Code No: 155DG

R18

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year I Semester Examinations, August - 2022
THERMAL ENGINEERING - II
(Mechanical Engineering)

Time: 3 Hours **Max. Marks: 75**

Answer any Five Questions
All Questions Carry Equal Marks
- - -

1.a) A Simple Rankine Cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam is dry and saturated. Calculate the cycle efficiency, work ratio and specific steam consumption.
b) Explain the concept of mean temperature of heat addition. [7+8]

2. Describe with a neat line sketch of a Benson Boiler mentioning its distinguishing features. State the advantages and disadvantages for this type of boilers. [15]

3.a) Explain the metastable expansion of steam in a nozzle with the help of h-s diagram.
b) Dry saturated steam enters a steam nozzle at a pressure of 15 bar and is discharged at a pressure of 2 bar. If the dryness fraction of the discharge steam is 0.96, what will be the final velocity of steam? Neglect initial velocity of steam. If 10% of heat drop is lost in friction, find the percentage reduction in the final velocity. [8+7]

4.a) Derive an expression for maximum discharge through convergent divergent nozzle for steam.
b) Dry saturated steam at a pressure of 8 bars absolute enters a convergent-divergent nozzle and leaves at 1.5 bars absolute. If the flow is isentropic and corresponding expansion index is 1.135, find the ratio of cross-sectional area at exit and throat for maximum discharge. [9+6]

5.a) What are the different methods of compounding of steam turbine stages? List the advantages and limitations of velocity compounding.
b) A stage of impulse-reaction turbine is provided with single row wheel whose mean diameter is 100cm and it is rotating at 50 rps. The nozzle angle=20^0 and the velocity of steam coming out of the turbine is 350 m/sec. Determine the power developed if the axial thrust on the end bearings is limited to 118N. Take blade friction factor=0.8. Assume the blades are equi-angular. [7+8]

6. In a reaction turbine, the blade tips are inclined at 35^0 and 20^0 in the direction of motion. The guide blades are of same shape as that of the moving blades, but reversed in direction. At a certain place in the turbine, the drum diameter is 1m and the blades are 10 cm high. At this place, the steam has a pressure of 1.75 bar and dryness fraction of 0.935. If the speed of this turbine is 250 rpm and the steam passes through the blades without shock, find the mass of steam flow and power developed in the ring of moving blades? [15]

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7.a) Briefly state the effects of air leakage on the performance of a condenser.

b) In a simple gas turbine plant, air enters at 1 bar and 20^0C and compressed with isentropic efficiency of 80% to 4bar. Then it is heated in combustion chamber with A:F ratio=90:1. The Calorific value of a fuel used is 41.8 MJ/kg. If air flow is 3kg/sec, find the power developed and thermal efficiency by the plant. Take Cp= 1kJ/kg ^{0}C and γ=1.4 for air as well as gas? [7+8]

8.a) Discuss in detail Solid and Liquid propellant Rocket Engines.

b) Draw the schematic diagram of Turbo jet and explain its working. [8+7]

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year I Semester Examinations, March - 2021
THERMAL ENGINEERING - II
(Mechanical Engineering)

Time: 3 Hours **Max. Marks: 75**

Answer any five questions.
All questions carry equal marks.
- - - -

1.a) Explain the concept of "mean temperature of heat addition".
b) In a regenerative cycle the inlet conditions are 40 bar and 400^{0}C for the Rankine cycle steam is bled at 10 bar for regenerative heating. The exit pressure of the turbine is 0.8 bar. Neglecting pump work, determine the efficiency of the cycle. [6+9]

2. A convergent-divergent nozzle is required to discharge 2 kg of steam per second. The nozzle is supplied with steam at 10 bar and 200^{0}C and the discharge takes place against a back pressure of 0.34 bar. Estimate the throat and exit areas. Assume isentropic flow and take the index n=1.3. Nozzle efficiency is assumed to be 85%. [15]

3.a) An impulse turbine is provided with single row wheel whose mean diameter is 100 cm and it is rotating at 50 rps. The nozzle in inclined at an angle of 20^0 and the velocity of steam coming out of the turbine is 350 m/sec. Determine the power developed if the axial thrust on the end bearings is limited to 118 N. Take blade friction factor=0.8. Assume the blades are equi-angular.
b) Explain the working of a single-stage impulse turbine. Sketch pressure and velocity variations along the axis of the turbine. [8+7]

