Code No: RT31035 **R13** SET - 1

III B. Tech I Semester Regular/Supplementary Examinations, October/November - 2017

THERMAL ENGINEERING – II

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1	a)	Draw the different processes of Rankine cycle on a T-S diagram. Mention the different operations of Rankine cycle.	[3M]
	b)	Write any Six comparisons between fire tube and water tube boilers.	[4M]
	c)	Mention various types of nozzles and distinguish their features.	[4M]
	d)	Write the expression for blade efficiency for a single stage reaction turbine for getting the maximum blade efficiency.	[4M]
	e)	List out the differences between the open cycle gas turbines and closed cycle gas turbines.	[3M]
	f)	Brief the working differences between the propeller-jet, turbojet and turbo-prop.	[4M]

PART -B

2	a)	Write short note on adiabatic flame temperature.	[4M]
	b)	In a Rankine cycle, the steam at inlet to turbine is saturated at pressure of 30 bar and exhaust pressure is 0.25 bar. Determine (i)The pump work (ii) Turbine work (iii) Rankine efficiency (iv) Condenser heat flow (v) dryness at the end of expansion. Assume flow rate of 10 kg/s.	[12M]
3	a)	Explain the working of Babcock and Wilcox boiler with the help of a neat sketch.	[8M]
	b)	A boiler is to provide 7000 kg/hr of steam with superheated by 40ºC at a pressure of 20bar. The temperature of water is 60ºC. If the thermal efficiency of the boiler is 75%, how much fuel oil will be consumed in one hour? The calorific value of oil used is 45000 kJ/kg. Take specific heat of superheated steam as 2.093 kJ/kg K and also calculate the equivalent evaporation from and at 100ºC.	[8M]
4	a)	Derive an expression for maximum mass flow per unit area of flow through a convergent- divergent nozzle when steam expands isentropic ally from rest.	[8M]
	b)	What do you mean by compounding of steam turbine? Discuss various methods of compounding steam turbines?	[8M]
5	a)	In a surface condenser the vacuum reading is 721 mm of Hg. The barometric reading is 758 mm of Hg. The amount of air leakage in the condenser amounts to 6 kg/hr. The temperature at inlet to the air cooler section is 30ºC and at the outlet is 26ºC. Calculate: (i) mass of steam condensed in the air cooler section (ii) reduction in the air pump capacity following the cool air	[10M]
	b)	Explain the functions of the blading of a reaction turbine.	[6M]
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6 a) i) List the merits and demerits of gas turbines. [3M]
ii) Explain about the open cycle and closed cycle turbines with neat sketches and also draw P-V & T-S diagrams. [5M]

b) In an air standard regenerative gas turbine cycle the pressure ratio is 5. Air enters the compressor at 1 bar, 300 K and leaves at 490 K. The maximum temperature in the cycle is 1000 K. Calculate the cycle efficiency, given that the efficiency of regenerator and the adiabatic efficiency of the turbine are each 80%. Assume for air, the ratio of specific heats is 1.4. Also show the cycle on T-S diagram. [8M]

7 a) i) Explain the Ram-Jet engine with neat sketch. [4M]
ii) Explain the turbo prop with a neat sketch. [4M]

b) In a jet propulsion unit, initial pressure and temperature to the compressor are 1.0 bar and 100C. The speed of the unit is 200m/s. The pressure and temperature of the gases before entering the turbine are 750^0 C and 3 bar. Isentropic efficiencies of compressor and turbine are 85% and 80%. The static back pressure of the nozzle is 0.5 bar and efficiency of the nozzle is 90%. Determine (a) Power consumed by compressor per kg of air. (b)Air-fuel ratio if calorific value of fuel is 35,000 kJ/kg. Cp of gases=1.12 kJ/kg K, γ =1.32 for gases. [8M]

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2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1	a)	Draw diagram of 'reheat cycle' and state the advantages and disadvantages of reheating	[4M]
	b)	Give any four comparisons between fire tube and water tube boilers.	[4M]
	c)	Define the following as related to steam turbines. (i) blade velocity coefficient (ii) Diagram efficiency (iii) stage efficiency	[3M]
	d)	Brief about the High level Jet condenser.	[4M]
	e)	What are the different methods to improve the efficiency of gas turbines?	[3M]
	f)	Write the principle of jet propulsion and classify the Jet propulsive engines.	[4M]

