GYANMANJARI INSTITUTE OF TECHNOLOGY (GMIT)

MECHANICAL ENGINEERING DEPARTMENT

QUESTION BANK

SUBJECT CODE: **2131905** SUBJECT: **ENGINEERING THERMODYNAMICS**

Sr. No.	Detail	Year	Mark
	UNIT 1 BASIC CONCEPT		
1.	Differentiate between open system, closed system and an isolated system.	Dec-2015	3
2.	Define system, surrounding and boundary. Explain type of system with suitable example	Dec-2014	7
3.	Define Thermodynamic system. Also explain different thermodynamic systems with appropriate examples.	May-2012	7
4.	Define following terms: isolated system, control volume, property.	Oct-2012	3
5.	Recognize whether the system is open, closed or isolated. 1. A tube of bicycle filled with air 2. A jet engine in flight 3. water pump 4. car battery 5. An Electric geyser 6. Thermos flask	June-2010	3
6.	Differentiate between the followings; 1) Intensive properties and extensive properties, 2) Point function and path function , 3) Microscopic approach and macroscopic approach, 4) Pure substance and working substance.	Jan-2015	7
7.	Discuss macroscopic and microscopic point of view in thermodynamics	June-2013	4
8.	(1) Explain different types of systems with suitable examples. (2) Discuss the concept of thermodynamic equilibrium. (3) Distinguish between Intensive and extensive properties.	Dec-2012	7
9.	Explain microscopic and macroscopic point of view of thermodynamics and also discuss open, close and isolated system.	June-2014	7
10	Define property. What is meant by intensive and extensive property? State the differences between Microscopic approach and macroscopic approach.	June-2015 Dec-2010	7 3
11	Differentiate between Intensive and Extensive properties of system.	May-2012	3
12	Define following terms: state, path, process, isolated system, intensive property, quasi-static process, perfect gas.	Dec-2013	7
13	What is thermodynamics equilibrium ? Describe complete thermodynamics equilibrium	Dec-2014 Oct-2012	7 4
14	Explain the following terms: Point Function, Homogenous system, First law of thermodynamics, Quasi-static process, pure substance.	May-2015	7
15	What is difference between heat and work? Show that heat is a path function and not a property.	June-2014	7
16	Explain following terms: Flow work, critical point, triple point.	June-2010	3
17	Define following: pure substance, saturation states, triple point	Oct-2012	3
18	Explain concept of Quasi-static process with necessary figure.	May-2012	4
19	Define the followings. i) Thermodynamic equilibrium ii) Reversible and irreversible processes iii) One Pascal pressure and one bar pressure iv) Dithermal boundary of a thermodynamic system v) Point function and Path function	June-2011	7

Sr. No.	Detail	Year	Mark
	vi) Critical points of pure substance vii) Availability of system at given state		
20	Describe the phase change process of water using a T-V diagram.	June-2010	4
	UNIT:2 FIRST LAW OF THERMODYNAMICS		
1.	State the first law of thermodynamics, its applications and limitations.	Jan-2015	7
2.	State and write the 1st Law of thermodynamics for a thermodynamic process and explain the conventional meanings for positive ness and negative ness for heat and work interactions between thermodynamic system and its surroundings across the system boundary.	June-2011	7
3.	Prove that internal energy is a property of the system. Also explain perpetual motion machine of first kind.	June-2014	7
4.	Prove that 'Energy' is a point function of a system undergoing change of state.	May-2012	7
5.	Show that internal energy and enthalpy of an ideal gas are functions of temperature only.	Oct-2012	7
6.	Write steady flow energy equation in case of boiler, turbine and condenser.	Dec-2010 June-2013	3 4
7.	Write continuity equation. Derive the general steady flow energy equation. Making suitable assumptions reduce the same for turbine, nozzle and steam condenser.	Dec-2012	7
8.	Derive the general equation for steady flow process. Explain the physical significance of several terms of the equation.	may-2015	7
9.	Derive general steady flow energy equation.	June-2015	7
10	Distinguish between energy of non flow system and flow system. Deduce the steady flow energy equation for a reciprocatingcompressor.	Dec-2013	7
11	State the Steady Flow Energy Equation and explain how this equation can be applied for (i) Nozzle, (ii) Boiler, and (iii) Steam Turbine.	June-2015	7
12	Derive equation for a) filling of a tank and b) emptying of tank.	Jan-2015 May-2015	7 7
13	Explain the difference between isentropic process and adiabatic process.	June-2013	7
14	Steam at 6.87bar, 205°C enters in an insulated nozzle with a velocity of 50m/sec. It leaves at a pressure of 1.37bar and a velocity of 500m/sec. Determine the final enthalpy of the steam. Also clearly mentioned the applied assumptions. Use of steam table is permitted.	Jan-2015	7
15	The mass flow rate of steam into a steam turbine is 1.5 Kg/s and heat loss from the turbine is 8.5 KW. The steam is entering the turbine at the pressure of 2MPa, temperature 3500C, Velocity 50 m/s, elevation 6 m/s and is leaving the turbine at a pressure of 0.1 MPa, quality of 100%, velocity of 200 m/s, elevation of 3 m/s. Determine power output of turbine.	June-2015	7
16	A piston–cylinder device initially contains 0.5 m3 of nitrogen gas at 400 kPa and 27°C. An electric heater within the device is turned on and is allowed to pass a current of 2 A for 5 min from a 120-V source. Nitrogen expands at constant pressure, and a heat loss of 2800 J occurs during the process. Consider nitrogen gas as ideal gas and nitrogen has constant specific heats. Take characteristics gas constant for nitrogen is 0.297 kJ/kg.K. Take Cp = 1.039 kJ/kg·K for nitrogen at room temperature. Determine the final temperature of nitrogen.	May-2016	7

