	----	CO 1,CO 7
11	Explain the equation of state?	Understand	The learner to remember the state equation by recalling the properties to describe fundamental relationship between intensive properties for perfect gases.	CO1,CO 8

12	Deduce the changes in internal energy during a process with variable specific heats.	Remember	----	CO 1,CO 4,CO 8
13	Derive the changes in enthalpy during a process with variable specific heats.	Remember	----	CO 1,CO 8
14	Explain the process of free expansion?	Understand	The learner to remember the state equation by recalling the properties to describe fundamental relationship between intensive properties for perfect gases.	CO 1,CO 8
15	Explain the process of Throttling?	Remember	----	CO 1,CO 8
16	Write the expression for Vander Wall's equation and determine the constants?	Remember	----	CO 1,CO 8
17	Explain On what coordinates compressibility charts can be drawn?	Understand	The learner to remember the ideal gas equation and to explain the compressibility chary on coordinates.	CO 1,CO 8
18	List the molar specific heats, explain?	Remember	---	CO 1,CO 8
19	Analyze the expression for work done in a non-flow process, if the Process is adiabatic?	Analyze	The learner to remember the ideal gas equation and understand the possibility of process and apply piston displacement work to analyze the work in different processes in nature.	CO 1,CO 4,CO 8
20	Outline briefly the reduced properties?	Understand	The learner to remember the basic properties and describe the relation with critical parameters.	CO 1,CO 8
	PART - B (LONG ANSWER QUESTIONS)			
1	Explain the procedure adopted in Steam calorimetry?	Understand	The learner to remember dryness fraction and explain the different methods of its measurement.	CO 1,CO 7
2	Why can not a throttling calorimeter measure the quality, if the Steam is wet? Explain how is the quality been measured?	Understand	The learner to remember dryness fraction and explain the different methods of its measurement.	CO 1,CO 7
3	Explain the saturation temperature, the changes in specific Volume, enthalpy and entropy during evaporation at 1MPa.	Understand	The learner to remember properties of steam and determine the property values of thermodynamic systems from Mollier charts.	CO 1,CO 7
4	Compare the enthalpy, entropy and volume of steam at 1.4MPa, 38^{O}C.	Understand	The learner to remember properties of steam and determine the property values of thermodynamic systems from Mollier charts.	CO 1,CO 7
5	A vessel of volume $0.04m^3$ contains a mixture of saturated water and saturated steam at a temperature of 25^{0}C. The mass of the liquid present is 9kg.Find the pressure, mass, specific volume, enthalpy, entropy and internal energy?	Apply	The learner to remember the basic properties and interpreting concepts of relevant inlet and exit conditions of thermodynamic systems from steam tables and Mollier charts	CO 1,CO 7
6	Steam initially at 1.5MPa, 30^{0}C expands reversibly and adiabatically in a steam turbine to 40^{0}C. Determine the ideal work output of the Turbine per kg of steam?	Understand	The learner to remember the basic properties and determine work output of thermodynamic systems from steam tables and Mollier charts.	CO 1,CO 7
7	Steam flows in a pipe line at 1.5MPa. After expanding to 0.1MPa in a throttling calorimeter,	Understand	The learner to remember the basic properties and determine	CO 1,CO 7

	the temperature is found to be 120^0C. Determine the quality of the steam in pipe line?		work output of thermodynamic systems from steam tables and Mollier charts..	
