INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**THERMAL ENGINEERING**				
Course Code	AME013				
Programme	B Tech				
Semester	V	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. P. Sadanandam, Assistant Professor				
Course Faculty	Dr. CH VKNSN Moorthy, Professor Mr. P. Sadanandam, Assistant Professor				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Understand ideal and air standard vapor cycle and evaluate the performance in open systems like steam power plant, gas turbine etc.
II	Analyse different air standard cycles specifically related to IC engines and solve problems on the intricacies of performance of the cycle
III	Understand the direction law and concept of entropy increase of the universe.

COURSE OUTCOMES (COs)

COs	Course Outcome
CO1	Discuss the Carnot vapor cycle and basic concept of steam power plant working cycle & modification of Rankine cycle.
CO2	Understand the working principles of different types of steam generators, mounting and accessories and also understand the types of nozzles as well as turbines
CO3	Understand the shape of blades, there work output of typical turbine stages with its velocity diagram and also working principles of condensers. Understand the turbine design and its applications.
CO4	Explore the concept of heat transfer principles in gas turbines and Carry out performance calculations of real Gas turbines
CO5	Understand the fundamentals of jet propulsion and understand the concepts of Rocket propulsion and its classification

COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:
AME013.01	CLO 1	Discuss the basic concepts of thermodynamics in the analysis for Carnot vapor power cycle.
AME013.02	CLO 2	Determine the efficiency and output of a basic and modern Rankine cycle steam power plant from given data.
AME013.03	CLO 3	Determine the efficiency of a modified Rankine cycle including superheat, reheat, and regeneration techniques.
AME013.04	CLO 4	Discuss the concept of stoichiometric analysis of fuels and combustion.
AME013.05	CLO 5	Discuss different types of steam generators and its working principles.
AME013.06	CLO 6	Discuss mountings and accessories of boilers.
AME013.07	CLO 7	Understand the working of different types of steam nozzles and its applications, conditions for maximum discharge of steam through it.
AME013.08	CLO 8	Classify different types of steam turbines and working of impulse turbine and its performance parameters and methods of compounding to reduce rotor speed of an impulse turbine.
AME013.09	CLO 9	Explain the blade shapes, and calculate work output of typical turbine stages with its velocity diagrams.
AME013.10	CLO 10	Demonstrate different types of condensers and its working principles.
AME013.11	CLO 11	Recognize the different gas turbine arrangements, their advantages and disadvantages and different applications application.
AME013.12	CLO 12	Applying the relation between gas turbine design, application and environment.
AME013.13	CLO 13	Applying the basic thermodynamic and heat transfer principles in performance calculation of industrial gas turbines
AME013.14	CLO 14	Recognizing the differences of a real cycle (from the theoretical ones)
AME013.15	CLO 15	Carry out performance calculations of real Gas turbines
AME013.16	CLO 16	Examine the effect of various design parameters on the GT performance (pressure ratio, temperature ratio, pressure drop, polytrophic efficiency ...etc.).
AME013.17	CLO 17	Explain the fundamentals of jet propulsion and basic propulsion cycle
AME013.18	CLO 18	Examine the effect of various design parameters of the jet propulsion performance and its efficiency etc.
AME013.19	CLO 19	Discuss the concepts of Rocket propulsion and its classification.

S No	QUESTION	Blooms taxonomy level	Course Outcomes	Course Learning Outcomes
	UNIT – I			
	Part - A (Short Answer Questions)			
1	Define rankine cycle.	Remember	CO 1	AME013.04
2	Define reheating cycle.	Understand	CO 1	AME013.03
3	Write the different operations in rankine cycle.	Understand	CO 1	AME013.03
4	What is the efficiency of rankine cycle?	Remember	CO 1	AME013.04
5	Differentiate between rankine and carnot cycle.	Understand	CO 1	AME013.03
6	Write the different methods to improve performance of rankine cycle.	Remember	CO 1	AME013.03
7	What do you mean by mean temperature?	Understand	CO 1	AME013.03

