SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur– 603203

DEPARTMENTOF MECHANICAL ENGINEERING

QUESTION BANK

IV SEMESTER

AG3432 -THERMODYNAMICS FOR AGRICULTURE ENGINEERING

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UNIT-I FIRST LAW OF THERMODYNAMICS

Internal energy – Law of conservation of energy – First law of thermodynamics – Energy - Application of first law of thermodynamics to a non-flow or closed system – Application of first law to steady flow process – Engineering applications of steady flow energy equation (S.F.E.E.).

PART A (2 Marks)

1	Define 'internal energy' and its property of a system.	BT1	Remembering
2.	Differentiate between point function and path function.	BT1	Remembering
3	What is meant by control volume and control surface?	BT2	Understanding
4	What is microscopic approach in thermodynamics?	BT2	Understanding
5	What is perpetual motion machine of first kind [PMM1]?	BT1	Remembering
6	Give the limitations of first law of thermodynamics.	BT1	Remembering
7	Compare intensive and extensive properties.	BT1	Remembering
8	Differentiate quasi static and non quasi static process.	BT2	Understanding
9	Define the term State and Process.	BT1	Remembering
10	Illustrate the reversible and irreversible process.	BT1	Remembering
11	Define an isolated system, there is no change in internal energy.	BT2	Understanding
12	Show any four reasons for irreversibility in a process.	BT1	Remembering
13	Interpret the conditions of steady flow process.	BT1	Remembering
14	Summarize thermodynamic equilibrium.	BT2	Understanding
15	What is a steady flow process?	BT1	Remembering
16	Give the differential form of the S.F.E.E.	BT1	Remembering
17	Write the general energy equation for a variable flow process.	BT2	Understanding
18	Define enthalpy.	BT1	Remembering
19	Define the specific heats at constant volume and at constant pressure.	BT1	Remembering
20	Why should specific heat nor be defined in terms of heat transfer?	BT2	Understanding
21	What is the difference between heat and internal energy?	BT2	Understanding
22	Which is the property introduce by the first law?	BT1	Remembering

23	State the first law for a closed system undergoing a cycle.	BT2	Understanding
24	Shown that energy is a property of a system.	BT2	Understanding
25	What are the modes in which energy is stored in a system?	BT1	Remembering

PART B (16 MARKS)			
1	In a gas turbine unit, the gases flow through the turbine is 15 kg/s and the power developed by the turbine is 12000 kW. The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively, and the velocity of gases at the inlet and outlet are 50 m/s and 110 m/s respectively. Calculate : (i) The rate at which heat is rejected to the turbine, and (ii) The area of the inlet pipe given that the specific volume of the gases at the inlet is 0.45 m^3/kg.	BT5	Evaluating
2	In an air compressor air flows steadily at the rate of 0.5 kg/s through an air compressor. It enters the compressor at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg and leaves at 5 m/s with a pressure of 7 bar and a specific volume of 0.16 m^3/kg. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at the rate of 60 kJ/s. Calculate : (i) The power required to drive the compressor ; (ii) The inlet and output pipe cross-sectional areas.	BT5	Evaluating
3	10 kg of fluid per minute goes through a reversible steady flow process. The properties of fluid at the inlet are : p_1 = 1.5 bar, ρ_1 = 26 kg/m^3, C_1 = 110 m/s and u_1 = 910 kJ/kg and at the exit are p_2 = 5.5 bar, ρ_2 = 5.5 kg/m^3, C_2 = 190 m/s and u_2 = 710 kJ/kg. During the passage, the fluid rejects 55 kJ/s and rises through 55 metres. Determine : (i) The change in enthalpy (Δ h) ; (ii) Work done during the process (W).	BT5	Evaluating
4	In an air motor cylinder the compressed air has an internal energy of 450 kJ/kg at the beginning of the expansion and an internal energy of 220 kJ/kg after expansion. If the work done by the air during the expansion is 120 kJ/kg, calculate the heat flow to and from the cylinder.	BT5	Evaluating
5	0.3 kg of nitrogen gas at 100 kPa and 40°C is contained in a cylinder. The piston is moved compressing nitrogen until the pressure becomes 1 MPa and temperature becomes 160°C. The work done during the process is 30 kJ. Calculate the heat transferred from the nitrogen to the	BT5	Evaluating