Sr. No.	Detail	Year	Mark
17	In steam power plant, steam pressure, temperature and velocity are 2 MPa, 4000 C and 50 m/s respectively at inlet of steam turbine. At exit of steam turbine, steam pressure, dryness fraction and velocity are 15 kPa, 0.9 and 180 m/s respectively. Elevation difference between inlet and exit of steam turbine is 4 m. The power output of an adiabatic steam turbine is 5 MW. (1) Compare the magnitudes of Δh, Δke, and Δpe. (2) Determine the work done per unit mass of the steam flowing through the turbine. (3) Calculate the mass flow rate of the steam.	Dec-2015	7
18	3 Kg of air at 1.5 bar pressure and 77 °C temperature at state is compressed polytropically to state 2 at pressure 7.5 bar, index of compression being 1.2.It is then cooled at constant temperature to its original state 1. Calculate the net work done and heat transferred.	May-2015	7
19	A vessel of 2 m3 volume contains hydrogen at atmospheric pressure and 27 °C temperature. An evacuating pump is connected to vessel and the evacuation process is continued till its pressure becomes 70 cm of Hg vacuum. Estimate the mass of hydrogen pumped out. Also determine the final pressure in the vessel if cooling is carried up to 10°C. Take atmospheric pressure as 76 cm of Hg and universal gas constant as 8.314 kJ/Kg K.	Dec-2013	7
20	In a gas turbine installation air is heated inside heat exchanger by 750 °C from ambient temperature of 27 °C. Hot air then enters into gas turbine with the velocity of 50 m/s and leaves at 600°C. Air leaving turbine enters a nozzle at 60 m/s velocity and leaves at temperature of 500°C. For unit mass flow rate of air determine the following assuming adiabatic expansion in turbine and nozzle, i. Heat transfer to air in heat exchanger ii. Power output from turbine iii. Velocity at exit of nozzle Take Cp for air as 1.005 kJ/Kg K	Dec-2013	7
21	A rigid and insulated tank of 1 m3 volume is divided by partition into two equal volume chambers having air at 0.5 M Pa, 27°C, and 1 M Pa, 500 K. Determine final pressures and temperature if partition is removed.	Dec-2013	7
22	calculate the final temperature, pressure, work done and heat transfer if the fluid is compressed reversibly from volume of 6 m^3 to $1m^3$ when the initial temperature and pressure of fluid as 20°C and 1 bar respectively. Assume the index of compression as 1 and 1.4 , cp=1.005 and cv=0.718 and R=0.287 Kj/kgk	Dec-2014	7
23	A container is divided into two compartments by a partition wall, the container is completely insulated so that there is no heat transfer. One portion contains gas at temperature 25C and pressure 5 bar while the other portion also has the same gas but at temperature 40C and pressure 10bar. Calculate the amount of work done, heat transfer and change in internal energy if the partition wall is removed from container	Dec-2014	7
24	(1) A turbine operating under steady flow conditions receives steam at a velocity of 50 m/s and elevation of 5 m and a specific enthalpy of 2700 KJ/kg. The steam leaves the turbine at a velocity of 83.3 m/s, an elevation of 1.5 m and a specific enthalpy of 2250 kJ/kg. Heat losses from the turbine to the surroundings amount to 1.41 kJ/hr. Determine the mass flow rate of steam required in kg/hr for output power of 360 kW. (2) A well-insulated rigid tank of 1 m3 is attached to a large line containing pressurized oxygen. A valve is opened allowing the oxygen to enter the tank. The state of oxygen in the line is 2 MPa and 300°C. The valve remains open till the oxygen inside the tank reaches pressure equilibrium with the oxygen in the line. Determine the temperature of oxygen inside the tank at the end of process. Initial pressure and temperature of oxygen in the tank is 1 bar and 300K. Take R = 0.259	Dec-2012	7

Sr. No.	Detail	Year	Mark
	kJ/kg K and γ = 1.395		
25	A cylinder contains 0.45 m3 of gas at 1 x 105 N/m2 and 80 °C. The gas is compressed to a volume of 0.13 m3. The final pressure being 5 x 105 N/m2. Assume γ=1.4 , R=294.2 J/Kg°C. Calculate mass of gas, index of compression n, increase in internal energy of gas, heat rejected by gas during compression.	Oct-2012	7
26	The mass flow rate of steam into a steam turbine is 1.5Kg/s and heat transfer from the turbine is 8.5KW. The steam is entering in the turbine at the pressure of 2 MPa, temperature 350 °C, velocity 50m/s, elevation 6m and is leaving the turbine at a pressure of 0.1 MPa, quality of 100% velocity of 200m/s, elevation of 3m. Determine the power output of turbine.	Oct-2012	7
27	An air compressor compresses atmospheric air at 0.1 MPa and 270 C by 10 times of inlet pressure. During compression the heat loss to surrounding is estimated to be 5% of compression work. Air enters in compressor with velocity of 40 m/s and leaves with 100 m/s. Inlet and exit cross-section areas are 100 cm2 and 20 cm2 respectively. Estimate the temperature of air at exit from compressor and power input to compressor.	May-2012	7
28	Write a steady flow energy equation for steam flowing through an inclined constant diameter pipe, where steam looses heat at a rate 'Q' kJ/kg . For driving a steam turbine, steam flows from boiler to steam turbine, through a horizontal steam pipe of constant diameter of 0.25m. The steam conditions at boiler and turbine entrance are as under: At boiler — At turbine entrance Pressure= 3.5 MPa — Pressure= 3.25 MPa Temperature=500˚C — Temperature=490˚C Total enthalpy=3450.9kJ/kg-K — Total enthalpy=3440.0kJ/kg-K Sp.volume= 0.11324m3/kg. — Sp.volume= 0.1204m3/kg. There occurs a heat loss of 9.0 kJ/kg from pipe line.	June-2011	7
29	The air compressor takes in air steadily at the rate of 0.6 kg/sec from the surroundings with pressure of 100.0kPa and density of 1.0526 kg/m3. The air entry velocity is 7.0 m/sec. The pressure ratio of air compressor is 7.0. The leaving air has density of 5.26315kg/m3 and leaves with velocity of 5.0 m/sec. The internal energy of the leaving air is 100.0kJ/kg more than that at entering. Cooling water in the compressor jackets absorbs heat from air at the rate of 65.0 KW. i) Compute the rate of shaft work to air ii) Find the ratio of inlet pipe diameter to outlet pipe diameter.	June-2011	7
30	Air at a temperature of 15°C passes through a heat exchanger at velocity of 30 m/s where temperature is raised to 800°C. It then enters a turbine with same velocity of 30m/s and expands until temperature falls to 650°C. On leaving the turbine the air is taken at velocity of 60m/s to a nozzle where it expands until the temperature has fallen to 500°C, If the air flow rate is 2kg/s, calculate (a) rate of heat transfer to air in the heat exchanger, (b) power output from turbine assuming no heat loss and (c) velocity at exit from the nozzle. Assuming no heat loss.	June-2010	7
31	In steam power plant 1 kg of water per second is supplied to the boiler. The enthalpy and velocity of water entering the boiler are 800 kj/kg and 5 m/s. the water receives 2200 kj/kg of heat in the boiler at constant pressure. The steam after passing through the turbine comes out with a velocity of 50 m/s, and its enthalpy is 2520 kj/kg. The inlet is 4 m above the turbine exit. Assuming the heat losses from the boiler and the turbine to the surroundings are 20 kj/sec. calculate the power developed by the turbine. Consider the boiler and turbine as single	June-2014	7