8	Draw the mechanical system to show different process of Rankine	Understand	CO 1	AME013.03
9	What does Rankine cycle comprises of?	Remember	CO 1	AME013.04
10	In which operation of steam engines, the vapour cycle is adopted?	Understand	CO 1	AME013.04
11	What is the range of Rankine cycle efficiency of a good steam power plant?	Remember	CO 1	AME013.04
12	Discuss shortly on flue gas analysis.	Understand	CO 1	AME013.03
13	Discuss shortly on regenerative cycle.	Understand	CO 1	AME013.03
14	Explain the adiabatic flame temperature?	Remember	CO 1	AME013.04
15	Classify the fuels.	Understand	CO 1	AME013.04
16	List the advantages of liquid fuels.	Remember	CO 1	AME013.04
17	List the advantages of gaseous fuels.	Understand	CO 1	AME013.03
18	Define Calorific value of fuel.	Remember	CO 1	AME013.04
19	Define the Fuel.	Understand	CO 1	AME013.03
20	Define the producer gas.	Remember	CO 1	AME013.04
	Part - B (Long Answer Questions)			
1	Explain working principle of Rankine cycle with a neat sketch.	Remember	CO 1	AME013.01
2	Classify and explain the classification of fuels	Remember	CO 1	AME013.01
3	Explain Adiabatic flame temperature.	Understand	CO 1	AME013.02
4	Explain the Regenerative cycle in detail with a neat sketch.	Remember	CO 1	AME013.01
5	How do you analyses the exhaust and flue gases by using Orsat's apparatus. Explain with neat diagram.	Understand	CO 1	AME013.02
6	How can you convert weight analysis in volumetric analysis?	Remember	CO 1	AME013.01
7	What is meant by stoichiometric Air fuel ratio?	Understand	CO 1	AME013.02
8	Explain the Reheat cycle in detail with a neat sketch.	Remember	CO 1	AME013.01
9	Explain the advantages and disadvantages of Reheating?	Remember	CO 1	AME013.01
10	Compare Rankine cycle and Carnot cycle?	Understand	CO 1	AME013.02
11	Derive the expression for efficiency of reheat cycle and compare with Rankine cycle.	Remember	CO 1	AME013.01
12	Discuss what are the Various methods for improving Performance of a rankine cycle?	Understand	CO 1	AME013.02
13	What are the various parameters improving efficiency of Rankine	Understand	CO 1	AME013.02
14	Draw the effect of efficiency of Rankine Cycle upon decreasing condenser pressure. Explain?	Understand	CO 1	AME013.03
15	Draw the effect of efficiency of Rankine Cycle upon increasing temperature of turbine Explain.	Understand	CO 1	AME013.03
16	Draw the effect of efficiency of Rankine Cycle upon superheating.	Understand	CO 1	AME013.03
17	What are the limitations of Carnot cycle?	Remember	CO 1	AME013.02
18	Draw the basic components of Rankine cycle and explain the function of each.	Understand	CO 1	AME013.03
19	Explain the combustion phenomena of hydrogen.	Understand	CO 1	AME013.02
20	Explain the combustion phenomena of carbon.	Understand	CO 1	AME013.02
	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	Understand	CO 1	AME013.03

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	CO 1	AME013.03
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	Understand	CO 1	AME013.01
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.	Understand	CO 1	AME013.01
5	Super-heated steam at a pressure of 10bar and 400 C is supplied to a steam engine. Adiabatic expansion takes place to release point at 0.9bar and it exhaust s into a condenser at 0.3bar. Neglecting clearance, determine for a steam flow rateof1.5kg/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	Understand	CO 1	AME013.03
6	Steam is supplied to a Turbine at a pressure of 30bar and at a temperature of 400 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 of130^0C. The condensed steam from the feed water is cooled in a drain coolert 2^0C. The feed water passes through the drain cooler before entering thefeed 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.	Understand	CO 1	AME013.01
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%	Determine	CO 1	AME013.01
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.	Understand	CO 1	AME013.03
9	Determine the gravimetric analysis of the products of complete combustion of acetylene with 200% stoichiometric air	Understand	CO 1	AME013.01
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	Understand	CO 1	AME013.01
	UNIT – II			
	Part – A (Short Answer Questions)			
1	What is a water tube boiler?	Understand	CO 2	AME013.05
2	List out any four loss components in a heat balance of a boiler.	Remember	CO 2	AME013.06