8	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 is 0.15 lt at 70^0C .steam condenses after throttling during 5 minis 3.24kg, and Determine the quality of steam in the pipe line?	Understand	The learner to remember the basic properties and determine work output of thermodynamic systems from steam tables and Mollier charts.	CO 1,CO 7
9	Determine the enthalpy and entropy of steam and the pressure is 2MPa and the specific volume is $0.09m^3/kg$.	Understand	The learner to remember the basic properties and determine work output of thermodynamic systems from steam tables and Mollier charts.	CO 1,CO 7
10	Saturated steam has entropy of 3.56 kJ/kg K. Determine the saturated pressure, temperature, specific volume, enthalpy.	Understand	The learner to remember the basic properties and determine work output of thermodynamic systems from steam tables and Mollier charts.	CO1,CO 7
11	Name the properties describes the equation of state.	Remember	----	CO 1,CO 8
12	Explain the equation of state with variations?	Understand	The learner to remember the state equation to describe the fundamental relationship between intensive properties in form of partial derivatives implemented for perfect gases.	CO 1,CO 8
13	Explain, how the heat and work transfer observed in perfect gas?	Understand	The learner to remember the perfect gas equation and describe fundamental relationship between intensive properties to determine work and heat transfer.	CO 1,CO8
14	Explain the change in internal energy in perfect gas?	Understand	The learner to remember the perfect gas equation and describe fundamental relationship between intensive properties to determine internal energy of a gas.	CO 1,CO 4,CO 8
15	State Vander Waals equation, what is the importance of it?	Remember	----	CO 1,CO 8
16	What is compressibility chart, explain the procedure of usage?	Remember	-----	CO 1,CO 8
17	Explain about law of corresponding states.	Understand	The learner to remember the perfect gas equation and describe fundamental relationship between intensive properties to explain the law of corresponding states.	CO 1,CO 8
18	What are the assumptions for deriving ideal gas equation?	Understand	The learner to **recall** the basic gas laws **to explain the** ideal gas equation.	CO 1,CO 8
19	Summarize the Clausius Claperon equation?	Understand	The learner to remember the steam relations to explain basic equation that d**escribes** the fundamental relationship between them.	CO 2,CO 8

20	Find the constants of Vander wall's equation.	Understand	The learner to remember real gas equation to determine the property constants of real gas equation.	CO 1,CO 8
PART – C (PROBLEM SOLVING AND CRITICAL THINKING)				
1	1 kg of water fills a 150 L rigid container at an initial pressure of 2 MPa. The container is then cooled to 40^{o}C. What is the initial temperature and final pressure of the water?	Understand	The learner to remember the properties of thermodynamic systems to determine the properties of gases from steam tables and Mollier charts	CO 1,CO 7
2	Saturated steam has entropy of 6.76kJ/kg K. Interpret the pressure, temperature, specific volume, enthalpy from Mollier chart.	Understand	The learner to remember the properties of thermodynamic systems to determine the properties of gases from steam tables and Mollier charts.	CO 1,CO 7
3	A vessel of volume 0.04 m^3 contains a mixture of saturated water and steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, mass, specific volume, enthalpy, entropy.	Understand	The learner to remember the properties of thermodynamic systems to determine the properties of gases from steam tables and Mollier charts.	CO 1,CO 7
4	A steam power plant uses steam at boiler pressure of 150 bars and temperature of 550°C with reheat at 40 bars and 550°Cat condenser pressure of 0.1 bar. Find the quality of steam at turbine exhaust, cycle efficiency and the steam rate.	Understand	The learner to remember the properties of thermodynamic systems to determine the properties of gases from steam tables and Mollier charts.	CO 1,CO 7
5	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, 0.8 quality at 0.5MPa. If the partition between the chambers is removed and the steam is mixed thoroughly and allow to settle. What is the final pressure steam quality and entropy change in the process?	Understand	The learner to remember the properties of thermodynamic systems to determine the properties of gases from steam tables and Mollier charts.	CO 1,CO 7
