



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	THERMAL ENGINEERING II
Course Code	:	A50326
Class	:	III B. Tech I Semester
Branch	:	ME
Year	:	2017 – 2018
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COURSE OVERVIEW

Thermal Engineering is the applications of thermodynamics. The objective of the course is to introduce the mechanical engineering students an understanding of the performance of rankine cycle, parameters to improve the performance like reheating, regenerating and also Gas turbines and rocket engines and their performance. The knowledge of thermal engineering helps us in improving and designing the various parts of machine elements. The course content is designed in such a way that efficiencies of different turbines could be achieved by the calculation of different empirical values.

S No	QUESTION	Blooms taxonomy level	Course Outcomes
UNIT - I			
Part - A (Short Answer Questions)			
1	Define rankine cycle.	Remember	4
2	Define reheating cycle.	Understand	3
3	Write the different operations in rankine cycle.	Understand	3
4	What is the efficiency of rankine cycle.	Remember	4
5	Differentiate between rankine and carnot cycle .	Understand	3
6	Write the different methods to improve performance of rankine cycle.	Remember	3
7	What do you mean by mean temperature?	Understand	3
8	Draw the mechanical system to show different process of Rankine cycle.	Understand	3
9	What does Rankine cycle comprises of ?	Remember	4
10	In which operation of steam engines, the vapour cycle is adopted?	Understand	4
11	What is the range of Rankine cycle efficiency of a good steam power plant?	Remember	4
12	Discuss shortly on flue gas analysis.	Understand	3
13	Discuss shortly on regenerative cycle.	Understand	3
14	Explain the adiabatic flame temperature?	Remember	4
15	Classify the fuels.	Understand	4
16	List the advantages of liquid fuels.	Remember	4
17	List the advantages of gaseous fuels.	Understand	3

18	Define Calorific value of fuel.	Remember	4
19	Define the Fuel.	Understand	3
20	Define the producer gas.	Remember	4
Part - B (Long Answer Questions)			
1	Explain working principle of Rankine cycle with a neat sketch..	Knowledge	1
2	Classify and explain the classification of fuels	Knowledge	1
3	Explain Adiabatic flame temperature.	Comprehension	2
4	Explain the Regenerative cycle in detail with a neat sketch.	Knowledge	1
5	How do you analyses the exhaust and flue gases by using Orsat's apparatus. Explain with neat diagram.	Comprehension	2
6	How can you convert weight analysis in volumetric analysis?	Knowledge	1
7	What is meant by stoichiometric Air fuel ratio?	Comprehension	2
8	Explain the Reheat cycle in detail with a neat sketch.	Knowledge	1
9	Explain the advantages and disadvantages of Reheating?	Knowledge	1
10	Compare Rankine cycle and Carnot cycle?	Comprehension	2
11	Derive the expression for efficiency of reheat cycle and compare with Rankine cycle.	Knowledge	1
12	Discuss what are the Various methods for improving Performance of a rankine cycle?	Comprehension	2
13	What are the various parameters improving efficiency of Rankine cycle?	Comprehension	2
14	Draw the effect of efficiency of Rankine Cycle upon decreasing condenser pressure. Explain?	Understand	3
15	Draw the effect of efficiency of Rankine Cycle upon increasing temperature of turbine Explain.	Understand	3
16	Draw the effect of efficiency of Rankine Cycle upon superheating. Explain	Understand	3
17	What are the limitations of Carnot cycle?	concept	2
18	Draw the basic components of Rankine cycle and explain the function of each.	Understand	3
19	Explain the combustion phenomena of hydrogen.	Comprehension	2
20	Explain the combustion phenomena of carbon.	Comprehension	2
Part - C (ANALYTICAL QUESTIONS)			
1	In a Rankine cycle, the steam at inlet to Turbine is saturated at a pressure of 35bar and the exhaust pressure is 0.2bar. Determine i)the pump work ii) Turbine work iii) Rankine efficiency iv) Condenser heat flow v) the dryness at the end of expansion. Assume flow rate of 9.5kg/sec	Evaluate	3
2	A Steam Turbine is fed with steam having an enthalpy of 3100kJ/Kg. It moves out of Turbine with an enthalpy of 2100KJ/Kg. Feed heating is done at a pressure of 3.2bar, with steam enthalpy of 2500KJ/kg. The condensate from a condenser with an enthalpy of 125KJ/kg enters into the feed heater. The quantity of bled steam is 11200Kg/hour. Find the power developed by the Turbine. Assume that the water leaving the feed heater is saturated liquid at 3.2bar and the heater is direct mixing type. Neglect pump work. Show the arrangements in figure	Determine	3
3	A simple Rankine cycle works between pressures 28bar and 0.06bar. The initial condition of steam is dry saturated. Calculate cycle efficiency, work ratio and specific steam consumption	Calculate	1
4	In a steam power cycle, the steam supply is at 15bar and dry and saturated. The condenser pressure is 0.4bar. Calculate the Carnot and Rankine efficiency of the cycles. Neglect pump work.	Calculate	1