3	Define boiler.	Remember	CO 2	AME013.06
4	What is a fire tube boiler?	Understand	CO 2	AME013.05
5	What are the main losses which are not accounted in an indirect method of boiler efficiency testing?	Remember	CO 2	AME013.06
6	Write the formula for evaluation of boiler efficiency by direct method.	Remember	CO 2	AME013.06
7	Write about boiler mountings.	Remember	CO 2	AME013.07
8	Differentiate between high pressure and low pressure boiler.	Understand	CO 2	AME013.05
9	List the advantages of high pressure boilers	Remember	CO 2	AME013.06
10	Write about boiler accessories	Remember	CO 2	AME013.05
11	Name the various types of nozzles and their function?	Understand	CO 2	AME013.06
12	Define critical pressure ratio.	Remember	CO 2	AME013.05
13	Analyze the effects of super saturation in a nozzle?	Understand	CO 2	AME013.05
14	Explain critical pressure ratio of a steam nozzle?	Remember	CO 2	AME013.06
15	Calculate the value of critical pressure ratio for saturated and supersaturated steam.	Remember	CO 2	AME013.05
16	List the factors reducing the final velocity of steam in nozzle flow?	Understand	CO 2	AME013.06
17	Differentiate between supersaturated flow and isentropic flow.	Remember	CO 2	AME013.05
18	Write the expression for critical pressure ratio in a steam nozzle.	Understand	CO 2	AME013.07
19	Express the effects of friction on the flow through a steam nozzle?	Remember	CO 2	AME013.05
20	Define nozzle efficiency.	Understand	CO 2	AME013.06
	Part – B (Long Answer Questions)			
1	State the differences between the following boilers? Externally fired and internally fired boilers	Remember	CO 2	AME013.05
2	State the differences between the High Pressure and low Pressure	Understand	CO 2	AME013.06
3	Explain the following boiler terms : Shell, setting, grate, furnace, water space and steam space	Remember	CO 2	AME013.05
4	Explain the terms mountings, accessories, water level, blowing off, lagging refractory	Understand	CO 2	AME013.06
5	Give the construction and working of the Babcock and Wilcox water tube boilers?	Remember	CO 2	AME013.05
6	Explain with neat sketch, the construction and working of the La Mont boiler and Bension boiler.	Remember	CO 2	AME013.06
7	Explain with neat sketches any three of the following mountings? i)water level indicator ii) Pressure gauge iii)Feed check valve iii)Blow-off cock iv)High steam and low water safety valve	Understand	CO 2	AME013.07
8	Explain the concept of discharge through the nozzle.	Remember	CO 2	AME013.07
9	Derive the conditions for discharge and its maximum value of a nozzle.	Understand	CO 2	AME013.05
10	Explain the concept of Meta stable state while representing Wilson line on h-s diagram.	Remember	CO 2	AME013.05
11	What is the effect of friction on nozzle efficiency explain with T-S diagram.	Understand	CO 2	AME013.06
12	Derive the expression for exit velocity of a nozzle using Steady flow energy equation..	Remember	CO 2	AME013.06
13	Differentiate between Forced circulation and natural circulation boilers.	Understand	CO 2	AME013.06
14	Explain the concept of Wilson line and represent it on h-s Diagram.	Remember	CO 2	AME013.07
15	Classify nozzles with neat sketches.	Remember	CO 2	AME013.07
16	Enumerate the terminology of boilers.	Remember	CO 2	AME013.05
17	Write a brief classification of steam generators.	Understand	CO 2	AME013.06
18	Explain the function of Cochran fire tube boiler with neat sketch.	Remember	CO 2	AME013.07
19	Write the function of fusible plug .Explain.	Remember	CO 2	AME013.05

20	Explain the function of Air Preheater and Economizer.	Remember	CO 2	AME013.06
	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.	Remember	CO 2	AME013.05
2	The nozzles of a De-laval 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.	Understand	CO 2	AME013.06
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 or 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	Remember	CO 2	AME013.07
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 0 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	Remember	CO 2	AME013.05
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.	Remember	CO 2	AME013.06
6	Steam at a pressure of 12 bar and dryness fraction 0.6 is discharged through a convergent divergent nozzle to a aback pressure of 0.1 bar. if the power developed is 220 kW. The mass flow rate is 7kg/kwh. Determine Throat pressure.	Understand	CO 2	AME013.06
7	In a convergent – divergent nozzle, the steam enters at 10 bar and 285C 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%.	Remember	CO 2	AME013.07
8	Steam is expanded in a set of nozzles from 10 bar and 25^{0}C to 5 bar. What type of nozzle is it .Assume the expansion to be isentropic.	Understand	CO 2	AME013.07
9	In a convergent – divergent nozzle, the steam enters at 15 bar and 300C 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%.	Remember	CO 2	AME013.05
10	Steam enters the nozzle at a pressure of 2 MPa and 400C 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	Understand	CO 2	AME013.06