6	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^{0}C to 5^{0}C. 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^{0}C.	Understand	The learner to remember the basic gas law and describe the fundamental relationship between intensive properties for perfect gases to determine the mass and volume of gas.	CO 1,CO 7
7	A fluid at 200kPa and 300^{0}C 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?	Understand	The learner to remember the basic gas law and describe the fundamental relationship between intensive properties for perfect gases to determine the final temperature and heat transfer.	CO 1,CO 7
8	A fluid at 25^{0}C and 300kPa is compressed reversibly and isothermally to 1/16th of its original volume. What is the final pressure, work done and change of internal energy per kg of fluid, if the fluid is air?	Understand	The learner to remember the basic gas law and describe the fundamental relationship between intensive properties for perfect gases to determine the internal energy, work done and heat transfer.	CO 1,CO 7
9	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.	Understand	The learner to remember the basic gas law and describe the fundamental relationship between intensive properties for perfect gases to determine the internal energy, work done and heat transfer.	CO 1,CO 7

10	At a temperature of 423K, 1 kg of nitrogen occupies volume of 200 liters. The gas undergoes constant expansion with fully resisted to a volume of 360 liters. Then the gas expanded isothermally to a volume of 500 liters. Sketch the process on p-V and T-S diagram. Find out overall change in entropy.	Understand	The learner to remember the basic gas law and describe the fundamental relationship between intensive properties for perfect gases to determine the internal energy, work done and heat transfer.	CO 1,CO 7
MODULE-IV				
MIXTURE OF PERFECT GASES				
PART - A(SHORT ANSWER QUESTIONS)				
1	Write Dalton's law of partial pressures?	Remember	----	CO 1,CO 9
2	Compute the characteristic gas constant and the molecular weight of the gas mixture?	Remember	-----	CO 1,CO 9
3	Write the expression for internal energy?	Remember	-----	CO 1,CO 9
4	Define mole fraction?	Remember	-----	CO 1,CO 9
5	Explain about volumetric and gravimetric analysis?	Understand	The learner to remember the properties of gas mixtures and explain gravimetric and volumetric analysis.	CO 1,CO 9
6	Define dry bulb temperature, wet bulb temperature, dew point temperature and degree of saturation?	Remember	----	CO 1,CO 10
7	Explain adiabatic saturation temperature?	Understand	The learner to remember properties of moist air and explain the psychrometric processes applicable in air-conditioning systems.	CO 1,CO 10
7	Write Dalton's law of partial pressures?	Remember	----	CO 8,CO 9, CO10
8	Explain psychometric charts while representing all the properties?	Understand	The learner to remember properties of moist air and explain the psychrometric processes applicable in air-conditioning systems.	CO 1,CO 10
9	Show i) sensible heating ii) sensible cooling iii) heating and Humidification iv) Heating and Dehumidification on psychometric chart?	Understand	The learner to remember properties of moist air and explain the psychrometric processes applicable in air-conditioning systems.	CO 1,CO 10
10	Define bypass factors represent adiabatic mixing of two air streams on psychrometric chart?	Remember	----	CO 1,CO 10
11	What is dry bulb temperature?	Remember	----	CO 1,CO 10
12	What is wet bulb temperature?	Remember	----	CO 1,CO 10
13	Define specific humidity?	Remember	----	CO 1,CO 10
14	Define relative humidity?	Remember	----	CO 1,CO 10
15	Explain Psychrometric chart?	Understand	The learner to remember properties of moist air and explain the psychrometric processes applicable in air-conditioning systems in psychrometric chart.	CO 1,CO 10

16	What do you mean by adiabatic saturation temperature?	Remember	----	CO 1,CO 10
17	Define degree of saturation?	Remember	----	CO 1,CO 10
18	Write the expression for enthalpy of gas mixture?	Remember	----	CO 9
19	Define mass fraction?	Remember	----	CO 1,CO 9
20	Write the law of additive volumes?	Remember	----	CO 1,CO 9
PART - B (LONG ANSWER QUESTIONS)				