4.a) Describe the factors which influence of condenser and vacuum efficiencies of a condensing plant.
b) Discuss briefly the methods employed for improvement of thermal efficiency of an open cycle gas turbine plant. [7+8]

5.a) Why mountings are essential in boilers? Name different mountings and give functions of each.
b) A gas turbine is operated with a temperature limits of 300 K and 1200 K. Calculate the optimum pressure ratio for maximum network output and also calculate the thermal efficiency. [6+9]

6.a) What are the different methods of compounding of steam turbine stages? List the advantages and limitations of velocity compounding.
b) Differentiate between jet condensers over surface condensers. [7+8]

7.a) What are different savers of air leakage from the condenser plant? Explain the method of removing the air.
b) Explain different types of propellants used in solid propellant rockets. [8+7]

8.a) A turbojet engine indicates 45 kg of air per second and propels an aircraft with a uniform flight speed of 880 km/h. The isentropic enthalpy change for nozzle is 188.37 kJ/kg and its velocity coefficient is 0.96. The fuel-air ratio is 0.012, the combustion efficiency is 0.95 and the lower heating value of the fuel is 44,000kJ/kg. Calculate: i) the thermal efficiency of the engine, ii) the fuel flow rate in kg/h, iii) the propulsion power in kW, iv) the thrust power, v) the propulsive efficiency.
b) Describe with a sketch a solid propellant rocket. What is gain? What are the applications of solid propellant rockets? [6+9]

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Code No: 155DG

R18

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year I Semester Examinations, September - 2021
THERMAL ENGINEERING - II
(Mechanical Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks

1.a) Explain the Regenerative cycle in detail with a neat sketch.
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. [7+8]

2.a) Sketch and describe the operation of Babcock and Wilcox boiler and explain its limitations.
b) Derive an expression for maximum discharge rate of gases through the chimney for a given height of the chimney. [7+8]

3. During a test on steam nozzle steam impinges a stationary flat plate which is perpendicular to the direction of flow and the force on the plate is measured. The force is found to be 350 N when dry saturated steam at 8 bar is expanded to 1 bar. Throat cross-section area is 5 cm^2 and exit area is such that the complete expansion is achieved under these conditions. Determine the discharge at throat. [15]

4.a) What do you understand by nozzle? Discuss different types of nozzles.
b) A convergent-divergent nozzle is required to discharge 2 kg of steam per second. The nozzle is supplied with steam of 10 bar and 200^0 C and discharge takes place against a back pressure of 0.34 bar. Estimate the throat and exit areas. Assume isentropic flow and take the index n = 1.3. If the nozzle efficiency is assumed to be 85%, determine the exit area. [7+8]

5.a) Why compounding is necessary in the impulse turbines? What are the types and explain any one type of compounding with neat sketch.
b) Sketch the velocity diagram of a single stage impulse turbine and determine the expression for the force, work done, diagram efficiency and axial thrust. [7+8]

6. A Parson's reaction turbine has mean diameter of blades as 1.6 m and rotor moving at 1500 rpm. The inlet and outlet angles are 80^0 and 20^0 respectively. Turbine receives steam at 12 bars, 200^0C and has isentropic heat drop of 26 kJ/kg. 5% of steam supplied is lost through leakage. Determine the following considering horse power developed in stage to be 600 hp.
a) The stage efficiency
b) The blade height. [8+7]

7.a) Explain working principle of Surface Condenser with neat sketch.

b) A surface condenser is designed to handle 10000 kg of steam per hour. The steam enters at 0.08 bar abs. and 0.9 dryness and the condensate leaves at the corresponding saturation temperature. The pressure is constant throughout the condenser. Estimate the cooling water flow per hour, if the cooling water temperature rise is limited to 10^0C. [8+7]

8.a) Derive the expressions of thrust and thrust power for jet engine.

b) A gas turbine unit receives air at 100kPa and 300K and compresses it adiabatically to 620kPa with efficiency of the compressor 88%. The fuel has a heating value of 44,180kJ/kg and the fuel/air ratio is 0.017kg fuel/kg air. The turbine internal efficiency is 90%. Calculate the compressor work, turbine work and thermal efficiency. [8+7]

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R16

Code No: 136EB

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year II Semester Examinations, May - 2019
THERMAL ENGINEERING – II
(Mechanical Engineering)