Sr. No.	Detail	Year	Mark
	system.		
	UNIT:3 SECOND LAW OF THERMODYNAMICS		
1.	Define 1. Heat engine 2. Heat pump 3. Heat source 4. Heat sink	Dec-2010	8
2.	Define following terms (1) Heat Engine (2) Thermal Energy Reservoir (3) Refrigerator	Dec-2015	3
3.	Write the limitation of first law of thermodynamics. Explain the second law of thermodynamics by Clausius statement and Kelvin-Plank statement.	Dec-2015	4
4.	State clausius statement. Explain equivalence of Kelvin and clausius statement.	Dec-2014	7
5.	Write down any two statements for the 2nd law of thermodynamics. Also state the Carnot theorem and its corollary.	June-2011	7
6.	State Kelvin-Plank Statement of Second Law of thermodynamics and show that violation of Kelvin-Plank statement leading to violation of Clausius statement.		
7.	Prove that violation of Kelvin-Plank statement leads to violation of Clausius statement.	Dec-2013	7
8.	Define following terms: Kelvin Plank statement, Third law of Thermodynamics, Thermodynamic temperature scale, Exergy	June-2010	7
9.	Show that the COP of heat pump is greater than the COP of refrigerator by unity.	June-2010 June-2013	7 7
10	State Carnot theorem and explain PMM-II	Dec-2014	7
11	Explain Clausius theorem.	Jan-2015 Oct-2012 Dec-2010	7 7 3
12	Prove that all reversible engines operating between operating between same temperatures limits have are equally efficient.	Jan-2015 Dec-2015 June-2013 May-2012	7 4 7 7
13	Explain third law of thermodynamics.	Dec-2010	7
14	What is irreversibility? State various types of irreversibilities and explain them.	June-2015	7
15	State various reasons for irreversibility in system. How does mechanical reversibility differ from thermodynamic reversibility?	Dec-2010	6
16	Explain the concept of temperature and differentiate between heat, temperature and internal energy.	May-2015	7
17	prove that “ no heat engine working in a cycle between two constant temperature reservoirs can be more efficient than a reversible engine working between the same two reservoirs”	Dec-2014	7
18	Prove the equivalency of Kelvin-Plank and Clausius statements.	June-2013 May-2012	7 7
19	Why the Carnot engines is the most efficient engine for a given source and sink temperature? Explain.	Dec-2011	7
20	A heat pump is used to heat the house in winter. A house requires 50 KJ/s heat for heating in winter which is delivered by heat pump from outside air. Work required to operate the heat pump is 8 KW. Calculate the Co-efficient of Performance of heat pump and heat abstracted from outside.	June-2015	7
21	300 kJ/s of heat is supplied at a constant fixed temperature of 290° C to a heat engine. The heat rejection takes place at 8.5° C. The following results were	Dec-2015	7

Sr. No.	Detail	Year	Mark
	obtained : (i) 215 kJ/s are rejected. (ii) 150 kJ/s are rejected. (iii) 75 kJ/s are rejected. Classify which of the result report a reversible cycle or irreversible cycle or impossible results.		
22	A Carnot engine getting heat at 800 K is used to drive a Carnot refrigerator maintaining 280 K temperature. Both engine and refrigerator reject heat at same temperature T when heat given to engine is equal to heat absorbed by refrigerator. Determine efficiency of engine and COP of refrigerator.	May-2015	7
23	A reversible heat engine operates between two reservoirs at 600°C and 40°C. The engine drives a reversible refrigerator which operates between the same 40°C reservoir and reservoir at -18°C. The heat transfer at heat engine is 2100 kJ and there is a net work output of 370 kJ from the combined plant. Evaluate the heat transfer to refrigerator and net heat transfer to 40 °C reservoir.	Dec-2013	7
24	An inventor claims that his engine has the following specifications: 1. Temperature limits 750°C and 25°C 2. Power developed 75kw 3. Fuel burned per hour 3.9 kg 4. Heating value of the fuel 74500kJ/kg State weather his claim is valid or not.	Dec-2014	7
25	A heat pump working on a reversed Carnot cycle takes in energy from a reservoir maintained at 3ºC and delivers it to another reservoir where temperature is 77ºC. The heat pump drives power for its operation from a reversible engine operating within the higher and lower temperature limits of 1077ºC and 77ºC. For 100 kJ/s of energy supplied to the reservoir at 77ºC, estimate the energy taken from the reservoir at 1077ºC.	June-2013	7
26	Two Carnot engine A & B are connected in series between two thermal reservoirs maintained at 2000K and 300K. Engine A receives 1680 kJ of heat from the high temperature reservoir and reject heat to the Carnot engine B. Engine B takes in heat rejected by A and rejects heat to the low temperature reservoir. If engines A & B have equal thermal efficiencies, determine (a) the heat rejected by engine B (b) the temperature at which heat is rejected by engine A, (c) work done by engine A & B. If engine A & B delivers equal work, determine (d) the amount of heat taken by engine B, and (e) efficiencies of engine A & B.	Dec-2012	7
27	Two Carnot engines work in series between the source and sink temperatures of 550K and 350K. If both engines develop equal power, derive the formulae to find out the intermediate temperature and determine the intermediate temperature also.	Jan-2015	7
28	A reversed carnot cycle operates at either a refrigerator or heat pump. In either case, the power input is 20.8 kW. Calculate the quantity of heat extracted from the cold body for either type of machine. In both case 3500 kJ/min heat is delivered by the machine. In case of the refrigerator the heat is transferred to the surroundings while in case of heat pump, the space is to be heated. What is their respective coefficient of performances? If the temperature of cold body is 0°C for the refrigerator and 5°C for heat pump what will be respective temperatures of surrounding for refrigerator and heated space for heat pump? What reduction in heat rejection temperatures would be achieved by doubling the COP for same cold body temperature?	June-2010	7
29	A Carnot engine receives 4000 KJ as heat addition at 3370c and rejects energy at triple point of water. Calculate (1) thermal efficiency (2) The net work output in KJ If the efficiency of an irreversible engine is 70 % of Carnot engine. Find the % change in heat rejected for the same input and fluid temperature	Dec-2011	7