1	Explain the Mole fraction and Mass fraction in the Mixture of Perfect gas?	Understand	The learner to remember the terms for expressing the portion of molecules in a system by **showing** the performance parameters of gaseous mixtures	CO 1,CO 9
2	Explain Gravimetric Analysis of mixtures?	Understand	The learner to remember the properties of gas mixtures and explain gravimetric and volumetric analysis.	CO 1,CO 9
3	Explain the Volumetric Analysis of mixtures?	Understand	The learner to remember the properties of gas mixtures and explain gravimetric and volumetric analysis.	CO 1,CO 9
4	Explain the Dalton's law of partial pressure with an example?	Understand	The learner to remember the basic laws for properties by recalling the significance of partial pressure and temperature of gaseous mixtures	CO 1,CO 9
5	Explain the Avogadro's laws of additive volumes?	Understand	The learner able to write the basic laws for properties by recalling the thermodynamic properties and **shows** the significance of partial pressure and temperature of gaseous mixtures.	CO 1,CO 9
6	Compare the Volumetric and Gravimetric Analysis of mixtures?	Understand	The learner understands to analyze the gaseous mixtures by gravimetric and volumetric analysis.	CO 1,CO 9
7	Using definitions of mass and mole friction, derive a relation between them.	Remember	----	CO 1,CO 9
8	Somebody claims that the mass and mole fraction for mixture of CO2 and N2O are identical. Is it true? Why? Explain.	Understand	The learner Defines the terms for expressing the portion of molecules in a system of gaseous mixtures	CO 1,CO 9
9	Explain Equivalent gas constant of a gas mixture?	Remember	----	CO 1,CO 9
10	Explain Molecular internal energy of a gas mixture?	Understand	The learner obtains property relations by recalling the thermodynamic properties of gaseous mixtures to obtain molecular internal energy.	CO 1,CO 9
11	Fine the expressions for enthalpy and entropy of a gas mixture?	Remember	----	CO 1,CO 9
12	Are the dry bulb temperature and dew point temperature are same? Explain when they are same.	Understand	The learner describes the different terms applicable in air-conditioning systems by **recalling** the properties of psychrometry processes	CO 1,CO 10

			applicable in air-conditioning systems.	
13	Explain the various properties of psychrometry?	Understand	The learner understands to explain the charts which describes the properties of psychrometry processes applicable in air-conditioning systems	CO 1,CO 10
14	Compare dry bulb temperature and wet bulb temperature with a sketch?	Understand	The learner to remember properties of moist air and explain the psychrometric processes applicable in air-conditioning systems in psychrometric chart.	CO 1,CO 10
15	Explain the concept of dew point temperature?	Understand	The learner to remember properties of moist air and explain the psychrometric processes applicable in air-conditioning systems in psychrometric chart	CO 1,CO 10
16	Differentiate the Relation between specific humidity and relative humidity and derive the relation between them?	Understand	The learner to remember properties of moist air and explain the psychrometric processes applicable in air-conditioning systems in psychrometric chart	CO 1,CO 10
17	Explain the degree of saturation with an example?	Understand	The learner to remember the moist air properties and explains the saturation temperature.	CO 1,CO 10
18	Explain the adiabatic saturation. And compare with degree of saturation.	Understand	The learner to remember the properties of psychrometry and explains the concept of adiabatic saturation temperature.	CO 1,CO 10
19	List out different psychrometric processes that are taking place.	Remember	----	CO 1,CO 10
20	How will you construct psychrometric chart?	Remember	----	CO 1,CO 10
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	The analysis by weight of a perfect gas mixture at 200C 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, What would be the partial pressure of the constituent and what is the gas constant of mixture.	Understand	The learner to remember the performance parameters of gaseous mixtures to determine the pressure of gas mixture.	CO 1,CO 9
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 9500C and gas mixture expands reversibly through a volume ratio of 8:1. According to the law pV1.2=constant. Find per kg of gas, the work done and the heat flow. Take Cp for CO_2=1.235kJ/kg K and O_2=1.088kJ/kg K and N_2 is 1.172kJ/kg K.	Understand	The learner to remember the performance parameters of gaseous mixtures to determine the work and heat of gas mixture.	CO 1,CO 9