Time: 3 hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

(25 Marks)

1.a) Draw a line diagram of Babcock and Wilcox water tube boilers. [2]
b) What are the advantages and disadvantages of regenerative cycle over simple Rankine Cycle? [3]
c) Define Metastable state and critical velocity. [2]
d) Discuss the effects of friction on the performance of nozzles. [3]
e) What are the advantages and disadvantages of velocity compounded Impulse Turbine. [2]
f) Explain, why pure reaction turbine is not used in practice. [3]
g) What is the purpose of inter cooling in gas turbine. [2]
h) What is the High level Jet condenser? [3]
i) Why propeller engines are not recommended now a days in air craft's? [2]
j) State the fundamental differences between the jet propulsion and rocket propulsion. [3]

PART - B

(50 Marks)

2.a) Discuss various types of safety valves.
b) A steam turbine is fed with steam having an enthalpy of 3100 kJ/kg. It moves out of the turbine with an enthalpy of 2100 kJ/kg. Feed heating is done at a pressure of 3.2 bar with steam enthalpy of 2500 kJ/kg. The condensate from a condenser with an enthalpy of 125 kJ/kg enters into the feed heater. The quantity of bled steam is 11200 kg/h. Find the power developed by the turbine. Assume that the water leaving the feed heater is saturated liquid at 3.2 bar and the heater is direct mixing type. Neglect pump work. [3+7]

OR

3.a) Explain the Regenerative cycle in detail with a neat sketch.
b) Discuss in brief with their function
i) Man hole, ii) Fusible plug, iii) Feed check valve, iv) Blow-off cock [5+5]

4.a) During a test on steam nozzle steam impinges a stationary flat plate which is perpendicular to the direction of flow and the force on the plate is measured. The force is found to be 350 N when dry saturated steam at 8 bar is expanded to 1 bar. Throat cross-section area is 5 cm^2 and exit area is such that the complete expansion is achieved under these conditions. Determine the discharge at throat.

b) What do you understand by nozzle? Discuss different types of nozzles. [6+4]

OR

5.a) Air is expanded reversibly and adiabatically in a nozzle from 13 bar and 150^{0}C to a pressure of 6 bar. The inlet velocity of the nozzle is very small and the process occurs under steady flow conditions. Calculate the exit velocity of the nozzle.

b) Describe the 'over expansion' and 'under expansion' in nozzles. [6+4]

6.a) Sketch the velocity diagram of a single stage impulse turbine and determine the expression for the force, work done, diagram efficiency and axial thrust.

b) A single stage steam Turbine is supplied with steam at 5bar and 200^{0}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 20^0 to the plane of wheel and outlet blade angle is 30^0. Neglecting friction losses. Determine the power developed, blade efficiency and stage efficiency. [5+5]

OR

7.a) Define the following:
i) Blade efficiency
ii) Stage efficiency
iii) Overall efficiency

b) In an impulse turbine (with a single row wheel) the mean diameter of the blades is 1.05m and the speed is 3000 r.p.m. The nozzle angle is 18^0, 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 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) Blade efficiency [3+7]

8.a) Derive an expression for the efficiency as a function of temperature ratio and pressure ratio of the cycle for an ideal gas turbine cycle with reheat and heat exchange.

b) The following data refers to a test of the surface condenser of a steam turbine
Absolute pressure of the steam entering the condenser =5.628 kPa
Temperature of condensate leaving the condenser =32^{0}C
Inlet temperature of cooling water=15^{0}C
Outlet temperature of cooling water=30^{0}C
Mass of cooling water per kg of steam=32 kg
Assuming that all the heat lost by the exhaust steam is taken up by the circulating water; determine the dryness fraction of the steam as it enters the condenser. [5+5]

OR

R18

Code No: 155DG

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year I Semester Examinations, July/August - 2023

THERMAL ENGINEERING - II

(Mechanical Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: i) Question paper consists of Part A, Part B.
ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.
iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A

(25 Marks)

1.a)	What are the merits of artificial draught over natural draught.	[2]
b)	How does the Rankine cycle differ from the Carnot cycle for a vapour?	[3]
c)	Briefly explain the saturated flow through the nozzle.	[2]
d)	Explain the physical concept of critical pressure ratio.	[3]
e)	Classify the turbines.	[2]
f)	Explain the importance of velocity triangles in impulse turbine.	[3]
g)	What are the sources of air in the condensers?	[2]
h)	Write the requirement of a good combustion chamber for a gas turbine.	[3]
i)	What are the various propulsive devices for aircrafts and missiles?	[2]
j)	What is meant by thrust augmentation? When it is necessary.	[3]