5	Super heated steam at a pressure of 10bar and 400 ⁰ C is supplied to a steam engine. Adiabatic expansion takes place to release point at 0.9bar and it exhausts into a condenser at 0.3bar. Neglecting clearance, determine for a steam flow rate of 1.5kg/sec. i) quality of steam at the end of expansion and the end of constant volume operation ii) power developed iii) specific steam consumption iv) modified Rankine cycle efficiency	Evaluate	3
6	Steam is supplied to a Turbine at a pressure of 30bar and at a temperature of 400 ⁰ C and is expanded adiabatically to a pressure of 0.04bar. At a stage of Turbine, where the pressure is 3bar, a connection is made to a surface heater in which the feed water is heated by bled steam to a temperature of 130 ⁰ C. The condensed steam from the feed water is cooled in a drain cooler to 27 ⁰ C. The feed water passes through the drain cooler before entering the feed heater. The cooled drain water combines with the condensate in the well of condenser. Assuming no heat losses in the steam. Calculate i) mass of steam used for feed heating per kg of steam entering the Turbine ii) Thermal efficiency of cycle.	Calculate	1
7	The percentage composition of sample of liquid fuel by weight is, C=84.8% and H ₂ =15.2%. Calculate i)the weight of air needed for the combustion of 1kg of fuel ii) the volumetric composition of product of combustion if 15% excess air is supplied	Determine	1
8	The following is the ultimate analysis of a sample of petrol by weight: Carbon =85%, Hydrogen=15%.Calculate the ratio of air to petrol consumption by weight if the volumetric analysis of dry exhaust gas is CO ₂ =11.5%, CO=1.2%,O ₂ =0.9% and N ₂ =86%. Also find percentage excess air.	Evaluate	3
9	Determine the gravimetric analysis of the products of complete combustion of acetylene with 200% stoichiometric air	Calculate	1
10	The percentage composition of sample of liquid fuel by weight is, C=84.8% and H ₂ =15.2%. Calculate i)the weight of air needed for the combustion of 1kg of fuel ii) the volumetric composition of product of combustion if 15% excess air is supplied	Evaluate	1

UNIT - II

Part – A (Short Answer Questions)

1	What is a water tube boiler?	Understand	3
2	List out any four loss components in a heat balance of a boiler.	Remember	4
3	Define boiler.	Remember	4
4	What is a fire tube boiler?	Understand	3
5	What are the main losses which are not accounted in an indirect method of boiler efficiency testing?	Remember	4
6	Write the formula for evaluation of boiler efficiency by direct method.	Remember	4
7	Write about boiler mountings.	Remember	4
8	Differentiate between high pressure and low pressure boiler.	Understand	3
9	List the advantages of high pressure boilers	Remember	4
10	Write about boiler accessories	Remember	4
11	Name the various types of nozzles and their function?	Understand	3
12	Define critical pressure ratio.	Remember	4
13	Analyze the effects of super saturation in a nozzle?	Understand	3
14	Explain critical pressure ratio of a steam nozzle?	Remember	4
15	Calculate the value of critical pressure ratio for saturated and supersaturated steam.	Remember	4
16	List the factors reducing the final velocity of steam in nozzle flow?	Understand	3
17	Differentiate between supersaturated flow and isentropic flow.	Remember	4
18	Write the expression for critical pressure ratio in a steam nozzle.	Understand	3