	surroundings. cv for nitrogen = 0.75 kJ/kg K.		
6	Steam at a 6.87 bar, 205°C, enters in an insulated nozzle with a velocity of 50 m/s. It leaves at a pressure of 1.37 bar and a velocity of 500 m/s. Determine the final enthalpy of steam.	BT5	Evaluating
7	A cylinder containing the air comprises the system. Cycle is completed as follows : (i) 82000 N-m of work is done by the piston on the air during compression stroke and 45 kJ of heat are rejected to the surroundings. (ii) During expansion stroke 100000 N-m of work is done by the air on the piston. Calculate the quantity of heat added to the system.	BT5	Evaluating
8	Air enters a compressor at 10^5 Pa and 25°C having volume of 1.8 m^3/kg and is compressed to 5 × 10^5 Pa isothermally. Determine : (i) Work done ; (ii) Change in internal energy ; and (iii) Heat transferred	BT3	Applying
9	A tank containing air is stirred by a paddle wheel. The work input to the paddle wheel is 9000 kJ and the heat transferred to the surroundings from the tank is 3000 kJ. Determine : (i) Work done ; (ii) Change in internal energy of the system.	BT3	Applying
10	12 kg of air per minute is delivered by a centrifugal air compressor. The inlet and outlet conditions of air are C_1 = 12 m/s, p_1 = 1 bar, v_1 = 0.5 m^3/kg and C_2 = 90 m/s, p_2 = 8 bar, v_2 = 0.14 m^3/kg. The increase in enthalpy of air passing through the compressor is 150 kJ/kg and heat loss to the surroundings is 700 kJ/min. Find : (i) Motor power required to drive the compressor ; (ii) Ratio of inlet to outlet pipe diameter. Assume that inlet and discharge lines are at the same level.	BT3	Applying
11	The power developed by a turbine in a certain steam plant is 1200 kW. The heat supplied to the steam in the boiler is 3360 kJ/kg, the heat rejected by the system to cooling water in the condenser is 2520 kJ/kg and the feed pump work required to pump the condensate back into the boiler is 6 kW. Calculate the steam flow round the cycle in kg/s.	BT3	Applying
12	closed system of constant volume experiences a temperature rise of 25°C when a certain process occurs. The heat transferred in the process is 30 kJ. The specific heat at constant volume for the pure substance comprising the system is 1.2 kJ/kg°C, and the system contains 2.5 kg of this substance. Determine : (i) The change in internal energy ; (ii) The work done.	BT5	Evaluating

13	90 kJ of heat are supplied to a system at a constant volume. The system rejects 95 kJ of heat at constant pressure and 18 kJ of work is done on it. The system is brought to original state by adiabatic process. Determine : (i) The adiabatic work ; (ii) The values of internal energy at all end states if initial value is 105 kJ	BT4	Analyzing
14	0.2 m3 of air at 4 bar and 130°C is contained in a system. A reversible adiabatic expansion takes place till the pressure falls to 1.02 bar. The gas is then heated at constant pressure till enthalpy increases by 72.5 kJ. Calculate: (i) The work done; (ii) The index of expansion, if the above processes are replaced by a single reversible polytropic process giving the same work between the same initial and final states. Take cp = 1 kJ/kg K, cv = 0.714 kJ/kg K	BT5	Evaluating
15	A 15 cm diameter vertical cylinder, closed by a piston contains a combustible mixture at a temperature of 30°C. The piston is free to move and its weight is such that the mixture pressure is 3 bar. Upper surface of the piston is exposed to the atmosphere. The mixture is ignited. As the reaction proceeds, the piston moves slowly upwards and heat transfer to the surroundings takes place. When the reaction is complete and the contents have been reduced to the initial temperature of 30°C, it is found that the piston has moved upwards a distance of 8.5 cm and the magnitude of heat transfer is 4 kJ. Evaluate: (i) The work; (ii) Decrease in internal energy of the system.	BT3	Applying
16	A cylinder contains 0.45 m^3 of a gas at 1×10^5 N/m^2 and 80°C. The gas is compressed to a volume of 0.13 m3, the final pressure being 5×10^5 N/m^2. Determine: (i) The mass of gas; (ii) The value of index 'n' for compression; (iii) The increase in internal energy of the gas; (iv) The heat received or rejected by the gas during compression. Take $\gamma = 1.4$, R = 294.2 J/kg°C.	BT3	Applying
17	Air at 1.02 bar, 22°C, initially occupying a cylinder volume of 0.015 m^3, is compressed reversibly and adiabatically by a piston to a pressure of 6.8 bar. Calculate : (i) The final temperature ; (ii) The final volume ; (iii) The work done	BT4	Analyzing
18	0.1 m^3 of an ideal gas at 300 K and 1 bar is compressed adiabatically to 8 bar. It is then cooled at constant volume and further expanded	BT4	Analyzing

	isothermally so as to reach the condition from where it started. Calculate : (i) Pressure at the end of constant volume cooling. (ii) Change in internal energy during constant volume process. (iii) Net work done and heat transferred during the cycle. Assume cp = 14.3 kJ/kg K and cv = 10.2 kJ/kg K.		

UNIT-II BASIC STEAM POWER CYCLES

Carnot cycle – Rankine cycle – Modified Rankine cycle – Regenerative cycle – Reheat cycle.