PART -B

2	a)	Explain regeneration cycle with the help of neat sketches of layout, p-v and T-s plots.	[5M]
	b)	What are the different thermodynamic variables affecting efficiency and output of Rankine cycle. Explain their influence on Rankine cycle.	[6M]
	c)	Derive an expression for mass flow rates of bled steam considering 2- bleedings.	[5M]
3	a)	Mention any three boiler mountings and three Accessories with neat sketches.	[6M]
	b)	Estimate the height of the chimney to produce a static draught of 20 mm of water if the mean temperature of the hot gases is 250ºC and ambient temperature is 20ºC. Assume the density of air and hot gases as 1.293 kg/m^3 and 1.34 kg/m^3 respectively at NTP. Also estimate the mass of flue gases formed per kg of fuel. Barometer reads 760 mm of Hg.	[10M]
4	a)	What is compounding of turbines? Discuss in brief with relevant sketches.	[8M]
	b)	A convergent nozzle is used to expand ethane gas at 780 kPa and 3500K isentropically into a chamber at 370 kPa. Find the nozzle exit area for a mass flow rate of 1400 kg/s. Assume the initial velocity is zero, C p=1.9 kJ/kgK, R=277 J/kg K and γ=1.17.	[8M]
5	a)	Define the term 'Degree of reaction' as applied to a steam turbine. Show that Parson's reaction turbine the degree of reaction is 50 %.	[8M]
	b)	What are the components of a steam condensing plant? What are the functions of each component working in steam condensing plant?	[8M]
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6 a) In a gas turbine plant, air is drawn at 1 bar, 150 C and the pressure ratio is 6. The expansion takes place in two turbines. The efficiency of compressor is 0.82, high pressure turbine is 0.85 and low pressure turbine is 0.84. The maximum cycle temperature is 625^0 C. Calculate [10M]
i) Pressure and temperature of gases entering the low pressure turbine.
ii) Net power developed
iii) Work ratio
iv) Thermal efficiency. Work output of high pressure turbine is equal to compressor work

b) What are the different types of combustion chambers in gas turbine engines? Explain them in detail with relevant sketches. [6M]

7 a) In a turbojet, air is compressed in an axial compressor at inlet conditions of 1 bar and 100^0C 3.5 bar. The final temperature is 1.25 times that for isentropic compression. The temperature of gases at inlet to turbine is 480^0C. The exhaust gases from turbine are expanded in a velocity of approach is negligible and expansion may be taken to be isentropic in both turbine and nozzle. Value of gas constant R and index r are same for air and flue gases. [8M]
Determine
i) Power required to drive the compressor per kg of air/sec
ii) Air-fuel ratio if the calorific value of fuel is 42,000 kJ/kg
iii) Thrust developed / kg of air / sec.

b) i) Write a detailed classification of rockets. [4M]
ii) Explain liquid propellant rocket with a neat sketch. [4M]

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2. Answering the question in **Part-A** is compulsory
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PART –A

1	a)	Sketch the process diagram of a 'regenerative cycle'. State the advantages of regenerative cycle over simple Rankine cycle.	[3M]
	b)	How boilers are classified on different accounts with examples for each category.	[4M]
	c)	Differentiate the terms "over expanding" and "under expanding" as applied to a fluid flow through a nozzle.	[4M]
	d)	Draw the schematic diagram of parallel flow jet condenser.	[3M]
	e)	List different applications of gas turbine power cycles in power sector industries.	[4M]
	f)	Where rocket propulsion is is used? What are the kinds of rocket propellants?	[4M]

PART -B

2	a)	Draw the schematic for an ideal Rankine cycle. Draw p-v, T-s and h-s diagrams for this cycle.	[6M]
	b)	In a reheat cycle steam enters the H.P turbine at 100 bar and 500ºC. The expansion is continued to a pressure of 8.5 bar with isentropic efficiency of 80%. There is a pressure drop of 1.5 bar in the reheater and then steam enters the L.P turbine at 7 bar and 500ºC in which expansion is continued to a back pressure of 0.04 bar with isentropic efficiency of 85%. Determine i) thermal efficiency ii) specific steam consumption.	[10M]
3	a)	Define equivalent evaporation and boiler efficiency. Write the formulae.	[3M]
	b)	A boiler is to provide 7000 kg/hr of steam with superheated by 40ºC at a pressure of 20bar. The temperature of water is 60ºC. If the thermal efficiency of the boiler is 75%, how much fuel oil will be consumed in one hour? The calorific value of oil used is 45000 kJ/kg. Take specific heat of superheated steam as 2.093 kJ/kg K and also calculate the equivalent evaporation from and at 100ºC.	[8M]
	c)	Sketch and describe a Cochran boiler. What are its special features?	[5M]
4	a)	Dry saturated steam expands through a nozzle from a pressure of 13.7 bar down to 9.6 bar. Assuming the flow to be frictionless and adiabatic, estimate velocity of steam jet.	[8M]
	b)	In a single-stage impulse turbine, the steam jet leaves the nozzles at 20º to the plane of the wheel at a speed of 670 m/s and it enters the moving blades at an angle of 35º to the drum axis. The moving blades are symmetrical in shape. Determine the blade velocity and diagram efficiency.	[8M]
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5	a)	Write a note on degree of reaction. Derive an expression for degree of reaction and show that inlet and outlet velocity triangles are symmetrical for a 50% degree of reaction turbine.	[8M]
	b)	Classify steam condensers. What are the differences between the jet Condensers and surface condensers? List out the advantages of condenser in a steam power plant.	[8M]
6	a)	Draw the schematic diagram of closed cycle gas turbine and explain its working.	[8M]
	b)	A constant pressure open cycle gas turbine plant works between temperature range of 15ºC and 700ºC and pressure ratio of 6. Find the mass of air circulating in the installation, if it develops 1100 kW. Also find the heat supplied by the heating chamber.	[8M]
7	a)	Define and explain the terms: i. Thrust ii. Thrust power, iii. Effective jet exit velocity, iv. Propulsive efficiency related to turbojet engines.	[8 M]
	b)	A jet propulsion system has to create a thrust of 100 tonnes to move the system at a velocity of 700 km/hr. If the gas flow rate through the system is restricted to a maximum of 30 kg/s. find the exit gas velocity and propulsive efficiency.	[8 M]