19	Express the effects of friction on the flow through a steam nozzle?	Remember	4
20	Define nozzle efficiency.	Understand	3
Part – B (Long Answer Questions)			
1	State the differences between the following boilers? Externally fired and internally fired boilers	Knowledge	1
2	State the differences between the High Pressure and low Pressure boilers?	Comprehension	2
3	Explain the following boiler terms : Shell, setting, grate, furnace, water space and steam space	Knowledge	1
4	Explain the terms mountings, accessories, water level, blowing off, lagging refractory	Comprehension	2
5	Give the construction and working of the Babcock and Wilcox water tube boilers?	Knowledge	1
6	Explain with neat sketches, the construction and working of the La Mont boiler and Benson boiler.	Knowledge	1
7	Explain with neat sketches any three of the following mountings? i) water level indicator ii) Pressure gauge iii) Blow-off cock iv) High steam and low water safety valve	Comprehension	2
8	Explain the concept of discharge through the nozzle.	Knowledge	1
9	Derive the conditions for discharge and its maximum value of a nozzle.	Comprehension	2
10	Explain the concept of Meta stable state while representing Wilson line on h-s diagram.	Knowledge	1
11	What is the effect of friction on nozzle efficiency explain with T-S diagram.	Comprehension	2
12	Derive the expression for exit velocity of a nozzle using Steady flow energy equation..	Knowledge	1
13	Differentiate between Forced circulation and natural circulation boilers.	Comprehension	2
14	Explain the concept of Wilson line and represent it on h-s Diagram.	Knowledge	1
15	Classify nozzles with neat sketches.	concept	3
16	Enumerate the terminology of boilers.	Knowledge	1
17	Write a brief classification of steam generators.	Comprehension	2
18	Explain the function of Cochran fire tube boiler with neat sketch.	concept	3
19	Write the function of fusible plug .Explain.	Knowledge	1
20	Explain the function of Air Preheater and Economizer.	concept	3
Part - C (ANALYTICAL QUESTIONS)			
1	Dry saturated steam enters a steam nozzle at a pressure of 15 bar and is discharged at a pressure of 2.0 bar. If the dryness fraction of discharge steam is 0.96.what will be the final velocity of steam? Neglecting initial velocity of steam.	Application	1
2	The nozzles of a Delaval turbine are supplied with dry saturated steam at a pressure of 9 bar. The pressure at the outlet is 1 bar. The turbine has two nozzles with a throat diameter of 2.5 mm. Assuming nozzle efficiency as 90 % and that of turbine rotor 35 %, find the quality of steam used per hour and power developed.	Evaluation	2
3	A Convergent divergent nozzle is to be designed in which steam initially at 14 bar and 80 ⁰ C of superheat is to be expanded down to a back pressure of 1.05 bar. Determine the necessary throat and exit diameters of the nozzle for a steam discharge of 500 kg/hour, assuming that the expansion is in thermal equilibrium throughout and the friction reheat amounting to 12 % of the total isentropic enthalpy drop to be effective in the divergent part of the nozzle	Application	1

4	A convergent divergent nozzle is required to discharge 2 kg of steam per second. The nozzle is supplied with steam at 6.9 bar and 180 °C and discharge takes place against a back pressure of 0.98 bar. Expansion up to throat is isentropic and the frictional resistance between the throat and exit is equivalent to 62.76 kJ/kg of steam. Taking approach velocity of 75m/s. and throat pressure 3.9 bar, estimate (a) Suitable areas for the throat and exit (b) Overall efficiency of the nozzle based on the enthalpy drop between the actual inlet pressure, and the temperature and the exit pressure	Application	1
5	A steam nozzle is supplied steam at 15 bar 350 °C and discharges steam at 1 bar. If the diverging portion of the nozzle is 80 mm long and the throat diameter is 6 mm, determine the cone angle of the divergent portion. Assume 12 % of the total available enthalpy drop is lost in friction in the divergent portion. Also determine the velocity and temperature of the steam at throat.	Application	1
6	Steam at a pressure of 12 bar and dryness fraction 0.6 is discharged through a convergent divergent nozzle to a back pressure of 0.1 bar. if the power developed is 220 kW. The mass flow rate is 7kg/kwh. Determine Throat pressure.	Evaluation	2
7	In a convergent – divergent nozzle, the steam enters at 10 bar and 285 °C and leaves at a pressure of 5 bar. The inlet velocity to the nozzle is 100 m/s. Calculate the required throat and exit areas for a mass flow rate of 1 kg/s. Assume the nozzle efficiency to be 98%.	Application	1
8	Steam is expanded in a set of nozzles from 10 bar and 250°C to 5 bar. What type of nozzle is it .Assume the expansion to be isentropic.	Evaluation	2
9	In a convergent – divergent nozzle, the steam enters at 15 bar and 300 °C and leaves at a pressure of 2 bar. The inlet velocity to the nozzle is 150 m/s. Calculate the required throat and exit areas for a mass flow rate of 1 kg/s. Assume the nozzle efficiency to be 90%.	Application	1
10	Steam enters the nozzle at a pressure of 2 MPa and 400 °C with a negligible approach velocity and leaves at a pressure of 3 bar. Determine the shape of the nozzle. Assuming isentropic flow through nozzle, obtain the exit diameter for a mass flow rate of 2.5 kg/s	Evaluation	2

UNIT-III

Part - A (Short Answer Questions)

1	Explain ‘degree of reaction’ in a steam turbine.	Understand	3
2	List the functions of governors in steam turbine.	Remember	4
3	Differentiate between impulse and reaction turbine	Understand	3
4	Discuss the importance of compounding of steam turbine.	Remember	4
5	Explain the following terms for reaction turbines: (i) Diagram efficiency and (ii) Stage efficiency	Understand	3
6	Illustrate the pressure and velocity compounding diagram of multi stage turbine with a neat sketch.	Remember	4
7	Classify the steam turbines.	Understand	3
8	List the advantages of steam turbine over the steam engines.	Remember	4
9	Define the reaction turbine.	Understand	3
10	List the conditions for Maximum Efficiency of Reaction turbines.	Remember	4
11	List the energy losses in steam turbine.	Understand	3
12	What methods are used in reducing the speed of the turbine rotor?	Remember	4
13	Explain Reheat factor.	Understand	3
14	Define the term “Degree of Reaction” used in reaction turbines.	Remember	4
15	Explain bleeding of steam turbines.	Understand	3