PART A (2 Marks)

1	Name the different components in steam power plant working on Rankine cycle.	BT1	Remembering
2	Why is excessive moisture in steam undesirable in steam turbines?	BT1	Remembering
3	Draw the standard Rankine cycle on P-V and T-S coordinates	BT2	Understanding
4	Classify the effects of condenser pressure on the Rankine Cycle.	BT1	Remembering
5	Show Carnot cycle cannot be realized in practice for vapour power cycles.	BT2	Understanding
6	State the advantages of regenerative cycle.	BT2	Understanding
7	Describe the different operations of Rankine cycle.	BT2	Understanding
8	Outline the various operation of a Carnot cycle.	BT1	Remembering
9	Define saturation pressure and saturation temperature.	BT2	Understanding
10	What do you understand by triple point and critical point?	BT1	Remembering
11	Outline the p-T diagram? What is its use?	BT2	Understanding
12	What do you mean by the entropy of superheated steam	BT2	Understanding
13	What do you understand by the degree of superheat and the degree of sub cooling?	BT2	Understanding
14	What do you understand by steam rate and heat rate? What are their units?	BT2	Understanding
15	Why is carnot cycle not practicable for a steam power plant?	BT1	Remembering
16	When is reheating of steam recommended in a steam power plant?	BT2	Understanding
17	How does the reheat pressure get optimized?	BT1	Remembering
18	Why is one open feed water heaters used in a steam plan?	BT2	Understanding
19	What is open and closed heaters?	BT1	Remembering
20	State the methods of increasing the thermal efficiency of a Rankine cycle.	BT1	Remembering
21	State the advantages of regenerative cycle/simple Rankine cycle.	BT2	Understanding
22	Define internal work.	BT1	Remembering
23	Define internal efficiency.	BT2	Understanding
24	What is the effect of regeneration on the specific output?	BT1	Remembering
25	What is the effect of regeneration on mean temperature of heat addition?	BT2	Understanding

PART B (16 MARKS)			
1	Explain the various operation of a Carnot cycle. Also represent it on a T-s and p-V diagrams.	BT1	Remembering
2	Explain with the help of neat diagram a 'Regenerative Cycle'.	BT1	Remembering
3	Explain with a neat diagram the working of a Rankine cycle.	BT1	Remembering
4	Explain with a neat diagram the working of a Reheat-Rankine cycle.	BT1	Remembering
5	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 pump work.	BT3	Applying
6	A Rankine cycle operates between pressures of 80 bar and 0.1 bar. The maximum cycle temperature is 600°C. If the steam turbine and condensate pump efficiencies are 0.9 and 0.8 respectively, Analyze the specific work and thermal efficiency.	BT5	Evaluating
7	A simple Rankine cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Calculate the cycle efficiency, work ratio and specific steam consumption.	BT4	Analyzing
8	A steam power plant operates on a theoretical reheat cycle. Steam at boiler at 150 bar, 550°C expands through the high pressure turbine. It is reheated at a constant pressure of 40 bar to 550°C and expands through the low pressure turbine to a condenser at 0.1 bar. Draw T-s and h-s diagrams. Evaluate: (i) Quality of steam at turbine exhaust ; (ii) Cycle efficiency (iii) Steam rate in kg/kWh	BT4	Analyzing
9	A turbine is supplied with steam at a pressure of 32 bar and a temperature of 410°C. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction at the end of expansion and thermal efficiency of the cycle. If the steam is reheated at 5.5 bar to a temperature of 395°C and then expanded isentropically to a pressure of 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle ?	BT3	Applying
10	Steam at a pressure of 15 bar and 250°C is expanded through a turbine at first to a pressure of 4 bar. It is then reheated at constant pressure to the initial temperature of 250°C and is finally expanded to 0.1 bar. Using Mollier chart, estimate the work done per kg of steam flowing through the turbine and amount of heat supplied during the process of reheat.	BT5	Evaluating

	Compare the work output when the expansion is direct from 15 bar to 0.1 bar without any reheat. Assume all expansion processes to be isentropic.		
11	In a steam turbine steam at 20 bar, 360°C is expanded to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assume ideal processes, find per kg of steam the net work and the cycle efficiency.	BT5	Evaluating
12	In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine: (i) The pump work, (ii) The turbine work, (iii) The Rankine efficiency, (iv) The condenser heat flow, (v) The dryness at the end of expansion. Assume flow rate of 9.5 kg/s.	BT4	Analyzing
13	Steam at a pressure of 15 bar and 300°C is delivered to the throttle of an engine. The steam expands to 2 bar when release occurs. The steam exhaust takes place at 1.1 bar. A performance test gave the result of the specific steam consumption of 12.8 kg/kWh and a mechanical efficiency of 80 per cent. Determine : (i) Ideal work or the modified Rankine engine work per kg. (ii) Efficiency of the modified Rankine engine or ideal thermal efficiency. (iii) The indicated and brake work per kg. (iv) The brake thermal efficiency. (v) The relative efficiency on the basis of indicated work and brake work.	BT3	Applying
14	A steam turbine is fed with steam having an enthalpy of 3100 kJ/kg. It moves out of the turbine with an enthalpy of 2100 kJ/kg. Feed heating is done at a pressure of 3.2 bar with steam enthalpy of 2500 kJ/kg. The condensate from a condenser with an enthalpy of 125 kJ/kg enters into the feed heater. The quantity of bled steam is 11200 kg/h. Find the power developed by the turbine. Assume that the water leaving the feed heater is saturated liquid at 3.2 bar and the heater is direct mixing type. Neglect pump work.	BT3	Applying
15	A simple Rankine cycle works between pressure of 30 bar and 0.04 bar, the initial condition of steam being dry saturated, calculate the cycle efficiency, work ratio and specific steam consumption.	BT4	Analyzing
16	A steam power plant works between 40 bar and 0.05 bar. If the steam supplied is dry saturated and the cycle of operation is Rankine, find : (i) Cycle efficiency (ii) Specific steam consumption.	BT5	Evaluating