Sr. No.	Detail	Year	Mark
	UNIT:4 ENTROPY		
1.	Prove that entropy is a property of system.	Jan-2015	3
2.	What the meaning of word "Entropy "?	Dec-2011	3
3.	With usual notations prove that ΦδQ/T <=0.	Jan-2015 June-2010	4 7
4.	Show that entropy of universe during mixing of flow fluid always increases.	June-2010	4
5.	Define entropy and show that it is a property of system	Dec-2010	5
6.	Define Clausius inequality and prove it.	May-2015 Dec-2012	7 4
7.	State the principle of increase of entropy. List the four application of entropy principle.	May-2016	3
8.	Explain principle of increase of entropy for an isolated system.	June-2015	7
9.	Explain Clausius inequality for reversible and irreversible cyclic processes.	May-2012	7
10	State and prove clausious theorem.	June-2014	7
11	5 kg of water at 0°C is exposed to reservoir at 98°C. Calculate the change of entropy of water, reservoir and universe. Assume that specific heat of water is 4.187 KJ/Kg-K.	June-2015	7
12	An iron cube at a temperature of 400° C is dropped into an insulated bath containing 10 kg water at 25° C. The water finally reaches a temperature of 50° C at steady state. Given that the specific heat of water is equal to 4186 J/kg K. Find the entropy changes for the iron cube and the water. Is the process reversible? If so why?	Dec-2015	7
13	1 kg of ice at 0° C is mixed with 12 kg of water at 27° C. Assuming the surrounding temperature as 15°C, calculate the net increase in entropy and unavailable energy when the system reaches common temperature : Given: Specific heat of water = 4.18 kJ/kg K; specific heat of ice = 2.1 kJ/kg K and enthalpy of fusion of ice (latent heat) = 333.5 kJ/kg.	Dec-2015 June-2014	7 7
14	2 kg of N2 at 1550C and 0.25 m3 is expanded to 0.40 m3 at constant pressure, and then expanded isothermally to volume of 0.6 m3. Assume that specific heat at constant volume is 0.750 kJ/kg.K and gas constant is 0.298 kJ/kg.K. Calculate the overall change of entropy of the process.	May-2016	7
15	A steam power plant operates between boiler temperature of 160°C and condenser temperature of 50°C. Water enters the boiler as saturated liquid and steam leaves the boiler as saturated vapour. Assuming the isentropic expansion in turbine. Enthalpy of water entering boiler = 687 kJ/kg. Enthalpy of steam leaving boiler = 2760 kJ/kg Condenser pressure = 0.124×10^5 N/m^2. Verify the Clausius inequality for the cycle.	May-2016	7
16	What do you mean by the term entropy? What are the characteristics of entropy? How the principle of entropy is used to determine whether the process path is reversible, irreversible or impossible.	June-2014	7
17	A reversible heat engine absorbs heat from two thermal reservoirs at constant temperatures of 800 k and 550 k, rejects heat to a reservoir at 300 k, calculate the thermal efficiency and heat supplied by each thermal reservoirs when the engine produces 80 kw and rejects 55 kj/sec to heat sink.	June-2014	7