16	List the various methods of 'steam turbine governing'.	Remember	4
17	Classify Condensers.	Understand	3
18	Compare between Jet and Surface Condensers.	Remember	4
19	Define steam condenser and state its objects.	Understand	3
20	State the organs of a steam condensing plant.	Remember	4
Part – B (Long Answer Questions)			
1	Draw the velocity diagram of impulse Turbine and find the work done on the blade, blade efficiency.	Comprehension	2
2	Derive the expression for condition for maximum efficiency of an impulse Turbine?	Knowledge	1
3	What are the advantages and disadvantages of velocity compounded Impulse Turbine.	Comprehension	2
4	Define the following: i) Blade efficiency ii) Stage efficiency iii) overall efficiency	Knowledge	1
5	What are the methods of reducing wheel or rotor speed	Comprehension	2
6	What are the differences between Impulse turbine and reaction turbine?	Knowledge	1
7	Classify Steam turbine with different considerations.	Comprehension	2
8	Explain the concept of pressure compounding. with neat diagram	Knowledge	1
9	Explain the concept of velocity compounding. with neat diagram .	Comprehension	2
10	Explain the concept of pressure and velocity compounding. with neat diagram	Knowledge	1
11	What are the types of Condensers? Classify?.	Comprehension	2
12	Compare the Jet Condensers and Surface Condensers with? Determine the mass of cooling water?	Knowledge	1
13	Define degree of reaction and prove that Parsons Reaction turbine is a 50 % reaction turbine.	Comprehension	2
14	Derive the condition for maximum efficiency of reaction turbine with giving assumptions to be followed.	Knowledge	1
15	Define the terms Vacuum efficiency and Condenser efficiency.	Comprehension	2
16	Explain working principle of Low level Jet Condenser with neat sketches?	Knowledge	1
17	Explain working principle of Surface Condenser with neat sketch?	Knowledge	1
18	What the sources of air leakage in to the condensers? How its pressure is determined?	Knowledge	1
19	Explain the function of cooling the air before it is to be extracted from the condenser?	Comprehension	2
20	Discuss the merits and demerits of surface condensers and jet condensers, which type is recommended for large plants?	Knowledge	1
Part - C (Analytical Questions)			
1	A stage of a steam turbine is supplied with steam at a pressure of 50 bars and 350°C, and exhausts at a pressure of 5 bars. The isentropic efficiency of the stage is 0.82 and the steam consumption is 2270 kg/min. determine the power output of the stage	Application	1
2	The velocity of steam exiting the nozzle of the impulse stage of a turbine is 400 m/s. The blades operate close to the maximum blading efficiency. The nozzle angle is 20°. Considering equiangular blades and neglecting blade friction, calculates the steam flow of 0.6 kg/s. the diagram power and	Application	1
3	In a DeLaval turbine, steam issues from the nozzle with a velocity of 1200m/sec, the nozzle angle is 20°, the mean blade velocity is 400m/sec and the inlet and outlet of angles are equal. The mass of steam flowing through the turbine per hour is 1000kg. Calculate blade angle, Power developed and blade efficiency	Evaluation	2

4	A single stage steam Turbine is supplied with steam at 5bar and 200°C at the rate of 50Kg/min. It expands into a condenser at a pressure of 0.2bar. The blade speed is 400m/sec. The nozzles are inclined at an angle of 20° to the plane of wheel and outlet blade angle is 30°. Neglecting friction losses. Determine the power developed , blade efficiency and stage efficiency	Application	1
5	In an impulse turbine (with a single row wheel) the mean diameter of the blades is 1.05m and the speed is 3000r.p.m. The nozzle angle is 18°, the ratio of blade speed to steam speed is 0.42 and the ratio of the relative velocity at outlet from the blades to that at inlet is 0.84. The outlet angle of the blade is to be made 3° less than the inlet angle. The steam flow is 10kg/s. Draw the velocity diagram for the blades and derive the following: i)Tangential thrust on the blades ii)Axial thrust on the blades iii)Resultant thrust on the blades iv) Power developed in the blades v) Blading efficiency	Evaluation	2
6	One stage of an impulse turbine consists of a converging nozzle ring and one ring of moving blade. The nozzles are inclined at 22° to the blades, whose tip angles are both 35°. If the velocity of steam is at exit from nozzle is 660m/sec. Find the blade speed. So that the steam passes on without shock. Find the diagram efficiency neglecting losses if the blades are run at the speed	Evaluation	2
7	Steam with absolute velocity of 300m/sec is supplied through a nozzle to a single stage impulse turbine. The nozzle angle is 25°, the mean diameter of blade rotor is 1meter and it has a speed of 2000rpm. Find suitable blade angle for zero axial thrust. If the blade velocity coefficient is 0.9 and the steam flow rate is 10kg/sec. Calculate power developed.	Application	1
8	A simple impulse turbine has 1ring of moving blades running at 150m/sec. The absolute velocity of steam at exit from the stage is 85m/sec at an angle of 80° from the tangential direction.Blade velocity co-efficient is 0.8 and the rate of steam flowing through the stage is 2.5kg/sec. If the blades are equi angular, determine blade angle, nozzle angle and axial thrust.	Evaluation	2
9	In a single stage impulse turbine, the nozzle angle is 20°and blade angles are equal. The velocity coefficient for blade is 0.85. Find maximum blade efficiency possible if the blade axial efficiency is 92% of maximum blade efficiency; find the possible ratio of blade speed to steam speed.	Application	1
10	In a single stage steam turbine, saturated steam at 10bar is supplied to a convergent divergent steam nozzle. The nozzle angle is 20° and the mean blade speed is 400m/sec. The steam pressure leaving the nozzle is 1bar. Find i)the best blade angle if the blades are equi angular ii) the maximum power developed by the turbine if a number of nozzles used are 5and area at the throat of each nozzle is 0.6cm ² . Assume nozzle efficiency 88% and blade friction co-efficient is 0.87.	Application	1