	UNIT-III			
	Part - A (Short Answer Questions)			
1	Explain 'degree of reaction' in a steam turbine.	Understand	CO 3	AME013.08
2	List the functions of governors in steam turbine.	Remember	CO 3	AME013.09
3	Differentiate between impulse and reaction turbine	Understand	CO 3	AME013.08
4	Discuss the importance of compounding of steam turbine.	Remember	CO 3	AME013.09
5	Explain the following terms for reaction turbines: (i) Diagram efficiency and (ii) Stage efficiency	Understand	CO 3	AME013.10
6	Illustrate the pressure and velocity compounding diagram of multi stage turbine with a neat sketch.	Remember	CO 3	AME013.11
7	Classify the steam turbines.	Understand	CO 3	AME013.11
8	List the advantages of steam turbine over the steam engines.	Remember	CO 3	AME013.10
9	Define the reaction turbine.	Understand	CO 3	AME013.09
10	List the conditions for Maximum Efficiency of Reaction turbines.	Remember	CO 3	AME013.08
11	List the energy losses in steam turbine.	Understand	CO 3	AME013.08
12	What methods are used in reducing the speed of the turbine rotor?	Remember	CO 3	AME013.09
13	Explain Reheat factor.	Understand	CO 3	AME013.10
14	Define the term "Degree of Reaction" used in reaction turbines.	Remember	CO 3	AME013.11
15	Explain bleeding of steam turbines.	Understand	CO 3	AME013.10
16	List the various methods of 'steam turbine governing'.	Remember	CO 3	AME013.11
17	Classify Condensers.	Understand	CO 3	AME013.10
18	Compare between Jet and Surface Condensers.	Remember	CO 3	AME013.11
19	Define steam condenser and state its objects.	Understand	CO 3	AME013.10
20	State the organs of a steam condensing plant.	Remember	CO 3	AME013.11
	Part – B (Long Answer Questions)			
1	Draw the velocity diagram of impulse Turbine and find the work done on the blade, blade efficiency.	Understand	CO 3	AME013.08
2	Derive the expression for condition for maximum efficiency of an impulse Turbine?	Remember	CO 3	AME013.09
3	What are the advantages and disadvantages of velocity compounded Impulse Turbine.	Understand	CO 3	AME013.08
4	Define the following: i)Blade efficiency ii)Stage efficiency iii)overall efficiency	Remember	CO 3	AME013.09
5	What are the methods of reducing wheel or rotor speed	Understand	CO 3	AME013.09
6	What are the differences between Impulse turbine and reaction turbine?	Remember	CO 3	AME013.10
7	Classify Steam turbine with different considerations.	Understand	CO 3	AME013.09
8	Explain the concept of pressure compounding. with neat diagram	Remember	CO 3	AME013.10
9	Explain the concept of velocity compounding. With neat diagram.	Understand	CO 3	AME013.09
10	Explain the concept of pressure and velocity compounding. with neat diagram	Remember	CO 3	AME013.10
11	What are the types of Condensers? Classify?	Understand	CO 3	AME013.11
12	Compare the Jet Condensers and Surface Condensers with? Determine the mass of cooling water?	Remember	CO 3	AME013.10
13	Define degree of reaction and prove that Parsons Reaction turbine is a 50 % reaction turbine.	Understand	CO 3	AME013.11
14	Derive the condition for maximum efficiency of reaction turbine with giving assumptions to be followed.	Remember	CO 3	AME013.10
15	Define the terms Vacuum efficiency and Condenser efficiency.	Understand	CO 3	AME013.11