17	Compare the Rankine efficiency of a high pressure plant operating from 80 bar and 400°C and a low pressure plant operating from 40 bar 400°C, if the condenser pressure in both cases is 0.07 bar.	BT4	Analyzing
18	In a regenerative cycle the inlet conditions are 40 bar and 400°C. Steam is bled at 10 bar in regenerative heating. The exit pressure is 0.8 bar. Neglecting pump work determine the efficiency of the cycle.	BT3	Applying

UNIT-III STEAM NOZZLES AND STEAM TURBINES

Introduction – Steam flow through nozzles – Nozzle efficiency – Classification of the steam turbine – Advantages of the steam turbine over steam engines – Methods of reducing wheel – Impulse turbine – Turbine Efficiency.

PART A (2 Marks)

1	Define the steam nozzle.	BT1	Remembering
2	What are the various types of nozzles and their functions?	BT2	Understanding
3	State the relation between the velocity of steam and heat during any part of a steam nozzle.	BT2	Understanding
4	Define nozzle efficiency.	BT1	Remembering
5	What are the effects of supersaturation in a steam nozzle?	BT1	Remembering
6	Differences between supersaturated flow and isentropic flow through steam nozzles.	BT2	Understanding
7	What is the critical pressure ratio of a steam nozzle?	BT1	Remembering
8	Draw T-s and h-s plot of supersaturated expansion of steam in a nozzle.	BT2	Understanding
9	Define the critical pressure ratio.	BT1	Remembering
10	Define stagnation enthalpy.	BT1	Remembering
11	Define indicated pressure ratio in steam nozzles.	BT1	Remembering
12	Mention the applications of the nozzle.	BT1	Remembering
13	Define the degree of reaction.	BT2	Understanding
14	Define the degree of super saturation.	BT2	Understanding
15	What is a steam turbine?	BT1	Remembering
16	State the use of large sizes and small sizes turbines.	BT2	Understanding
17	How does the impulse turbine work?	BT2	Understanding
18	State the function of fixed blades.	BT1	Remembering
19	Difference between the operation of impulse and reaction steam turbine?	BT1	Remembering
20	State the function of moving blades.	BT2	Understanding
21	State any two advantages and disadvantages of velocity-compounded turbines.	BT1	Remembering
22	Define the degree of reaction.	BT1	Remembering
23	Enumerate the energy losses in the steam turbine.	BT2	Understanding
24	Differentiate Impulse and Reaction Turbines.	BT2	Understanding
25	List out some internal losses in steam turbines.	BT1	Remembering

PART B (16 MARKS)			
1	Steam approaches a nozzle with velocity of 200 m/s, pressure of 4 bar and dryness fraction of 0.98. If the isentropic expansion in the nozzle proceeds till the pressure of the exit is 1 bar, determine the change in enthalpy and dryness fraction of steam using Mollier diagram. Also calculate the exit velocity of steam from nozzle and area of exit of the nozzle for flow of 0.8 kg/s.	BT5	Evaluating
2	In a steam nozzle, the steam expands from 4 bar to 1bar. The initial velocity is 60 m/s and initial temperature is 200ºC. Determine the exit velocity if the nozzle efficiency is 92% and dryness fraction at exit.	BT4	Analyzing
3	Dry saturated steam at 2.8 bar is expanded through a convergent nozzle to 1.7 bar. The exit area is 3 cm^2. Calculate the exit velocity and mass flow rate for (i) isentropic expansion and (ii) supersaturated flow.	BT4	Analyzing
4	The inlet condition of nozzle is 10 bar and 250ºC. The exit pressure is 2 bar. Assuming isentropic expansion and negligible inlet velocity, determine the (i) throat area, (ii) exit velocity and (iii) exit area of the nozzle for a flow rate of 0.2 kg/s.	BT4	Analyzing
5	Steam at 3 bar with 10ºC superheat is passed through a convergent nozzle. The velocity of steam entering the nozzle is 91.5 m/s. The backpressure is 1.5 bar. Assuming that the nozzle efficiency is 90% determine the area of the nozzle at exit. Discharge through the nozzle is limited to 0.45 kg/s. Take C_{ps} (Superheated steam) = 2.2 KJ/kgºC.	BT5	Evaluating
6	Steam enters a nozzle in a dry saturated condition and expands from a pressure of 2 bar to a pressure of 1 bar. It is observed that the supersaturated flow takes place and steam flow is reverted to a normal flow at 1 bar. What is the degree of undercooling and increase in entropy and also loss in the available heat drop due to irreversibility?	BT4	Analyzing
7	Dry saturated steam at a pressure of 8 bar enters a convergent divergent nozzle and leaves it at a pressure of 1.5 bar. If the steam flow process is isentropic and the corresponding expansion index is 1.135, find the ratio of cross sectional area at exit and throat for maximum discharge.	BT4	Analyzing
8	Steam at 10.5 bar and 0.95 dryness is expanded through a convergent divergent nozzle. The pressure of steam leaving the nozzle is 0.85 bar.	BT4	Analyzing