UNIT-IV

Part – A (Short Answer Questions)

1	How are gas turbines classified.	Understand	3
2	Define gas turbine.	Remember	4
3	State the merits of gas turbines over I.C. engines and steam turbines.	Understand	3
4	Enumerate the various uses of gas turbines.	Understand	3
5	Write a short notes on fuels used for gas turbines.	Remember	4
6	State the merits of closed cycle gas turbine.	Understand	3
7	List the methods for improvement of thermal efficiency of open cycle gas turbine.	Remember	4
8	Write the applications of gas turbines.	Understand	3
9	Sketch the open cycle gas turbine.	Remember	4
10	List the effects of operating variables on thermal efficiency.	Understand	3
11	State the demerits of closed cycle gas turbine.	Remember	4
12	Sketch the closed cycle gas turbine	Understand	3

13	List the merits of closed cycle gas turbine over open cycle gas turbine.	Understand	3
14	List the uses of gas turbines.	Remember	4
15	Draw the p-V diagram for closed cycle gas turbine.	Understand	3
16	Write about liquid fuels of gas turbine.	Remember	4
17	Draw the T-s diagram for closed cycle gas turbine plant.	Understand	3
18	Write about gaseous fuels of gas turbine.	Remember	4
19	Write about solid fuels of gas turbine.	Understand	3
20	List the demerits of closed cycle gas turbine over open cycle gas turbine.	Remember	4
Part – B (Long Answer Questions)			
1	Explain the method INTER COOLING employed to increase the specific output and thermal efficiency of Gas Turbine plant? Draw the T-S diagram for the same.	Knowledge	1
2	Explain the merits and demerits of closed cycle Gas Turbine over Open cycle Gas Turbine?	Comprehension	2
3	Describe with neat sketch, the working of a simple constant pressure open cycle Gas Turbine?	Knowledge	1
4	Explain with a neat sketch, the working of a constant volume combustion Turbine	Comprehension	2
5	Explain the method REHEATING employed to increase the specific output and thermal efficiency of Gas Turbine plant and also draw the T-S diagram for the same.	Knowledge	1
6	Explain the method REGENERATION employed to increase the specific output and thermal efficiency of Gas Turbine plant and also draw the T-S diagram for the same.	Comprehension	2
7	What is the effect of thermal efficiency of open cycle Gas Turbine with the following operating variables (i)Pressure ratio ii)Turbine inlet temperature iii)Compressor inlet temperature iv)Efficiency of the turbine v)Efficiency of compressor.	Knowledge	1
8	Draw the block diagram of closed cycle gas turbine plant and also represent the processes on T-S diagram with intercooler, heat exchanger and reheating processes.	Comprehension	2
9	State the merits of gas turbines over IC engines and steam turbines. Discuss also the demerits over gas turbines.	Knowledge	1
10	Write a short notes on fuels used for gas turbines.	Comprehension	2
11	Draw p-v and T-s diagrams for Brayton cycle. Derive its efficiency.	Knowledge	1
12	Derive the expression for optimum pressure ratio of gas turbine.	concept	3
13	Derive the expression for reheating cycle of gas turbine.	Knowledge	1
14	What are the different combustion chambers available. Explain.	concept	3
15	Classify compressors. That are used in Gas turbines.	Knowledge	1
16	What is the difference between axial flow and centrifugal flow compressors	concept	3
17	Draw p-v and T-s diagram of compressor and represent its work done.	Knowledge	1
18	what are the advantages of multistage compression.	Knowledge	1
19	What are the major fields of application of Gas turbines .explain.	Comprehension	2
20	Describe and explain the different thermodynamic variable upon which the thermal efficiency of gas turbine cycle depends.	concept	3
Part - C (ANALYTICAL QUESTIONS)			
1	The air enters the compressor of an open cycle constant pressure gas turbine at a pressure of 1bar and temperature of 20 ⁰ C. The pressure of the air after compression is 4bar. The isentropic efficiency of compressor and turbine are 80% and 85% respectively. The air-fuel ratio used is 90:1. If flow rate of air is 3.0kg/sec. Find i) power developed ii) thermal efficiency of cycle. Assume Cp = 1.0KJ/KgK , $\gamma = 1.4$ of air and gases, calorific value of fuel is 41800KJ/Kg	Evaluation	2