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PART –A

1	a)	What is regeneration? Draw the schematic and T-s diagram for an ideal regenerative Cycle.	[4M]
	b)	Draw the sketch of Babcock and Wilcox boiler and label the parts.	[4M]
	c)	Discuss the process of super-saturation in steam nozzles with the help of enthalpy-entropy diagram.	[3M]
	d)	Draw the velocity-compounded impulse steam turbine showing pressure and velocity variations along the axis of the turbine.	[4M]
	e)	What are the various thrust augmentation techniques used in turbo-jet engine?	[4M]
	f)	What are the various applications of rockets?	[3M]

PART -B

2	a)	What is reheating? What the advantages of reheat Rankine cycle?	[4M]
	b)	Superheated steam at 10 bar abs. and 300ºC admitted into the cylinder of a steam engine expands isentropically to a pressure of 0.7 bar. The pressure then falls at constant volume to a back pressure of 0.28 bar. Determine (a) modified Rankine cycle efficiency (b) steam consumption per kWhr (c) mean effective pressure (d) heat removed in the condenser per kg of steam (e) loss of work due to incomplete expansion (f) if the cylinder diameter and stokes are 30 cm and 58 cm respectively, what would be the new stroke if the steam is allowed to expand without any restriction up to the condenser pressure.	[8M]
	c)	Brief about analysis of exhaust gas and flue gas .	[4M]
3	a)	Explain Lancashire boiler with neat sketch.	[6M]
	b)	A steam power plant equipped with combined reheat and regenerative arrangements is supplied with steam to H.P turbine at 80 bar and 470ºC. For feed heating a part of steam is extracted at 7 bar and the remainder of steam is reheated to 350ºC in a reheater and then expanded in L.P turbine down to 0.035 bar. Determine (i) amount of steam bled off for feed heating (ii) amount of steam in L.P turbine (iii) heat supplied in boiler and reheater (iv) Output of turbine (v) cycle efficiency.	[10M]
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4	a)	Write short notes on De-Laval Turbine and about its features. Steam leaves the nozzle of a single-stage impulse turbine at 840 m/s. The nozzle angle is 18º and the blade angles are 29º at the inlet and outlet. The friction coefficient is 0.9. Calculate (i) blade velocity (ii) steam mass flow rate in kg/h to develop 300 kW power.	[8M]
	b)	For a nozzle, show the area on p-v diagram which represents the conversion of heat energy to kinetic energy. Prove that this area equals the heat drop during expansion. Assume isentropic flow in a nozzle. Further show the expansion for steam on T-s and h-s charts and for air on T-s chart.	[8M]
5	a)	In surface condenser the vacuum maintained is 700mmof Hg. The barometer reads 754mm.If the temperature of condensate is 180c, Determine (i) mass of air per kg of steam (ii)Vacuum Efficiency	[8M]
	b)	Derive an expression for optimum stage efficiency of a reaction turbine.	[8M]
6	a)	Explain the operating principle of Brayton cycle with a schematic diagram p-v and T-s diagrams.	[8M]
	b)	A simple gas turbine cycle works with a pressure ratio of 8. The compressor and turbine inlet temperatures are 300 K and 800 K respectively. If the volume flow rate of air is 250 m^3/s, compute the power output and thermal efficiency.	[8M]
7	a)	Explain working of turbo prop engine with a neat sketch.	[8M]
	b)	Explain the advantages and disadvantages of bipropellants used in rocket engines over monopropellants.	[8M]

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