Sr. No.	Detail	Year	Mark
18	Determine entropy change of universe if two copper blocks of 1 Kg and 0.5 kg at 150°C and 0°C are joined together. Specific heat for copper at 150°C and 0°C are 0.393kJ/Kg K and 0.381kJ/Kg K resply.	Dec-2013	7
19	Using second laws of thermodynamics check the following and also indicate nature of cycle. (i) Heat engine receiving 1000 kJ of heat from a reservoir at 500 K and rejecting 700 kJ heat to a sink at 27ºC. (ii) Heat engine receiving 1000 kJ of heat from a reservoir at 500 K and rejecting 600 kJ of heat to a sink at 27ºC.	June-2013	7
20	A cool body at temperature T1 is brought in contact with high temperature reservoir at temperature T2. Body comes in equilibrium with reservoir at constant pressure. Considering heat capacity of body as C, show that entropy change of universe can be given as; $C\left[\left(\frac{T_1-T_2}{T_2}\right)-\ln\frac{T_1}{T_2}\right]$	June-2013	7
21	(1) In a boiler, water evaporates at 200°C. The hot gases which transfer the heat to the boiler are cooled from 1000°C to 500°C. Determine the total entropy increase of combined system of gas and water and the increase in unavailable energy. T_0 = 30°C. Take c_{pg} = 1 kJ/kg K. (2) 2 kg of water at 97°C is mixed with 3 kg of water at 17°C in an isolated system. Calculate the change in entropy due to the mixing process.	Dec-2012	7
22	Air at 200 C and 1.05 bar occupies 0.025 m3. The air is heated at constant volume until the pressure is 4.5 bar, and then cooled at constant pressure back to original temperature. Calculate (i) The net heat flow from the air. (ii) The net entropy change. Also draw the processes on T-s diagram.	May-2012	7
23	A 50kg block of iron casting at 500K is thrown into a large lake which is at a temperature of 285K. After the iron block reaches thermal equilibrium with the lake determine i. Entropy change of iron block ii. Entropy change of lake water iii. Total change entropy change during this process, assume average specific heat of iron block as 0.45KJ/KgK	Oct-2012	7
24	A volume of 0.14 m3 of air at 1 bar and 90°C is compressed to 0.014m3 according to the law pv1.3= C . Heat is then added at constant volume the pressure is 66 bar. Determine (a) Heat exchange with cylinder walls during compression and (b) Change of entropy during each portion of the process. Assume γ=1.4 and R=286 J/Kg K	June-2010	7
	UNIT:5 ENERGY		
1.	Define the following terms: 1) Critical point temperature, 2) thermodynamic equilibrium , 3) Dead state of a given system,4) Availability, 5) Irreversibility, 6) enthalpy,7) entropy.	Jan-2015	7
2.	Define the following terms: i) Elements of irreversibility ii) Maximum work iii) Dead state of a given system iv) Availability v) Irreversibility vi) Second law of efficiency vii) Availability function.	June-2011	7
3.	Explain concept of available Energy, unavailable Energy and lost work.	Dec-2010 May-2015 Dec-2011	7 7 7
4.	Derive the expression for Availability in a closed system at a given state. Mention clearly the assumptions made.	June-2011	7
5.	Define following terms (1) Availability (2) Dead State (3) High Graded Energy	Dec-2015	3
6.	Explain the concept of decrease in available energy when heat is transferred through a finite temperature difference with the aid of T-S diagram	June-2015	7

Sr. No.	Detail	Year	Mark
7.	Explain the available energy referred to finite heat source.	Dec-2015	4
8.	Define available energy, unavailable energy, dead state, reversibility, irreversibility and effectiveness.	June-2014	7
9.	Identify the cause of irreversibility.	May-2016	4
10	Derive expressions for availability of steady flow open system.	June-2014	7
11	Derive equation for exergy of finite heat capacity source at temperature T. Also differentiate between available and unavailable energy	Dec-2012	7
12	Define "Availability". Also derive expression for availability in a non-flow system.	May-2012	7
13	What is the law of degradation of energy?	Dec-2011	7
14	What is dead state and why it is referred in the concept of availability?	Dec-2011	7
15	The same amount of heat loss at higher temperature is more harmful than that at a lower temperature discuss.	Dec-2011	4
16	In a steam turbine the steam enters at 50 bar, 600°C and 150 m/s and leaves as saturated vapour at 0.1 bar, 50 m/s. During the expansion work of 1000 kJ/kg is delivered. Determine the inlet steam availability, exit steam availability and irreversibility. Take dead state temperature as 15 °C.	Dec-2013	7
17	5 kg of air at 550 K and 4 bar is enclosed in a closed system. (i) Determine the availability of the system if the surrounding pressure and temperature are 1 bar and 290 K respectively. (ii) If the air is cooled at constant pressure to the atmospheric temperature, determine the availability and effectiveness.	May-2012 May-2016	7 7
18	10 Kg of water undergoes transformation from initial saturated vapour at 150 °C, velocity of 25 m/s and elevation of 10 m to saturated liquid at 20°C, velocity of 10m/s and elevation of 3m. determine the availability of for initial state, final state and change if availability considering environment to be taken at 0.1 MPa and 25°C and g=9.8 m/s^2	June-2010	7
19	Two Kg of air at 500 KPa, 80°C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of surrounding which is at 100 kPa, 5 °C . For this process, determine (a) maximum work, (b) Change in availability and irreversibility , for air take Cv =0.718 kJ/Kg K, R=0.287 kJ/Kg K	June-2010	7
	UNIT:6 VAPOR POWER CYCLE		
1.	Carnot cycle is not practical, Justify. State carnot theorem and perpetual motion machine of second kind.	June-2014 Dec-2011	7 4
2.	Explain Carnot cycle and derive necessary expression.	May-2015	7
3.	List various components of steam turbine power plant.	May-2016	3
4.	Give comparison of Carnot cycle and Rankine cycle for vapour.	May-2012	4
5.	Explain Carnot vapor cycle .State and explain required modifications with help of suitable diagrams to make the cycle feasible.	Jan-2015	7
6.	Explain Rankine cycle.	Dec-2010	7
7.	Sketch the Ideal Rankine cycle on p-V, T-s, and h-s diagram.	Dec-2015 May-2015 Oct-2012	4 7 7
8.	Draw ideal simple Rankine cycle with reheating on T-s and h-s diagram. Identify	May-2016	4