2	A gas turbine unit has a pressure ratio of 6:1 and maximum cycle temperature of 610 ⁰ C. The isentropic efficiencies of the compressor and turbine are 0.80 and 0.82 respectively. Calculate the power output in kilowatts of an electric generator geared to the turbine when the air enters the compressor at 15 ⁰ C at the rate of 16kg/s. Take Cp=1.005 kJ/kgK and $\gamma = 1.4$ for the compression process, and take Cp=1.11kJ/kgK and $\gamma = 1.333$ for the expansion process	Application	1
3	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 ⁰ C. The working fluid can be taken as air (Cp=1.0kJ/kgK, $\gamma = 1.4$) which enters the compressor at 1bar and 27 ⁰ C. The pressure ratio is 4. The fuel used has calorific value of 42000kJ/kg. There is a loss of 10% of calorific value in the combustion chamber	Evaluation	2
4	A gas turbine plant consists of two turbines. One compressor turbine to drive compressor and other power turbine to develop power output and both are having their own combustion chambers which are served by air directly from the compressor. Air enters the compressor at 1bar and 288K and is compressed to 8bar with an isentropic efficiency of 76%. Due to heat added in the combustion chamber, the inlet temperature of gas to both turbines is 900 ⁰ C. The isentropic efficiency of turbines is 86% and the mass flow rate of air at the compressor is 23kg/s. The calorific value of fuel is 4200kJ/kg. Calculate the output of the plant and the thermal efficiency if mechanical efficiency is 95% and generator efficiency is 96%. Take Cp=1.005kJ/kgK and $\gamma = 1.4$ for air and Cpg = 1.128kJ/kgk and $\gamma = 1.34$ for gases	Application	1
5	The pressure ratio of an open-cycle gas turbine power plant is 5.6. Air is taken at 30 ⁰ C and 1bar. The compression is carried out in two stages with perfect inter cooling in between. The maximum temperature of the cycle is limited to 700C. Assuming the isentropic efficiency of eac compressor stage as 85% and that of turbine as 90%, determine the power developed and efficiency of the power plant, if the air-flow is 1.2kg/s. The mass of fuel may be neglected, and it may be assumed that Cp= 1.02 kJ/kgK and $\gamma = 1.41$	Application	1
6	In an air-standard regenerative gas turbine cycle the pressure ratio is 5. Air enters the compressor at 1bar, 300K and leaves at 490K. The maximum temperature in the cycle is 1000K. Calculate the cycle efficiency, given that the efficiency of the regenerator and adiabatic efficiency of the turbine are each 80%. Assume for air the ratio of specific heats is 1.4. Also show the cycle on a T-S diagram	Application	1
7	In a gas turbine, the compressor is driven by the high pressure turbine. The exhaust from the high pressure turbine goes to a free low pressure turbine, which runs the load. The air flow rate is 20Kg/sec and minimum and maximum temperatures are respectively 300K and 1000K. The compressor pressure ratio is 4. Calculate the pressure ratio of the low pressure turbine and temperature of exhaust gases from the unit. The compressor and turbine are isentropic. Cp=1.005kJ/kgK and $\gamma = 1.4$ for air.	Evaluation	2
8	In a closed cycle gas turbine there is two stage compressor and two stage turbine. All the components are mounted on the same shaft. The pressure and temperature at the inlet of first stage compressor are 1.5bar and 20 ⁰ C, the maximum cycle temperature and pressure are limited to 750 ⁰ C and 6bar. A perfect intercooler is used between the two stage compressor and a reheater is used between the two turbines. Gasses are heated in the reheater to 750 ⁰ C before entering the L-P turbine. Assuming the compressor and turbine efficiencies as 0.82. Calculate i) the efficiency of cycle without regenerator ii) the efficiency of the cycle with regenerator whose effectiveness is 0.70 iii) the mass of the fluid circulated if the power developed by the plant is 350Kw. The working fluid used in the cycle is air	Evaluation	2