	Find (i) velocity of steam at throat for maximum discharge, (ii) the area at exit and (iii) steam discharge if the throat area is 1.2 cm^2. Assume the flow as isentropic and there are no friction losses. Take n =1.135.		
9	A convergent-divergent adiabatic steam nozzle is supplied with steam at 10 bar and 250ºC. The discharge pressure is 1.2 bar. Assuming that the nozzle efficiency is 100% and initial velocity of steam is 50 m/s, find the discharge velocity.	BT4	Analyzing
10	Dry saturated steam at a pressure of 11 bar enters a convergent-divergent nozzle and leaves at a pressure of 2 bar. If the flow is adiabatic and frictionless, determine the (i) exit velocity of steam (ii) ratio of cross-section of exit and that at throat.	BT4	Analyzing
11	Steam enters a convergent divergent nozzle at 2 MPa and 400ºC with a negligible velocity and mass flow rate of 2.5 kg/s and it exits at a pressure of 300 kPa. The flow is isentropic between nozzle entrance and throat, and overall nozzle efficiency is 93%. Determine (i) throat area and (ii) exit area.	BT4	Analyzing
12	The flow rate through steam nozzle with isentropic flow from pressure of 13 bar was found to be 60 kg/min. Steam is initially saturated. Determine the throat area. If the flow is superheated, determine the increase in the flow rate.	BT4	Analyzing
13	In a De-Laval turbine, the steam enters the wheel through a nozzle with a velocity of 350 m/s and at an angle of 20º to the direction of motion of the blade. The blade speed is 250 m/s and the exit angle of the moving blade is 35º. Find the inlet angle of the moving blade, exit velocity of steam and its direction, and work done/kg of steam.	BT5	Evaluating
14	A textile factory requires 10000 kg/h of steam for process heating at 3 bar saturated and 1000 kW of power, for which a back pressure turbine of 70% internal efficiency is to be used. Find the steam condition required at the inlet to the turbine.	BT4	Analyzing
15	The velocity of steam leaving the nozzle of an impulse turbine is 1000 m/s and the nozzle angle is 20º. The blade velocity is 350 m/s and the blade velocity of coefficient is 0.85. Assuming no losses due to shock at inlet calculate for a mass flow of 1.5 kg/s and symmetrical blading. (i) blade inlet angle. (ii) driving force on the wheel (iii) axial thrust in the	BT5	Evaluating

	wheel (iv) power developed by the turbine.		
16	A single row impulse turbine develops 132.4kW at a blade speed of 175 m/s using 2 kg of steam per second. Steam leaves the nozzle at 400 m/s. velocity coefficient of the blade is 0.9. Steam leaves the turbine blades axially. Assuming no shock, determine the nozzle angle, blade angles at entry and exit.	BT5	Evaluating
17	Briefly classify steam turbines and explain simple impulse turbine in detail with a neat sketch.	BT2	Understanding
18	Discuss the method of energy transfer in impulse turbine.	BT2	Understanding

UNIT-IV GAS POWER CYCLES

Air Standard Cycles – Otto Cycle - Diesel cycle - Dual cycle – Calculation of mean effective pressure - Air standard efficiency - Comparison of cycles.

PART A (2 Marks)

1	Define a cycle.	BT1	Remembering
2	Define Air Standard Efficiency.	BT2	Understanding
3	State the assumption made in deriving the air-standard efficiency of Carnot engine.	BT1	Remembering
4	Build the Otto cycle process by its P-V and T-S planes and name all the processes.	BT2	Understanding
5	What are the assumptions made in Air Standard Cycles?	BT1	Remembering
6	Compare the major differences between Otto and Diesel Cycle.	BT1	Remembering
7	Define mean effective pressure.	BT2	Understanding
8	In an Otto cycle, compression ratio is 8. Calculate the air standard cycle efficiency.	BT1	Remembering
9	Describe the expression for mean effective pressure for diesel cycle.	BT2	Understanding
10	Draw the Diesel cycle on p-V and T-s planes and mention the four thermodynamic processes involved.	BT2	Understanding
11	Define relative efficiency.	BT1	Remembering
12	Construct the dual cycle on p-V plane and mention the five thermodynamic processes involved.	BT1	Remembering
13	Draw the dual cycle on T-s planes and mention the five thermodynamic processes involved.	BT2	Understanding
14	Name the factors that affect the air standard efficiency of diesel cycle.	BT1	Remembering
15	Define the terms compression ratio and cut-off ratio.	BT1	Remembering
16	State the merits and demerits of Otto cycle.	BT1	Remembering
17	Express the Diesel cycle efficiency and its M.E.P.	BT2	Understanding
18	What is the limitation of compression ratio?	BT2	Understanding
19	Define ‘diagram factor’.	BT1	Remembering
20	Define cut-off ratio.	BT1	Remembering
21	What is a cycle?	BT1	Remembering
22	What is relative efficiency ?	BT1	Remembering
23	What is an air-standard efficiency ?	BT2	Understanding