16	Explain working principle of Low level Jet Condenser with neat	Remember	CO 3	AME013.10
17	Explain working principle of Surface Condenser with neat sketch?	Remember	CO 3	AME013.09
18	What the sources of air leakage in to the condensers? How its pressure is determined?	Remember	CO 3	AME013.10
19	Explain the function of cooling the air before it is to be extracted from the condenser?	Understand	CO 3	AME013.08
20	Discus the merits and demerits of surface condensers and jet condensers, which type is recommended for large plants?	Remember	CO 3	AME013.10
	Part - C (Analytical Questions)			
1	A stage of a steam turbine is supplied with steam at a pressure of 50 bars and 350C, 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	Remember	CO 3	AME013.08
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 blade efficiency. The nozzle angle is 20^o. Considering equiangular blades and neglecting blade friction, the steam flow of 0.6 kg/s. calculates the diagram power	Remember	CO 3	AME013.09
3	In a De-Laval turbine, steam issues from the nozzle with a velocity of 1200m/sec, the nozzle angle is 20^o, 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	Understand	CO 3	AME013.10
4	A single stage steam Turbine is supplied with steam at 5bar and 200C at the rate of 50Kg/min. It expands into a condenser at a pressure of 0.2bar. The blade speed is 400 m/sec. The nozzles are inclined at an angle of 20 to the plane of wheel and outlet blade angle is 30^o. Neglecting friction losses. Determine the power developed , blade efficiency and stage efficiency	Remember	CO 3	AME013.10
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^o, 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 3^0 less than the inlet angle. The steam flowis10kg/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) Blade efficiency	Understand	CO 3	AME013.11
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^o to the blades, whose tip angles are both 35^o 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	Understand	CO 3	AME013.08
7	Steam with absolute velocity of 300m/sec is supplied through a nozzle to a single stage impulse turbine. The nozzle angle is 25^o, 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.	Remember	CO 3	AME013.09

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^o 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.	Understand	CO 3	AME013.10
9	In a single stage impulse turbine, the nozzle angle is 20^o 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.	Remember	CO 3	AME013.11
10	In a single stage steam turbine, saturated steam at 10bar is supplied to a convergent divergent steam nozzle. The nozzle angle is 20^o 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 0.6 cm^2. Assume nozzle efficiency is 88% and blade friction co-efficient is 0.87.	Remember	CO 3	AME013.11
	UNIT-IV			
	`Part – A (Short Answer Questions)			
1	How are gas turbines classified?	Understand	CO 4	AME013.12
2	Define gas turbine.	Remember	CO 4	AME013.13
3	State the merits of gas turbines over I.C. engines and steam turbines.	Understand	CO 4	AME013.14
4	Enumerate the various uses of gas turbines.	Understand	CO 4	AME013.15
5	Write a short notes on fuels used for gas turbines.	Remember	CO 4	AME013.12
6	State the merits of closed cycle gas turbine.	Understand	CO 4	AME013.12
7	List the methods for improvement of thermal efficiency of open cycle gas turbine.	Remember	CO 4	AME013.13
8	Write the applications of gas turbines.	Understand	CO 4	AME013.14
9	Sketch the open cycle gas turbine.	Remember	CO 4	AME013.15
10	List the effects of operating variables on thermal efficiency.	Understand	CO 4	AME013.12
11	State the demerits of closed cycle gas turbine.	Remember	CO 4	AME013.13
12	Sketch the closed cycle gas turbine	Understand	CO 4	AME013.14
13	List the merits of closed cycle gas turbine over open cycle gas turbine.	Understand	CO 4	AME013.12
14	List the uses of gas turbines.	Remember	CO 4	AME013.13
15	Draw the p-V diagram for closed cycle gas turbine.	Understand	CO 4	AME013.13
16	Write about liquid fuels of gas turbine.	Remember	CO 4	AME013.14
17	Draw the T-s diagram for closed cycle gas turbine plant.	Understand	CO 4	AME013.15
18	Write about gaseous fuels of gas turbine.	Remember	CO 4	AME013.15
19	Write about solid fuels of gas turbine.	Understand	CO 4	AME013.14
20	List the demerits of closed cycle gas turbine over open cycle gas turbine.	Remember	CO 4	AME013.14
	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.	Remember	CO 4	AME013.12
2	Explain the merits and demerits of closed cycle Gas Turbine over Open cycle Gas Turbine?	Understand	CO 4	AME013.12
3	Describe with neat sketch, the working of a simple constant pressure open cycle Gas Turbine?	Remember	CO 4	AME013.13