Sr. No.	Detail	Year	Mark
	the reheating process and locate the increase in work done due to reheating in both graph.		
9.	Enlist the various components used in Rankine cycle based power plant.	Dec-2015	3
10	With suitable T-S diagram explain methods of improving efficiency of Rankine cycle.	June-2010	4
11	Discuss the effect of pressure of steam at inlet to turbine, temperature at inlet to turbine and pressure at exit from turbine upon Rankine cycle performance.	Dec-2013	7
12	State the various method of improving efficiency of Ideal Rankine cycle.	Dec-2015	3
13	State various methods to improve efficiency of Rankine cycle. With suitable diagrams, explain any two of them.	Jan-2015	7
14	With help of T-s diagram, explain the effects of variables on efficiency of the Rankine cycle.	Jan-2015	7
15	Draw Rankine cycle on P-v, T-s and h-s diagrams and derive an expression for its thermal efficiency with and without pump work.	June-2015	7
16	Sketch the ideal Rankine cycle on p-V, T-s and h-s diagram for dry saturated steam inlet into steam turbine.	May-2016	4
17	Prove following statements: i. Temperature of wet steam equals that of dry and saturated steam at same pressure ii. Dryness fraction of steam does not go below zero or above unity.	Oct-2012	4
18	In a Rankine cycle, the steam at inlet to the turbine is saturated at pressure of 35bar and exhaust pressure is 0.2bar. Determine: 1) the pump work, 2) the turbine work, 3) the Rankine efficiency, 4) the quality of steam at the end of expansion. Assume flow rate of 9.5kg/sec. **Use of steam table is permitted.**	Jan-2015	7
19	Dry and saturated steam at pressure of 10.5 bar is supplied to a turbine and expanded isentropically to a pressure 0.075 bar. Calculate Thermal efficiency of Rankine cycle.	June-2015	7
20	Consider a steam power plant operating on the ideal Rankine cycle. Steam enters the turbine at 3 MPa and 350° C and is condensed in the condenser at a pressure of 10 kPa. Determine (1) the thermal efficiency of this power plant, (2) the thermal efficiency if steam is superheated to 600° C instead of 350° C	Dec-2015	7
21	Steam at 50 bar, 400°c expands in a rankine cycle to 0.34 bar. For a mass flow rate of 150 kg/sec of steam, determine (1) Power developed (2) Thermal efficiency and (3) Specific steam consumption.	June-2014	7
22	Steam enters an adiabatic turbine steadily at 3 MPa and 400°C and leaves at 50 kPa and 100°C. If the power output of the turbine is 2 MW. Determine (a) the isentropic efficiency of the turbine and (b) the mass flow rate of the steam flowing through the turbine. Neglect the change in potential and kinetic energies.	May-2016	7
23	Dry saturated steam at 10 bar is supplied to a prime mover and exhaust takes at 0.2 bar. Determine the Rankine efficiency, efficiency ratio, specific steam consumption if thermal efficiency is 20%, also determine percentage change in Rankine efficiency if steam is initially 90% dry.	Dec-2013	7
24	What do you understand by ideal regenerative cycle? Why is it not possible in practice? Also give actual regenerative cycle.	June-2013	7
25	A steam power plant uses steam as working fluid and operates at a boiler pressure of 5 MPa, dry saturated and a condenser pressure of 5 kPa. Determine the cycle efficiency for (i) Carnot cycle (ii) Rankine cycle. Also show the T-s representation for both the cycles.	June-2013	7

Sr. No.	Detail	Year	Mark
26	(1) Explain the effect of boiler pressure on performance of Rankine cycle. (2) In a simple Rankine cycle condition of steam at inlet to turbine is 100 bar and 550 °C. If dryness fraction at exit to turbine is to be restricted to 0.9 calculate the ideal cycle efficiency and steam rate.	Dec-2012	7
27	Steam at 20 bar, 360 °C is expanded in a steam turbine at 0.08 bar. It then enters a condenser where it is condensed to saturated liquid water then pump feeds water back the water into boiler, calculate net work per Kg of steam and cycle efficiency.	Oct-2012	7
28	In a steam power cycle, the dry and saturated steam is supplied at 15 bar. If the condenser pressure is 0.4 bar, calculate the Carnot and Rankine cycle efficiencies neglecting the pump work.	May-2012	7
29	Write down the expressions for working out the total enthalpy and total entropy of superheated steam as well as for wet steam with dryness fraction 'x'. Determine the total enthalpy and total entropy for following qualities of steam. i) per kg of super heated steam at pressure 20 bar and 350˚C ii) per kg of wet steam at pressure 0.075bar with dryness fraction of 0.85. From steam table : i) At 20 bar saturation enthalpy=2574.8kJ/kg , saturation entropy=6.3408 kJ/kg-K , saturation temperature =212.42˚C and Cp for super heated steam=2.453 kJ/kg-K. ii) At 0.075 bar, saturation enthalpy=2574.8kJ/kg, saturation entropy=8.2514 kJ/kg-K, saturation temperature =40.29˚C ,hfg=2406.0 kJ/kg-K and ,hf=168.77.kJ/kg-K , sfg=7.6751 kJ/kg-K and ,sf=0.5763kJ/kg-K and Sp. Volume of saturated water is 0.001005m3/kg.	June-2011	7
30	Steam at 20 bar, 350˚C is expanded in a steam turbine to 0.075 bar. It then enters a condenser, where it is condensed to liquid water. The pump feeds back the water into boiler. i) Assuming ideal processes, find per kg of steam the net work and ii) The cycle efficiency. The above data for super heated and wet steams can be made use of if desired.	June-2011	7
31	A steam turbine of a power plant operating on ideal rankine cycle receives steam at 20 bar, 3000 c at the rate of 3 Kg/s and it exhausts at 0.1 bar. Determine the following (1) Net power output (2) Rankine cycle efficiency	Dec-2011	7
32	In a steam power cycle, the steam supply is at 15 bar and dry and saturated. The condenser pressure is 0.4 bar. Calculate the Carnot and Rankine efficiencies of the cycle. Neglect pumps work.	May2016	7
33	A carnot cycle works on steam between the pressure limits of 7 MPa and 7KPa. Determine the thermal efficiency, turbine work and compression work per kg of steam.	June-2010	7
34	A Carnot cycle has lowest pressure and temperature equal to 1bar & 200 C. pressure after Isothermal compression is 4 bar. Pressure after isentropic compression is 12 bar and after Isothermal heat addition process is 6 bar. Calculate. 1. The highest temp. in the cycle. 2. The change in entropy during Isothermal explain. 3. Heat added to the cycle. 4. Heat reflected by the cycle.	Dec-2010	7
	UNIT:7 GAS POWER CYCLES		
1.	Derive an expression for Otto cycle efficiency with usual notation.	Dec-2010	7
2.	What are the air standard assumptions?	Dec-2015	4
3.	Derive an expression for Otto cycle efficiency with usual notation.	Dec-2013	7