24	What is the difference between an ideal and actual cycle?	BT1	Remembering
25	State the merits and demerits of diesel cycle.	BT2	Understanding

PART B (16 MARKS)			
1	A Carnot engine working between 400°C and 40°C produces 130 kJ of work. Determine : (i) The engine thermal efficiency. (ii) The heat added. (iii) The entropy changes during heat rejection process.	BT3	Applying
2	0.5 kg of air (ideal gas) executes a Carnot power cycle having a thermal efficiency of 50 per cent. The heat transfer to the air during the isothermal expansion is 40 kJ. At the beginning of the isothermal expansion the pressure is 7 bar and the volume is 0.12 m3. Determine : (i) The maximum and minimum temperatures for the cycle in K ; (ii) The volume at the end of isothermal expansion in m3 ; (iii) The heat transfer for each of the four processes in kJ. For air cv = 0.721 kJ/kg K, and cp = 1.008 kJ/kg K.	BT3	Applying
3	In a Carnot cycle, the maximum pressure and temperature are limited to 18 bar and 410°C. The ratio of isentropic compression is 6 and isothermal expansion is 1.5. Assuming the volume of the air at the beginning of isothermal expansion as 0.18 m3, determine : (i) The temperature and pressures at main points in the cycle. (ii) Change in entropy during isothermal expansion. (iii) Mean thermal efficiency of the cycle. (iv) Mean effective pressure of the cycle. (v) The theoretical power if there are 210 working cycles per minutes.	BT3	Applying
4	The efficiency of an Otto cycle is 60% and γ = 1.5. What is the compression ratio ?	BT3	Applying
5	An engine of 250 mm bore and 375 mm stroke works on Otto cycle. The clearance volume is 0.00263 m3. The initial pressure and temperature are 1 bar and 50°C. If the maximum pressure is limited to 25 bar, find the following : (i) The air standard efficiency of the cycle. (ii) The mean effective pressure for the cycle. Assume the ideal conditions.	BT3	Applying
6	The minimum pressure and temperature in an Otto cycle are 100 kPa and 27°C. The amount of heat added to the air per cycle is 1500 kJ/kg. (i) Determine the pressures and temperatures at all points of the air standard	BT3	Applying

	Otto cycle. (ii) Also calculate the specific work and thermal efficiency of the cycle for a compression ratio of 8 : 1. Take for air : cv = 0.72 kJ/kg K, and γ = 1.4.		
7	A certain quantity of air at a pressure of 1 bar and temperature of 70°C is compressed adiabatically until the pressure is 7 bar in Otto cycle engine. 465 kJ of heat per kg of air is now added at constant volume. Determine : (i) Compression ratio of the engine. (ii) Temperature at the end of compression. (iii) Temperature at the end of heat addition. Take for air cp = 1.0 kJ/kg K, cv = 0.706 kJ/kg K. Show each operation on p-V and T-s diagrams.	BT4	Analyzing
8	In a constant volume 'Otto cycle', the pressure at the end of compression is 15 times that at the start, the temperature of air at the beginning of compression is 38°C and maximum temperature attained in the cycle is 1950°C. Determine (i) Compression ratio. (ii) Thermal efficiency of the cycle. (iii) Work done. Take γ for air = 1.4.	BT3	Applying
9	An engine working on Otto cycle has a volume of 0.45 m3, pressure 1 bar and temperature 30°C at the beginning of compression stroke. At the end of compression stroke, the pressure is 11 bar. 210 kJ of heat is added at constant volume. Determine : (i) Pressures, temperatures and volumes at salient points in the cycle. (ii) Percentage clearance. (iii) Efficiency. (iv) Net work per cycle. (v) Mean effective pressure. (vi) Ideal power developed by the engine if the number of working cycles per minute is 210. Assume the cycle is reversible.	BT3	Applying
10	A diesel engine has a compression ratio of 15 and heat addition at constant pressure takes place at 6% of stroke. Find the air standard efficiency of the engine. Take γ for air as 1.4	BT3	Applying
11	. The stroke and cylinder diameter of a compression ignition engine are 250 mm and 150 mm respectively. If the clearance volume is 0.0004 m3 and fuel injection takes place at constant pressure for 5 per cent of the stroke determine the efficiency of the engine. Assume the engine working on the diesel cycle.	BT4	Analyzing
12	Calculate the percentage loss in the ideal efficiency of a diesel engine with compression ratio 14 if the fuel cut-off is delayed from 5% to 8%.	BT4	Analyzing
13	The mean effective pressure of a Diesel cycle is 7.5 bar and compression	BT5	Evaluating