4	Explain with a neat sketch, the working of a constant volume combustion Turbine	Understand	CO 4	AME013.14
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.	Remember	CO 4	AME013.15
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.	Understand	CO 4	AME013.12
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.	Remember	CO 4	AME013.13
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.	Understand	CO 4	AME013.14
9	State the merits of gas turbines over IC engines and steam turbines. Discuss	Remember	CO 4	AME013.12
10	Write a short notes on fuels used for gas turbines.	Understand	CO 4	AME013.13
11	Draw p-v and T-s diagrams for Brayton cycle. Derive its efficiency.	Remember	CO 4	AME013.14
12	Derive the expression for optimum pressure ratio of gas turbine.	Remember	CO 4	AME013.12
13	Derive the expression for reheating cycle of gas turbine.	Remember	CO 4	AME013.13
14	What are the different combustion chambers available? Explain.	Remember	CO 4	AME013.14
15	Classify compressors. That are used in Gas turbines.	Remember	CO 4	AME013.12
16	What is the difference between axial flow and centrifugal flow	Remember	CO 4	AME013.13
17	Draw p-v and T-s diagram of compressor and represent its work done.	Remember	CO 4	AME013.14
18	What are the advantages of multistage compression?	Remember	CO 4	AME013.15
19	What are the major fields of application of Gas turbines? Explain.	Understand	CO 4	AME013.15
20	Describe and explain the different thermodynamic variable upon which the thermal efficiency of gas turbine cycle depends.	Remember	CO 4	AME013.14
	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^o 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 , γ =1.4 of air and gases, calorific value of fuel is 41800KJ/Kg	Understand	CO 4	AME013.16
2	A gas turbine unit has a pressure ratio of 6:1 and maximum cycle temperature of 610 ^{o} 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^o C at the rate of 16kg/s. Take Cp=1.005 kJ/kgK and γ=1.4 for the compression process, and take Cp=1.11kJ/kgK and γ =1.333for the expansion process	Remember	CO 4	AME013.15
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 875C. The working fluid can be taken as air (Cp=1.0kJ/kgK, γ =1.4) which enters the compressor at 1bar and 27 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	Understand	CO 4	AME013.16

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^o 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 C_p=1.005kJ/kgK and γ =1.4 for air and C_{pg} = 1.128kJ/kgk and γ = 1.34 for gases	Remember	CO 4	AME013.16
5	The pressure ratio of an open-cycle gas turbine power plant is 5.6. Air is taken at 30^o 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 700 C. 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 γ = 1.41	Remember	CO 4	AME013.15
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	Remember	CO 4	AME013.15
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 γ =1.4 for air.	Understand	CO 4	AME013.16
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 C, The maximum cycle temperature and pressure are limited to 750 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 75^0C 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	Understand	CO 4	AME013.15

9	Air is taken in a gas turbine plant at 1.1bar and 20^0C. 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 27^0C. The pressure of air after H.P compressor is 9.45bar.Loss in pressure duringintercoolingis 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 700^0C The gases expand in H.P turbine to 3.62bar and air then reheated to 670^0C 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 γ =1.4 for air and C_{pg} = 1.128kJ/kg k and γ = 1.34 for gases neglect the mass of the fuel.	Remember	CO 4	CAME013.15
10	In a constant pressure open cycle gas turbine, air enters at 1bar and 20^0C and leaves the compressor at 5bar. Using the following data: temperature of gases entering the turbine=680^0C, pressure loss in the combustion chamber= 0.1bar. η compressor = 85%, ηturbine =80% ηcombustion= 85%,γ =1.4, Cp=1.02kJ/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	Understand	CO 4	CAME013.16
	UNIT-V			
	Part - A (Short Answer Questions)			
1	Explain the working difference between propeller jet and turbo jet.	Understand	CO 5	CAME013.17
2	State the fundamental differences between the jet propulsion and rocket	Understand	CO 5	CAME013.18
3	Define jet propulsion.	Remember	CO 5	CAME013.17
4	List the advantages of turbo jet engines.	Understand	CO 5	CAME013.18
5	Explain the working difference between propeller jet and turbo prop.	Remember	CO 5	CAME013.17
6	Classify the jet propulsion.	Remember	CO 5	CAME013.18
7	List the applications of rockets.	Understand	CO 5	CAME013.17
8	Explain the requirements of an ideal rocket propellent.	Remember	CO 5	CAME013.17
9	Explain the working difference between turbo jet and turbo prop.	Understand	CO 5	CAME013.18
10	List the advantages of ram-jet engine.	Remember	CO 5	CAME013.18
11	Explain solid propellent rocket.	Understand	CO 5	CAME013.19
12	Explain Liquid propellent rocket	Remember	CO 5	CAME013.19
13	List the limitations of ram-jet engine.	Understand	CO 5	CAME013.19
14	Define Pulse jet engine.	Remember	CO 5	CAME013.19
15	List the disadvantages of turbo jet engine.	Understand	CO 5	CAME013.17
16	Define turbo jet.	Remember	CO 5	CAME013.18
17	Merits of closed cycle gas turbine.	Understand	CO 5	CAME013.19
18	Demerits of closed cycle gas turbine.	Remember	CO 5	CAME013.17
19	Merits of open cycle gas turbine.	Understand	CO 5	CAME013.19
20	Demerits of open cycle gas turbine.	Remember	CO 5	CAME013.18
	Part - B (Long Answer Questions)			
1	Draw the sketch of Turbo-Jet plant with T-S diagram of Turbo-Jet engine and explain?	Understand	CO 5	CAME013.18
2	Explain the working principle of Ram-Jet with diagram.	Understand	CO 5	CAME013.17
3	What are the advantages and disadvantages of Pulse Jet engines?	Understand	CO 5	CAME013.17