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 constituents -CO, H_2,H4 ,CO2 and N2are given 29.27kJ/mol.K,28.89kJ/mol.K,35.8kJ/mol.K,37.2kJ /mol.K,29.14kJ/ mol .K respectively. Interpret the values of Cp, Cv for the mixture.	Understand	The learner to remember the performance parameters of gaseous mixtures to interpret the Cp and Cv values.	CO 1,CO 9

4	Find the relative humidity and specific humidity for air at 30 ^{0} C and having dew point temperature of 15^{0}C. Show the process	Understand	The learner to remember the processes of psychrometry to illustrate on psychrometric chart.	CO 1,CO 10
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^{0}C, respectively. Find the mass of oxygen required and volume of the container?	Understand	The learner to remember the performance parameters of gaseous mixtures to determine the mass and volume of gas mixture.	CO1,CO 9
6	Air at 10 bar and a DBT of 40^{0}C and WBT of 36^{0}C. Determine degree of saturation, dew point temperature and enthalpy of the mixture?	Understand	The learner to remember the definition of psychrometric properties of psychrometry to illustrate and determine the enthalpy of the mixture.	CO 1,CO 10
7	Atmospheric air at 1.0132bar has DBT of 32^{0}C and a WBT of 26^{0}C. Interpret partial pressure of the water vapor, specific humidity, dew point temperature and relative humidity?	Understand	The learner to remember the definition of psychrometric properties of psychrometry to illustrate and determine them.	CO 1,CO 10
8	Air at 20^{0}C, 40% RH is mixed adiabatically with air at 40^{0}C, 40%RH in the ratio of 1kg of the former with 2kg of later (on dry basis).Find the final condition of air?	Understand	The learner to remember the definition of psychrometric properties of psychrometry and to illustrate, determine them.	CO 1,CO 10
9	Saturated air at 21^{0}C 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^{0}C 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?	Understand	The learner to remember the definition of psychrometric properties of psychrometry and to illustrate, determine them.	CO 1,CO 11
10	An air water vapor mixture enters an adiabatic saturator at 30^{0}C and leaves at 20^{0}C, which is the adiabatic saturation temperature? The pressure remains constant at 100kPa. Determine the relative humidity and humidity ratio of the inlet mixture.	Understand	The learner to remember the definition of psychrometric properties of psychrometry and to illustrate, determine them.	CO 1,CO 11
MODULE-V				
POWER CYCLES				
PART - A(SHORT ANSWER QUESTIONS)				
1	Classify the assumptions to be made for the analysis of all air standard cycles?	Remember	---	CO 5,CO 3
2	List the Processes of Otto cycle and represent on P-V and T-S diagrams?	Remember	-----	CO 3,CO 11, CO 12
3	List the Processes in Constant pressure cycle and represent on P- V and T-S diagrams?	Remember	----	CO 3,CO 11
4	What are the variable factors used for comparison of cycles?	Remember	----	CO 3,CO 11
5	Outline the modified Otto cycle? How it differs from Otto cycle?	Remember	----	CO 3,CO 11
6	Write the expression for air standard efficiency of Diesel cycle?	Remember	----	CO 3,CO 11
7	Define mean effective pressure?	Remember	----	CO 3,CO 12
8	List functional parts of simple vapor compression system represent the processes on T-S diagram?	Remember	----	CO 3,CO 10, CO 12
9	Illustrate Bell-Coleman cycle with P-V and T-S diagrams while representing process and hence deduce its COP?	Understand	The learner to remember the processes of refrigerant cycles and illustrate on p-v and T-S diagrams.	CO 3,CO 10, CO 12

10	Discuss limited pressure cycle, represent the processes of it on P-V diagram?	Understand	The learner understands to Illustrate the working of various air standard cycles and work out the performance characteristics.	CO 3,CO 11
11	Compare Otto cycle with Diesel cycle?	Understand	The learner to remember processes of Otto and diesel cycle and compare them working mechanism with the performance characteristics.	CO 3,CO 11
12	Define the unit of refrigeration?	Remember	----	CO 3,CO 10
13	Define COP of refrigeration?	Remember	----	CO 3,CO 10
14	Show the PV diagram of Otto Cycle?	Understand	The learner to remember the Otto cycle process and illustrate on thermodynamic coordinates.	CO 3,CO 11