	ratio is 12.5. Find the percentage cut-off of the cycle if its initial pressure is 1 bar.		
14	An engine with 200 mm cylinder diameter and 300 mm stroke works on theoretical Diesel cycle. The initial pressure and temperature of air used are 1 bar and 27°C. The cut-off is 8% of the stroke. Determine : (i) Pressures and temperatures at all salient points. (ii) Theoretical air standard efficiency. (iii) Mean effective pressure. (iv) Power of the engine if the working cycles per minute are 380. Assume that compression ratio is 15 and working fluid is air. Consider all conditions to be ideal.	BT3	Applying
15	The swept volume of a diesel engine working on dual cycle is 0.0053 m3 and clearance volume is 0.00035 m3. The maximum pressure is 65 bar. Fuel injection ends at 5 per cent of the stroke. The temperature and pressure at the start of the compression are 80°C and 0.9 bar. Determine the air standard efficiency of the cycle. Take γ for air = 1.4.	BT3	Applying
16	An oil engine working on the dual combustion cycle has a compression ratio 14 and the explosion ratio obtained from an indicator card is 1.4. If the cut-off occurs at 6 per cent of stroke, find the ideal efficiency. Take γ for air = 1.4.	BT3	Applying
17	The compression ratio for a single-cylinder engine operating on dual cycle is 9. The maximum pressure in the cylinder is limited to 60 bar. The pressure and temperature of the air at the beginning of the cycle are 1 bar and 30°C. Heat is added during constant pressure process upto 4 per cent of the stroke. Assuming the cylinder diameter and stroke length as 250 mm and 300 mm respectively, determine : (i) The air standard efficiency of the cycle. (ii) The power developed if the number of working cycles are 3 per second. Take for air cv = 0.71 kJ/kg K and : cp = 1.0. kJ/kg K	BT3	Applying
18	In an engine working on Dual cycle, the temperature and pressure at the beginning of the cycle are 90°C and 1 bar respectively. The compression ratio is 9. The maximum pressure is limited to 68 bar and total heat supplied per kg of air is 1750 kJ. Determine: (i) Pressure and temperatures at all salient points (ii) Air standard efficiency (iii) Mean effective pressure.	BT3	Applying

UNIT-V HEAT TRANSFER			
Modes of heat transfer – Heat transfer by conduction – Heat transfer by convection –Heat exchangers.			
PART A (2 Marks)			
1	Define heat transfer.	BT2	Understanding
2	What are the modes of heat transfer?	BT2	Understanding
3	What is conduction?	BT1	Remembering
4	Define convection.	BT2	Understanding
5	State Fourie's law of conduction.	BT2	Understanding
6	Define Thermal conductivity.	BT2	Understanding
7	List down the three types of boundary conditions.	BT2	Understanding
8	State Newtons law of cooling or convection law.	BT2	Understanding
9	Define overall heat transfer co-efficient.	BT1	Remembering
10	What is meant by steady state heat conduction?	BT1	Remembering
11	Define Reynolds number (Re).	BT2	Understanding
12	Define Prandtl number (Pr).	BT2	Understanding
13	Define Nusselt Number (Nu).	BT2	Understanding
14	Define Grashof number (Gr).	BT1	Remembering
15	Define Stanton number (St).	BT2	Understanding
16	State Newton's law of convection.	BT2	Understanding
17	What is forced convection.	BT2	Understanding
18	Define boundary layer thickness.	BT1	Remembering
19	Define momentum thickness.	BT2	Understanding
20	Define energy thickness.	BT2	Understanding
21	What is heat exchanger?	BT2	Understanding
22	What are the types of heat exchangers?	BT2	Understanding
23	What is meant by Direct heat exchanger (or) open heat exchanger?	BT1	Remembering
24	What is meant by indirect contact heat exchanger?	BT1	Remembering
25	What is meant by parallel flow heat exchanger?	BT2	Understanding