PART – B

(50 Marks)

2.a) Describe the intercooling arrangement in Rankine cycle with the help of neat sketch. Also represent the cycle on T-S diagram.

b) A power generating plant uses steam a working fluid and operates at a boiler pressure of 50 bar dry saturated and a condenser pressure of 0.05 bar. Calculate for these limits i) cycle efficiency for Carnot cycle and Rankine cycle, ii) work ratio and specific steam consumption for Carnot cycle and Rankine cycle. [5+5]

OR

3.a) Derive the formula to calculate the draught produced (in terms of height of mercury column) in chimney. Also derive condition for maximum efficiency.

b) Sketch and describe the working of a Babcock and Wilcox boiler. [5+5]

4.a) A group of convergent-divergent nozzles are supplied with steam at a pressure of 2 MN/m^2 and a temperature of 325 ^0C. Supersaturated expansion according to the law $PV^{1.3}$ = constant, occurs in the nozzle down to an exit pressure of 0.36 MN/m^2. Steam is supplied at the rate of 7.5 kg/s. Determine the required throat and exit areas.

b) Derive the expression relating the critical pressure ratio to index of expansion n, for expansion in a nozzle. [5+5]

OR

5. A convergent-divergent nozzle is required to discharge 2 kg of steam per second. The nozzle is supplied with steam at 100 bar and 200^0 C and the discharge takes place against back pressure of 0.34 bar. Estimate the throat and exit areas. Assume isentropic flow and take the index n = 1.3. If the nozzle efficiency is assumed to be 85 %, determine the exit area. [10]

6. A simple impulse turbine has one ring of moving blade running at 150m/s; velocity of steam reaching the nozzle 90 m/s; nozzle efficiency 0.85; absolute velocity of steam at exit from the stage 85 m/s at an angle of 80^0 with tangent of wheel; blade velocity coefficient 0.82; rate of steam flowing 2 kg/s. Assuming moving blade to be equiangular. Find the blade angles, nozzle angle, and absolute velocity of steam at entrance, axial thrust and power developed. [10]

OR

7.a) Prove that maximum diagram efficiency as a function of nozzle angle, for a simple impulse steam turbine with symmetric blades and no friction in blade passage.

b) At a particular stage of Parson's reaction turbine the mean blade speed is 60 m/s and the steam pressure is 3.5 bar with a temperature of 175 ^{0}C. The identical fixed and moving blades have inlet angles of 30^0 and outlet angles of 20^0. Determine i) power developed by the stage, ii) the blade height if it is $1/10^{th}$ of the blade ring diameter for a flow rate of 810 kg/min, and iii) the specific enthalpy drop if the stage efficiency is 85%. [5+5]

8. In a condenser test the following observations were made: vacuum 70 cm of Hg, barometer 76 cm of Hg, mean temperature of condensate 34 ^{0}C, hotwell temperature 29 ^{0}C, mass of cooling water 102000 kg per hour, inlet temperature 17 ^{0}C, outlet temperature 31 ^{0}C, mass of condensate per hour 2620 kg. Find a) mass of air present per m^3 of condenser volume, b) state of steam entering the condenser and c) vacuum efficiency. [10]

OR

9. In a gas turbine, the pressure ratio to which air at 15 ^{0}C is compressed is 6. The same air is then heated to a maximum permissible temperature of 750 ^{0}C, first in a heat exchanger and then combustion chamber. It is then expanded in two stages such that the expansion work is maximum. The air reheated to 750 ^{0}C after the first stage. Determine the cycle thermal efficiency, work ratio and net shaft work per kg of air. Take the compressor and turbine efficiency as 80% and 85% respectively. [10]

10.a) Explain the principle of jet propulsion and mention how the jet propulsion engines are classified.

b) Describe the two main methods of thrust augmentation. [5+5]

OR

11. The exit velocity from a jet unit is 650 m/s for airflow of 40 kg/s through the unit. The aircraft is flying at 250 km/hr. Calculate the thrust developed, thrust power and the propulsion efficiency. Neglect the effect of fuel. [10]