15	Illustrate Otto cycle on TS diagram.	Understand	The learner to remember the Otto cycle process and illustrate on thermodynamic coordinates.	CO 3,CO 11
16	Illustrate the PV diagram of diesel Cycle?	Understand	The learner to remember the Diesel cycle process and illustrate on thermodynamic coordinates	CO 3,CO 11
17	Illustrate the TS diagram of diesel Cycle?	Understand	The learner to remember the Diesel cycle process and illustrate on thermodynamic coordinates	CO 3,CO 11
18	Write the processes involved in Brayton cycle.	Remember	----	CO 3,CO 11
19	How do you test the performance of refrigeration cycle?	Remember	----	CO 3,CO 10
20	Show the PV and TS diagrams of dual combustion cycle?	Understand	The learner to remember the Dual cycle process and illustrate on thermodynamic coordinates	CO 3,CO 11
PART - B (LONG ANSWER QUESTIONS)				
1	Define compression ratio. What is the range for (a) SI engines (b) the CI engine? What factors limit the compression ratio in each type of engine?	Remember	---	CO 2,CO 12
2	What is an air standard cycle? What are the limitations of air standard cycle? State the assumptions to be taken for its analysis	Remember	----	CO 5,CO 11
3	Develop an expression for the air standard efficiency on a volume basis of an engine working on the Otto cycle. And represent the processes on p-V and T-S diagrams.	Apply	The learner to remember the processes of Otto cycle and understand the working to develop expression for efficiency.	CO 3,CO 11
4	What are the characteristic of air cycles? And what is the use of air standard cycle analysis	Remember	The learner explains the terms related to performance of power cycles and their significance in real world systems.	CO 3,CO 11
5	Define air standard efficiency of an Otto cycle and show that the efficiency of Otto cycle is lower than that of Carnot cycle.	Remember	----	CO 3,CO 11
6	Develop an expression for mean effective pressure of the Otto cycle?	Apply	The learner to remember the processes of Otto cycle and understand the working to develop expression for mean effective pressure.	CO 3,CO 11
7	Develop an expression for air standard efficiency of diesel cycle	Apply	The learner to remember the processes of diesel cycle and	CO 3,CO 11

			understand the working to develop expression for efficiency.	
8	Develop an expression for air standard efficiency of dual cycle	Apply	The learner to remember the processes of dual cycle and understand the working to develop expression for efficiency.	CO 3,CO 11
9	What is the difference between Otto and Diesel cycle? Show that the efficiency of Diesel cycle is always lower than the efficiency of the Otto cycle for the same compression ratio.	Remember	----	CO 3,CO 11
10	Show by graphs how the efficiency of Diesel cycle varies with compression ratio and cutoff ratio.	Apply	The learner to remember the processes of Diesel cycle and illustrate the working of diesel air standard cycles and work out the performance characteristics.	CO 3,CO 11
11	Explain the dual combustion cycle? Why the cycle is also called limited pressure cycle? Represent on p-V and T-S diagrams.	Apply	The learner to remember the processes of dual cycle and Illustrate the working of dual air standard cycles and work out the performance characteristics by representing on plots.	CO 3,CO 11
12	What are the processes involved in Otto cycle. Explain their standard efficiency of Otto cycle.	Apply	----	CO 3,CO 11
13	Compare the Otto and Diesel cycles for same constant maximum pressure and same heat input.	Understand	The learner to remember processes of Otto, diesel cycles and compare the working with performance characteristics by representing on plots.	CO 3,CO 11
14	Compare the thermal efficiency of Otto and dual and diesel cycles on the basis of same compression ratio and same heat input?	Apply	The learner to remember processes of Otto, diesel cycles and compare the working with performance characteristics by representing on plots..	CO 3,CO 11
15	In an Otto cycle, the pressure at the beginning of the compression is 1 bar and pressure at the end of compression is 15 bar. What the pressure ratio and the air standard efficiency of engine.	Understand	The learner to remember the processes of Otto cycle to determine the efficiency of engine.	CO 3,CO 11