PART B (15 MARKS)			
1	Determine the heat transfer through the plane of length 6m, height 4m and thickness 0.30m. The temperature of inner and outer	BT3	Applying

	surfaces are 100°C and 40°C, Thermal conductivity of wall is 0.55W/mK.		
2	A wall of 0.6m thickness having thermal conductivity of 11.2W/mK. The wall is to be insulated with a material having an average thermal conductivity of 0.3W/mK. Inner and outer surface temperatures are 1000°C and 10°C respectively. If heat transfer rate is 1400 W/m^2 calculate the thickness of insulation.	BT3	Applying
3	The wall of a cold room is composed of three layers. The outer layer is brick 30 cm thick. The middle layer is corking 10 cm thick; the inside layer is cementing 5 cm thick. The temperatures of the outside air are 25°C and on the inside air is -20°C. The film co-efficient for outside air and brick is 45.4 W/m^2K. film co-efficient for inside air and cement is $17W/m^2K$. (i) Thermal resistance (ii)Find heat flow rate. Take k for brick = 2.5 W/mK, for cork = 0.05 W/mK and for cement = 0.28 W/mK.	BT3	Applying
4	A wall of a cold room is composed of three layers. The outer layer is brick 20 cm thick. The middle layer is corking 20 cm thick; the inside layer is cementing 15 cm thick. The temperatures of the outside air are 25°C and on the inside air is -20°C. the film co-efficient for outside air and brick is 55.4 W/m^2K. film co-efficient for inside air and cement is $17W/m^2K$. find heat flow rate. Take k for brick = 3.45 W/mK, for cork = 0.043 W/mK and for cement = 0.294 W/mK.	BT3	Applying
5	A furnace wall is made up of three layers, inside layer with thermal conductivity 8.5 W/mK, the middle layer with conductivity 0.25 W/mK, the outer layer with conductivity 0.08 W/mK. The respective thickness of the inner, middle and outer layers are 25 cm, 5 cm and 3 cm respectively. The inside and outside wall temperature are 600°C and 50°C respectively. Draw the equivalent electrical circuit for conduction of heat through the wall and find thermal resistance, heat flow/m2 and interface temperatures.	BT3	Applying
6	A mild steel tank of wall thickness 20 mm contains water at 100°C. Estimate the loss of heat per square metre area of the tank surface, if the tank is exposed to an atmosphere at 15°C. Thermal conductivity for the outside and inside the tank are 10 W/m^2K and 2850 W/m^2K respectively. What will be the temperature on the outside of the tank wall.	BT4	Analyzing

7	The wall of refrigerators is made up of two mild steel plates 2.5 mm thick with a 6 cm thick glass wool in between the plates. The interior temperature is -20°C, while the outside of the refrigerator is exposed to 40°C. Estimate the heat flow. Thermal conductivity of steel and glass wool are 23 W/mK and 0.015 W/mK respectively.	BT3	Applying
8	An external wall of a house is made up of 10 cm common brick (k = 0.7 W/mK) followed by a 4 cm layer of gypsum plaster (k=0.48 W/mK). What thickness of loosely packed insulation (k = 0.065 W/mK) should be added to reduce the heat loss through the wall 80%.	BT3	Applying
9	Air at 20°C at a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s. If the plate is maintained at 60°C calculate the heat transfer per unit width of the plate. Assuming the length of the plate along the flow of air is 2 m.	BT5	Evaluating
10	Air at 25°C flows over a flat plate at a speed of 5 m/s and heated to 135°C. The plate is 3 m long and 1.5 m wide. Calculate the local heat transfer coefficient at x = 0.5 m and the heat transferred from the first 0.5 m of the plate.	BT4	Analyzing
11	Air at 20°C at atmospheric pressure flows over a flat plate at a velocity of 3 m/s. If the plate is 1m wide and 80°C, calculate the following at x = 300 mm. (i) Hydrodynamic boundary layer thickness. (ii) Thermal boundary coefficient, (iii) Local friction coefficient (iv) Average friction coefficient (v) Local heat transfer coefficient (vi) Average heat transfer coefficient (vii) Heat transfer.	BT3	Applying
12	A large vertical plate 5 m height is maintained at 100°C and exposed to air at 30°C. Calculate the convective heat transfer coefficient.	BT3	Applying
13	A stem pipe 10 cm outside diameter runs horizontally in a room at 23°C. Take the outside surface temperature of pipe as 165°C. Determine the heat loss per metre length of the pipe.	BT5	Evaluating
14	A steam pipe 10 cm OD urns horizontally in a room at 23°C. Take outside temperature of pipe as 165°C. Determine the heat loss per unit length of	BT4	Analyzing

	the pipe. If pipe surface temperature reduces to 80°C with 1.5 cm insulation, what is the reduction in heat loss?		
15	In a counter flow double pipe heat exchanger oil is cooled from 85°C to 55°C by water entering at 25°C. The mass flow rate of oil is 9800 kg/h and specific heat of oil is 2000 J/kg K. The mass flow rate of water is 8000 kg/h and specific heat of water is 4180 J/kg K. Determine the heat exchanger area and heat transfer rate for an overall heat transfer co-efficient of 280 W/m^2K.	BT5	Evaluating
16	In parallel flow double pipe heat exchanger water flows through the inner pipe and is heated from 30°C to 80°C. Oil flowing through the annulus is cooled from 220°C to 100°C. It is desired to cool the oil to a lower exit temperature by increasing the length of the heat exchanger. Determine the minimum temperature to which the oil may be cooled.	BT5	Evaluating
17	With a neat sketch explain natural of heat exchange process.	BT2	Understanding
18	With a neat sketch explain relative direction of fluid motion.	BT2	Understanding