Sr. No.	Detail	Year	Mark
4.	Explain briefly Otto cycle with help of p-v and T-s diagram and derive an expression for ideal efficiency of Otto cycle.	Dec-2013 June-2010 June-2011	7 7 7
5.	With usual notations derive an expression for air standard efficiency of Otto cycle.	May-2015	7
6.	Derive expression for air standard efficiency of diesel cycle.	June-2014	7
7.	Draw the Diesel cycle on p-v and T-s diagram. Also derive expression for air standard efficiency with usual notations for the cycle.	June-2013 May-2012	7 7
8.	State the thermodynamic process of open cycle gas turbine power plant	May-2016	3
9.	State various methods to improve efficiency of Brayton cycle. With suitable diagrams, explain any two of them.	Jan-2015	7
10	Compare Otto, Diesel and Dual cycle for i) Same compression ratio and heat supplied ii) Same Max. Pressure and temperature.	June-2015 Dec-2015 June-2014 May-2016	7 4 7 4
11	compare otto diesel and dual cycle for (1)efficiency versus compression ratio, (2)same compression ration and same heat supplied	Dec-2014	7
12	Compare Otto, diesel and dual cycles on basis of 1. Equal compression ratio and heat input. 2. Constant maximum pressure and heat input. 3. Constant maximum pressure and output. 4. Constant maximum pressure and temperature**.**	May-2015	7
13	How actual Brayton cycle differes from the theoretical cycle? Explain with the help of T-S diagram.	June-2015	7
14	Draw line diagram of Brayton cycle represent on p-v diagram and derive expression for efficiency of Brayton cycle.	Oct-2012	7
15	Enlist the various components used in intercooling and reheating gas cycle based power plant.	Dec-2015	3
16	In an I C Engine working with the Otto cycle, the cylinder diameter is 250mm and a stroke is 375mm. If the clearance volume is 0.00263 m^3, and the initial pressure and temperature are 1bar and 500C, calculate the air standard efficiency and mean effective pressure of the cycle. The maximum cycle pressure is limited to 25bar.	Jan-2015	7
17	In an Otto cycle air at start of isentropic compression is at 20˚C and 110kPa. If clearance volume is 20% of the swept volume and temperature at end of constant volume heat addition is 1400˚C, find the air standard efficiency and mean effective pressure in kPa. Take Cp/Cv=1.4.	June-2011	7
18	What is the difference between Otto cycle and diesel cycle? Explain why the higher efficiency of the Otto cycle compared to diesel cycle for the same compression ratio is not a result of practical importance.	Dec-2011	7
19	An air standard Otto cycle is required to operate between the temperature limits of 300k and 1800k. Estimate the optimum compression ratio and the corresponding thermal efficiency.	Dec-2011	7
20	In an Otto cycle the temperature at the beginning and end of the isentropic compression are 316K and 596K respectively. Determine the air standard efficiency and compression ratio.	June-2010	3
21	An air standard Otto cycle has a compression ratio of 8. At the start of the compression process, the temperature is 26o C and the pressure is 1bar. If the max. temperature of the cycle is 1080o C calculate, (a) The heat supplied per kg of air. (b) The thermal efficiency of the cycle.	Dec-2010	7
22	Show that for the max. work to be done per kg of air in Otto cycle between upper	Dec-2010	7

Sr. No.	Detail	Year	Mark
	and lower limits of absolute temperature T3 and T1 respectively, the ratio of compression should have the value $(T_3/T_1)^{1.25}$ When $\gamma = 1.4$		
23	An engine working on Diesel cycle has cylinder bore of 190 mm and piston stroke of 230 mm. The clearance volume is 290 cm3. The fuel injection takes place at constant pressure for 6% of the stroke. Determine the air standard cycle efficiency.	June-2015	7
24	What is regeneration in gas turbine plant? How it improves thermal efficiency of simple open cycle Gas Turbine Plant. Explain it with the help of schematic diagram and T-S Diagram of the cycle.	June-2015	7
25	In a gas turbine plant, operating on the Brayton cycle, the air compressor compresses the surrounding air to a pressure ratio of 6.0.The maximum temperature at inlet to the compressor is at 0.1MPa, 30˚C, the pressure ratio is 6.0. The maximum temperature of the cycle is maintained at 1000˚C..Surrounding air is at 0.1 MPa and 30 ˚C. Find (i) the turbine work and compressor work (ii) the plant efficiency. Assume compression and expansion are friction less adiabatic ,for air γ= 1.4 and C_p = 1.005 kJ/kg.	June-2011	7
26	An air-standard diesel cycle has a compression ratio of 20, and the heat transferred to the working fluid per cycle is 1800 kJ/kg. At the beginning of the compression process, the pressure is 0.1 MPa and the temperature is 15^0 C. Consider ideal gas and constant specific heat model. Determine (1) The pressure and temperature at each point in the cycle. (2) The thermal efficiency. (3) The mean effective pressure.	dec-2015	7
27	Find the required air-fuel ratio in a gas turbine whose turbine and compressor efficiencies are 85% and 80%, respectively. Maximum cycle temperature is 875° C. The working fluid can be taken as air (cp = 1.0 kJ/kg K, γ = 1.4) which enters the compressor at 1 bar and 27°C. The pressure ratio is 4. The fuel used has calorific value of 42000 kJ/kg. There is a loss of 10% of calorific value in the combustion chamber.	Dec-2015	7
28	In an air standard Diesel cycle the compression ratio is 14 and the beginning of isentropic compression is at 110kPa and 30˚C. If the fuel cut off takes place at 5% of stroke, find the air standard efficiency and mean effective pressure. Take γ =1.4, Cv=0.718kJ/kg-K and R=0.287 kJ/kg-K.	June-2011	7
29	The pressure limits in an Otto air cycle are 100 k N /m2 and 2000 k N/ m2 resply. The compression ratio is 4. Calculate the thermal efficiency and mean effective pressure assume γ=1.4 for air.	May-2015	7
30	The minimum pressure and temperature in an otto cycle are 100 kpa and 270c. The amount of heat added to the air per cycle is 1500 kj/kg. Determine the pressures and temperatures at all points of the air standard otto cycle if compression ratio is 8. Also calculate the specific work and thermal efficiency of the cycle. Assume Cv=0.72 kj/kg k and γ= 1.4.	June-2014	7
31	An ideal diesel engine has a diameter 150 mm and stroke 200 mm. The clearance volume is 10% of the swept volume. Determine the compression ratio and air standard efficiency of the engine if cut off takes place at 6% of the stroke.	Dec-2013	7
32	The compression ratio of air-standard Dual cycle is 12 and the maximum pressure in the cycle is limited to 70 bar. The pressure and temperature of cycle at the beginning of compression process are 1 bar and 27°C. Heat is added during constant pressure process up to 3% of the stroke. Assume diameter as 25 cm and stroke as 30 cm determine (1) pressure and temperature at each point in the cycle (2) Thermal efficiency (3) The mean effective pressure.	Dec-2012	7
33	In a Diesel cycle, air at 0.1 MPa and 300K is compressed adiabatically until the	Oct-2012	7