9	Air is taken in a gas turbine plant at 1.1bar and 20 ⁰ C. The plant comprises of L.P and H.P compressors and L.P and H.P turbines. The compression in L.P stage is up to 3.3bar followed by inter cooling to 27 ⁰ C. The pressure of air after H.P compressor is 9.45bar.Loss in pressure during inter cooling is 0.15bar. Air from H.P compressor is transferred to Heat exchanger of effectiveness 0.65 where it is heated by the gases of L.P turbine. After heat exchanger the air passes through combustion chamber. The temperature of the gases supplies to H.P turbine is 700 ⁰ C. The gases expand in H.P turbine to 3.62bar and air then reheated to 670 ⁰ C before expanding in L.P turbine. The loss of pressure in re-heater is 0.12bar. Determine i) the overall efficiency ii) the work ratio iii)mass flow rate when the power generated is 6000Kw. Assume isentropic efficiency of compression in both stages 0.82. Isentropic efficiency of expansion in turbine= 0.85. Cp=1.005kJ/kg K and $\gamma = 1.4$ for air and $C_{pg} = 1.128\text{kJ/kg k}$ and $\gamma = 1.34$ for gases neglect the mass of the fuel.	Application	1
10	In a constant pressure open cycle gas turbine, air enters at 1bar and 20 ⁰ C and leaves the compressor at 5bar. Using the following data: temperature of gases entering the turbine=680 ⁰ C, pressure loss in the combustion chamber= 0.1bar. $\eta_{\text{compressor}} = 85\%$, $\eta_{\text{turbine}} = 80\%$ $\eta_{\text{combustion}} = 85\%$, $\gamma = 1.4$, Cp= 1.02 kJ/kgK for air and gas. Find i) the quantity of air circulation, if the plant develops 1065Kw ii) heat supplied for Kg of air circulation iii) thermal efficiency of the cycle. Mass of the fuel may be neglected	Evaluation	2

UNIT-V

Part - A (Short Answer Questions)

1	Explain the working difference between propeller jet and turbo jet.	Understand	3
2	State the fundamental differences between the jet propulsion and rocket propulsion.	Understand	3
3	Define jet propulsion.	Remember	4
4	List the advantages of turbo jet engines.	Understand	3
5	Explain the working difference between propeller jet and turbo prop.	Remember	4
6	Classify the jet propulsion.	Remember	4
7	List the applications of rockets.	Understand	3
8	Explain the requirements of an ideal rocket propellant.	Remember	4
9	Explain the working difference between turbo jet and turbo prop.	Understand	3
10	List the advantages of ram-jet engine.	Remember	4
11	Explain solid propellant rocket.	Understand	3
12	Explain Liquid propellant rocket	Remember	4
13	List the limitations of ram-jet engine.	Understand	3
14	Define Pulse jet engine.	Remember	4
15	List the disadvantages of turbo jet engine.	Understand	3
16	Define turbo jet.	Remember	4
17	Merits of closed cycle gas turbine.	Understand	3
18	Demerits of closed cycle gas turbine.	Remember	4
19	Merits of open cycle gas turbine.	Understand	3
20	Demerits of open cycle gas turbine.	Remember	4

Part - B (Long Answer Questions)

1	Draw the sketch of Turbo-Jet plant with T-S diagram of Turbo-Jet engine and explain?	Comprehension	2
2	Explain the working principle of Ram-Jet with diagram.		
3	What are the advantages and disadvantages of Pulse Jet engines?	Comprehension	2

4	What are the requirements of an ideal Rocket propellant and applications of Rockets.		
5	Explain the thermal analysis of turbojet engine	Comprehension	2
6	State the fundamental differences between the jet propulsion and rocket propulsion	Describe	3
7	Classify rockets and explain solid and liquid propellant rockets	explain	3
8	What are the advantages and disadvantages of turbojet engines?	Comprehension	2
9	Explain with the help of entropy and enthalpy diagrams a turbojet gas turbine plant? How it differs from Turbo Prop plant?	knowledge	1
10	Briefly explain different methods to augment the thrust in propulsion engines .	Comprehension	2
11	With the help of a neat diagram, explain the function of a pulse jet engine along with its applications	knowledge	1
12	Explain the working of turbojet engine with neat sketches of layout, pressure, temperature and velocity profiles along the length of the engine?	Comprehension	2
13	Classify various propulsive devices?	Comprehension	2
14	Differentiate between jet and rocket engines.	Comprehension	2
15	What are the advantages of Turbojet engines	Comprehension	2
16	explain the thermal analysis of each component of turbojet by using steady flow energy equation.	explain	3
17	explain the functioning of Turbo-prop with neat diagram	Comprehension	2
18	What are the applications of rockets explain.	concept	3
19	Explain the working difference between propeller jet, and turbo jet .	analysis	4
20	Explain the working difference between turbo jet and turbo prop.	analysis	4

Part - C (ANALYTICAL QUESTIONS)