16	Determine the air standard efficiency of the diesel engine having a cylinder with a bore of 250 mm and a stroke of 375mm and a clearance volume of 1500 cc. with fuel cutoff occurring at 5% of the stroke.	Apply	The learner to remember the processes of Otto cycle and understand the working to determine the efficiency of engine.	CO 3,CO 11
17	Describe the components of vapour compression system with the help of P-V and T-S diagram.	Understand	The learner to remember the processes of vapour compression system and illustrate the processes on thermodynamic coordinates.	CO 3,CO 10
18	Explain the following (i)Wet Compression (ii)Dry compression (iii)sub cooling (iv)superheating	Understand	The learner to remember the processes of vapour compression system and explain with different conditions of the refrigerant.	CO 3,CO 10
19	Derive cop of Bell-Coleman cycle with the help of processes representing on p-V and T-S diagram?	Understand	The learner to remember the processes of Bell- Coleman cycle and illustrate on thermodynamic coordinates.	CO 3,CO 10
20	Relate the expression for air standard efficiency of Brayton cycle with Otto cycle.	Understand	The learner to remember the processes of cycles and compare them with performance	CO 3,CO 11

			characteristics by representing on plots.	
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	An air refrigeration open system operating between 1 M Pa and 100 k Pa is required to produce a cooling effect of 2000 kJ/min. Temperature of the air leaving the cold chamber is – 5°C and at leaving the cooler is 30°C. Neglect losses and clearance in the compressor and expander. Determine : i. Mass of air circulated per min. ii. Compressor work, expander work, and cycle work iii. COP and power in kW required	Apply	The learner to remember the processes of air refrigerant system and understand working to determines the coefficient of performance of refrigeration systems	CO 3,CO 10, CO 12
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 11 bar. 210 kJ of heat is added at constant volume. Solve for the efficiency and mean effective pressure.	Apply	The learner to remember the processes of SI engine and understand working to determine its performance characteristics	CO 3,CO 11, CO 12
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 3 0 0 ? Assume the compression ratio is 15 and the working fluid is air.	Apply	The learner to remember the processes of CI engine and understand working to determine its performance characteristics	CO 3,CO 11
4	Find the Compression ratio, if efficiency of an Otto cycle is 60% and $\gamma = 1.5$? 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? Discuss.	Apply	The learner to remember the processes of CI engine and understand working to determine its performance characteristics to check the existence of system.	CO 3,CO 11
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. Solve the following Work done per kg of gas and efficiency of the cycle. Take Cp = 0.92 and Cv=0.7.	Apply	The learner to remember the processes of CI engine and understand working to determine its performance characteristics	CO 3,CO 11
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. Find the efficiency of the engine. Assume the engine working on Diesel cycle?	Apply	The learner to remember the processes of CI engine and understand working to determine its performance characteristics.	CO 3,CO 11
7	An engine of 250 mm 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 25 bars. Find the air standard efficiency	Apply	The learner to remember the processes of SI engine and understand working to determine its performance characteristics	CO 3,CO 11

	and the mean effective pressure of the cycle? Assume ideal conditions?			
8	28 tonnes 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?	Understand	The learner to remember the processes of refrigerant cycle and determine the performance characteristics.	CO 3,CO 10, CO 12
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. Find theoretical C.O.P of the system. Take ɣ of air is 1.4.	Understand	The learner to remember the working of Bell-Coleman refrigerant cycle and work out the performance characteristics.	CO 3,CO 10, CO 12
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.	Apply	The learner to remember the processes of dual cycle and understand working to determine its performance characteristics	CO 3,CO 11

Signature of Course coordinator **HOD, ME**