4	What are the requirements of an ideal Rocket propellant and applications of Rockets.	Remember	CO 5	AME013.19
5	State the fundamental differences between the jet propulsion and rocket	Remember	CO 5	AME013.19
6	Classify rockets and explain solid and liquid propellant rockets	Understand	CO 5	AME013.19
7	What are the advantages and disadvantages of turbojet engines?	Understand	CO 5	AME013.17
8	Explain with the help of entropy and enthalpy diagrams a turbo jet gas	Remember	CO 5	AME013.17
9	Briefly explain different methods to augment the thrust in propulsion	Understand	CO 5	AME013.18
10	With the help of a neat diagram, explain the function of a pulsejetengine	Remember	CO 5	AME013.18
11	Explain the working of turbojet engine with neat sketchesoflayout,	Understand	CO 5	AME013.17
12	Classify various propulsive devices?	Understand	CO 5	AME013.17
13	Differentiate between jet and rocket engines.	Understand	CO 5	AME013.18
14	What are the advantages of Turbo jet engines	Understand	CO 5	AME013.19
15	Explain the thermal analysis of each component of turbojet byusingsteady	Understand	CO 5	AME013.18
16	Explain the functioning of Turbo-prop with neat diagram	Understand	CO 5	AME013.18
17	What are the applications of rockets explain.	Remember	CO 5	AME013.18
18	Explain the working differentness between propeller jet, and	Understand	CO 5	AME013.19
19	Explain the working difference between turbo jet and turboprop.	Understand	CO 5	AME013.18
20	Explain the thermal analysis of turbojet engine	Remember	CO 5	AME013.17
	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/m3. The drag on the plank is 6250 N, the calorific value of the fuel is 48000KJ/Kg. Calculate. i). absolute velocity of	Remember	CO 5	AME013.18
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	Understand	CO 5	AME013.18
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	Understand	CO 5	AME013.17
4	In a jet propulsion unit, the total pressure and temperature at intake to the compressor are 0.6bar and 0^0C the speed of the propulsion unit is 190m/sec. The total temperature and total pressure of gases after the combustion entering the turbine 750^0C 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%.	Remember	CO 5	AME013.18

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 Mpaand - 0^0C. The temperature and the pressure of the gases entering theturbine are 827^0C 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 Cp=1.12kJ/kgK and γ = 1.33 and for air γ = 1.4 and R=0.287kJ/kgK	Remember	CO 5	AME013.17
6	A turbojet aircraft is flying at a speed of 287m/sec, where the ambient conditions are 0.5bar and 200C. The compressor pressure ratio is 8.Themaximum 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 turbines are 85% and 80% respectively. Combustion efficiency is 98%, nozzle efficiency is 90%. If the outlet area of the nozzle is 0.1m2. Determine the mass flow rate, the thrust developed and specific fuel consumption.	Understand	CO 5	AME013.18
7	In a jet propulsion unit, the total pressure and temperature at intake to the compressor are 0.6bar and 00 the speed of the propulsion unit is 190m/sec.The total temperature and total pressure of gases after the combustion entering the turbine 7500C 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 is0.52 bar and the efficiency of the nozzle based on total pressure drop available is 90%.	Remember	CO 5	AME013.17
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	Understand	CO 5	AME013.18
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 is70:1.	Remember	CO 5	AME013.17
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.	Understand	CO 5	AME013.18

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