1	A turbojet has a speed of 750km/h while flying at an altitude of 10000m, the propulsive efficiency of the jet is 50% and overall efficiency of the turbine plant is 16%. The density of air at 10000m altitude is 0.173kg/m ³ . The drag on the plank is 6250 N, the calorific value of the fuel is 48000KJ/Kg. Calculate. i). absolute velocity of the jet . ii) volume of the air compressed per minute	Evaluation	1
2	A turbojet engine flying at a speed of 960km/hour consumes air at the rate of 54.5kg/sec. Calculate i) exit velocity of the jet when the enthalpy change for the nozzle is 200Kj/kg and velocity co-efficient is 0.97. ii) fuel flow rate in kg/sec, when air fuel ratio is 75:1. b) For the above problem also calculate i) thrust specific fuel consumption ii) Thermal efficiency of the plant when the combustion efficiency is 93 % and calorific value of the fuel is 45000 kJ/kg. iii) Propulsive power and efficiency	Evaluation	2
3	A turbo-jet engine consumes air at the rate of 60.2 kg/s when flying at speed of 1000km/h. Calculate: i)Exit velocity of the jet when the enthalpy change for the nozzle is 230KJ/Kg and velocity co-efficient is 0.96. ii) Fuel flow rate in Kg/sec when air-fuel ratio is 70:1iii) Thrust specific fuel consumption iv) Thermal efficiency of the plant when the combustion efficiency is 92% and calorific value of the fuel used is 42000KJ/kg. v)Propulsive power vi)propulsive efficiency vii)Overall efficiency	Application	1
4	In a jet propulsion unit, the total pressure and temperature at intake to the compressor are 0.6bar and 0°C the speed of the propulsion unit is 190m/sec. The total temperature and total pressure of gases after the combustion entering the turbine 750°C and 3.1bar. The speed of the propulsion unit is 190m/sec. The isentropic efficiencies of compressor and turbine are 85% and 80% respectively. The static back pressure of the propulsion nozzle is 0.52 bar and the efficiency of the nozzle based on total pressure drop available is 90%. Determine (a) power consumed by the compressor per kg of air(b) the air-fuel ratio if the calorific value of fuel is 41840kJ/kg of fuel	Evaluation	2

5	A high altitude flight jet propeller air craft is flying with a speed of 367m/sec, the ambient atmospheric pressure and temperature are 0.01 Mpa and -40°C . The temperature and the pressure of the gases entering the turbine are 827°C and 0.2Mpa, isentropic efficiency of compressor and turbine are 80% and 85% respectively. The ram air efficiency is 80%. The back pressure on the nozzle may be assumed as ambient pressure and efficiency of nozzle base on total pressure drop available is 90%. Neglecting the other losses and mass increased due to fuel consume. Determine compressor power per kg per sec and thrust per kg per sec. Also calculate thermal efficiency. Assume for gasses in combustion chamber, turbine and jet pipe $C_p=1.12\text{kJ/kgK}$ and $\gamma = 1.33$ and for air $\gamma = 1.4$ and $R=0.287\text{kJ/kgK}$	Application	1
6	A turbojet aircraft is flying at a speed of 287m/sec, where the ambient conditions are 0.5bar and 200°C . The compressor pressure ratio is 8. The maximum cycle temperature is not to exceed 1250K, with fuel of calorific value of 44000kJ/kg. The pressure loss in the combustion chamber is 0.1bar. The various efficiencies are listed as : Ram air efficiency is 90%, Isentropic efficiency of compressor and turbine are 85% and 80% respectively. Combustion efficiency is 98%, nozzle efficiency is 90%. If the outlet area of the nozzle is 0.1m^2 . Determine the mass flow rate, the thrust developed and specific fuel consumption.	Evaluation	2
7	In a jet propulsion unit, the total pressure and temperature at intake to the compressor are 0.6bar and 0°C the speed of the propulsion unit is 190m/sec. The total temperature and total pressure of gases after the combustion entering the turbine 750°C and 3.1bar. The speed of the propulsion unit is 190m/sec. The isentropic efficiencies of compressor and turbine are 85% and 80% respectively. The static back pressure of the propulsion nozzle is 0.52 bar and the efficiency of the nozzle based on total pressure drop available is 90%. Determine (a) the total pressure of gas leaving the turbine (b) thrust per kg of air per second	Application	1
8	A turbojet engine flying at a speed of 920km/hour consumes air at the rate of 44.5kg/sec. Calculate i) exit velocity of the jet when the enthalpy change for the nozzle is 200Kj/kg and velocity co-efficient is 0.87. ii) fuel flow rate in kg/sec, when air fuel ratio is 65:1. b) For the above problem also calculate i) thrust specific fuel consumption ii) Thermal efficiency of the plant when the combustion efficiency is 90 % and calorific value of the fuel is 45000 kJ/kg. iii) Propulsive power and efficiency	Evaluation	2
9	A turbo jet engine consumes air at the rate of 60.2 kg/s when flying at a speed of 1000km/h .calculate fuel flow rate in kg/s if the air-fuel ratio is 70:1.	Application	1
10	A turbo jet engine consumes air at the rate of 60.2 kg/s when flying at a speed of 1000km/h .calculate thrust fuel consumption.	Evaluation	2

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