Sr. No.	Detail	Year	Mark
	pressure rises to 5 MPa. If 700KJ/Kg of energy in form of heat is supplied at constant pressure, determine compression ratio, cut off ration, thermal efficiency and mean effective pressure.		
34	In an ideal Brayton cycle, the ambient air at 1 bar - 300 K is compressed to 6 bar and the maximum cycle temperature is limited to 1200 K. if the heat supply is 120 MW, find (i) The thermal efficiency of the cycle (ii) work ratio (iii) power output and (iv) mass flow rate of air. Also show the cycle on p-v and T-s diagram.	May-2012	7
35	In an air standard diesel cycle the compression ratio is 16.At the beginning of isentropic compression the temperatureis 15°c and pressure is 0.1 MPa. Heat is added until thetemperature at the end of constant pressure process is 1480°c Calculate (1) cut off ratio.(2) cycle efficiency(3) M. E. P.Take, γ = 1.4, R = 287 NM/Kg K, Cv = 0.718 KJ/Kg K, CP =1.005 KJ/Kg KAssume Mass of air = 1 Kg	Dec-2011	7
36	A diesel engine takes in air at pressure 1 bar and temperature 300C. The pressure at the end of the compression is 30 bar and the cut off is 6% of the stroke. Calculate (i) The compression ratio (ii) The percentage clearance (iii)The heat supplied in kJ/kg (iv) The heat rejected in kJ/kg (v) Mean effective pressure inbar	May-2016	7
37	An engine uses 6.5 Kg of oil per hour of calorific value of 30,000 kJ/Kg. If the Brake power of engine is 22 kW and mechanical efficiency is 85% calculate (a) indicate thermal efficiency (b) Brake thermal efficiency (c)Specific fuel consumption in Kg/B.P/hr.	June-2010	7
38	A closed cycle ideal gas turbine plant operates between temperature limits of 800°C and 30°C and produces a power of 100 kW. The plant is designed such that there is no need for a regenerator. A fuel of calorific 45000 kJ/kg is used. Calculate the mass flow rate of air through the plant and rate of fuel consumption. Assume cp = 1 kJ/kg K and γ = 1.4.	May-2016	7
	UNIT:8 PROPERTIES OF GASES AND GAS MIXTURE		
1.	Explain the following terms: Avogadro’s law, Equation of state, law of corresponding states.	May-2015	7
2.	Discuss deviation of real gas from ideal gas.	May-2016	3
3.	State the Boyle’s law, Charle’s and Avogadro’s law for perfect gas.	Dec-2015	3
4.	What is the Vander waal’s equation of state? State its importance and derive it	June-2015	7
5.	Derive Vander waal’s equation.	Jan-2015 Dec-2015 June-2013	7 4 7
6.	Write down Vanderwall’s equation of state. How does it differ from ideal gas equation?	June-2010	4
7.	From the Vander Waal’s equation derive the following equation for law of corresponding states. $(Pr + 3/Vr2\ )(3Vr - 1) = 8Tr$	Dec-2012 June-2011	7 7
8.	Define the following: Avogadro’s law, equation of state, law of corresponding states, Gibbs-Dalton law,	Dec-203	7
9.	State and explain Dalton’s law of partial pressure and Avogadro’s law.	Jan-2015 June-2010	7 3
10	State the statements of Dalton’s Law and Gibbs-Dalton Law. Explain in detail Dalton’s law of partial pressures.	June-2015 June-2014 Oct-2012	7 7 7
11	Explain briefly Dalton’s law, Gibbs-Dalton law and Amagat’s law for perfect gas mixture.	Dec-2015	7

Sr. No.	Detail	Year	Mark
12	Explain briefly Dalton's law and Gibbs-Dalton law applied to mixture of perfectgases.	June-2013	7
13	Draw the generalized compressibility chart.	May-2016	3
14	State Dalton's law of partial pressure. How is partial pressure of in a gas mixture related to the mole fraction? How are the characteristic gas constant, molecular weight and specific heats of a gas mixture computed?	Dec-2012	7
15	A mixture of hydrogen and oxygen is to be made so that the ratio of H2 and O2 is 3:1 by volume. If the pressure and temperature are 1 bar and 300 C respectively. Calculate (i) the mass of O2 required (ii) the volume of the container.	May-2012	5
16	A vessel of volume 0.4 m3 consists of 0.45 Kg of carbon monoxide and 1 kg of air at 15°C. Calculate the partial pressure of each constituents and total pressure in the vessel. The partial pressure of each constituent and total pressure in the vessel. The air contains 23.3% oxygen and 76.6% nitrogen by mass. Take the molar mass of carbon monoxide, oxygen and nitrogen as 28, 32 and 28Kg/ K mole, respectively.	June-2010	7