DEPARTMENT OF MECHANICAL ENGINEERING

REGULATION: R15

BATCH: 2017-2021

ACADEMIC YEAR: 2019 - 2020

PROGRAM: B.TECH (MECHANICAL ENGINEERING)

YEAR/SEM: III/I

COURSE NAME: THERMAL ENGINEEING-II

COURSE CODE: A15318

COURSE COORDINATOR

HOD

NAME OF THE FACULTY: K. SRINIVASA RAO

DESIGNATION: ASSISTANT PROFESSOR

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1. SYLLABUS

UNIT	TOPICS	Total No. of Hours
I	**BASIC CONCEPTS of RANKINE CYCLE:** Schematic layout, Thermodynamic Analysis, Concept of Mean Temperature of Heat addition, Methods to improve cycle performance – Regeneration & reheating, Combustion, fuels and combustion, concepts of heat of reaction, adiabatic flame temperature, stoichiometry, fuel gas analysis.	12
II	**BOILERS:** Classification – Working principles – with sketches including H.P Boilers – Mountings and Accessories – Working principles, Boiler horse power, equivalent evaporation, efficiency and heat balance – Draught, classification – Height of chimney for given draught and discharge, condition for maximum discharge, efficiency of chimney – artificial draught, induced and forced. **STEAM NOZZLES:** Function of nozzle – applications – types, flow through nozzles, thermodynamic analysis– velocity of nozzle at exit-ideal and actual expansion in nozzle, condition for maximum discharge, critical pressure ratio, super saturated flow, degree of under cooling – Wilson line.	15
III	**STEAM TURBINES:** Classification – impulse turbine, Mechanical details – velocity diagram – effect of friction – power developed, axial thrust, blade or diagram efficiency – condition for maximum efficiency. De-Laval Turbine – its features, Methods to reduce rotor speed-velocity compounding and pressure compounding - impulse turbine. **REACTION TURBINE:** Principle of operation, thermodynamic analysis of a stage, degree of reaction – velocity diagram – parson's reaction turbine – condition for maximum efficiency	15
IV	**STEAM CONDENSERS:** Requirements of steam condensing plant – Classification of condensers – working principle of different types – vacuum efficiency and condenser efficiency – air leakage, sources and its affects air pump – cooling water requirement. **GAS TURBINES:** Simple gas turbine plant – ideal cycle, essential components – parameters of performance – actual cycle – regeneration inter cooling and reheating – Closed and semi-closed cycles.	14
V	**JET PROPULSION:** Principle of operation – classification of jet propulsive engines – Working principles with schematic diagrams and representation on T-S diagram – Thrust, Thrust Power and Propulsion Efficiency – Turbo jet engines – Needs and demands met by Turbo jet – Schematic Diagram, Thermodynamic cycle, Performance Evaluation Thrust Augmentation – Methods.	9

	ROCKETS: Application – Working Principle – Classification – Propellant Type – Thrust, Propulsive Efficiency – Specific impulse – solid and liquid propellant Rocket Engines.	
	TOTAL HOURS	65

2. TEXT BOOKS & OTHER REFERENCES

S. NO.	TITLES
1	Thermal Engineering / R.K Rajput / Lakshmi Publications
2	Gas Turbines – V.Ganesan /TMH.
3	Thermodynamics and Heat Engines / R.Yadav / Central Book Depot.
4	Gas Turbines and Propulsive Systems – P. Khajuria & S.P.Dubey Dhanpatrai.
5	Gas Turbines / Cohen, Rogers and Saravana Muttoo / Addison Wesley – Longman
6	Thermal Engineering – R.S.Khurmi / JS Gupta / S.Chand.
7	Thermal Engineering – P.L Bellaney / Khanna publishers
8	Thermal Engineering M.L. Mathur & Mehta / Jain Bros.

3. TIME TABLE

Vidya Jyothi Institute of Technology (Autonomous)

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(Aziz Nagar, C.B.Post, Hyderabad -500075)

DEPARTMENT OF MECHANICAL ENGINERRING

TIMETABLE

A.Y- 2019-20

III B.Tech I Sem **SECTION-A** **w.e.f. 22/07/2019**

TIME/ DAY	9.00- 9.55	9.55-10.50	10.50.11-45	11.45-12.30	12.30-1.25	1.25-2.20	2.20-3.15	3.15-4.05
MON	MTM	DOM	TE-II	LUNCH BREAK	AE	DMM-I	VAC-III	
TUE	DOM	OE			AE	TE/MT LAB		
WED	AE	OE			DOM	DMM-I	MTM	TE-II
THU	PDBS	DOM	MTM		TE-II	DMM-I	AE	LIBRARY
FRI	DMM-I	AE	TE-II		PDBS	MT/TE LAB		
SAT	TE-II	MTM	DMM-I		DOM	TECHNICAL SEMINAR	TECHNICAL SEMINAR	SPORTS

SL.NO	SUBJECT	FACULTY
1	THERMAL ENGINEERING-II (TE-II)	Dr.L.Madan Anand Kumar
2	DYNAMICS OF MACHINES(DOM)	Mr.Hasan
3	MACHINE TOOLS & METROLOGY (MTM)	Mr.P.Sampath Kumar
4	DESIGN OF MACHINE MEMBER-I(DMM-I)	Mr.G.Rajesh Babu
5	AUTOMOBILE ENGINEERING(AE)	Mr.RNSV.Ramakanth
6	PDBS	Mr.Surender
7	THERMAL ENGINEERING LAB	Dr.L.Madan Anand Kumar,G.Sowmya/ Mr.RNSV.Ramakanth,G.Ambika
8	MACHINE TOOLS LAB	Mr.P.Sampath Kumar,Mr.G.Rajesh Babu/ Mr.Bhupal Reddy,Mr.RNSV.Ramakanth
9	VALUE ADDED COURSE	Mr.RNSV.Ramakanth/ Mr.P.Chandra kumar
10	TECHNICAL SEMINAR	Mr.Hasan
11	LIBRARY/SPORTS	Mr.P.Sampath Kumar

H.O.D

Dr.G.Sreeram Reddy

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DEPARTMENT OF MECHANICAL ENGINERRING

TIMETABLE

A.Y- 2019-20

III B.Tech I Sem **SECTION-B** **w.e.f. 22/07/2019**

TIME/ DAY	9.00- 9.55	9.55-10.50	10.50.11-45	11.45-12.30	12.30-1.25	1.25-2.20	2.20-3.15	3.15-4.05
MON	TE/MT LAB			LUNCH BREAK	DMM-I	MTM	AE	TECHNICAL SEMINAR
TUE	TE-II	OE			VAC-III		DMM-I	LIBRARY
WED	MTM	OE			AE	DOM	DOM	PDBS
THU	AE	MTM	DMM-I		TE-II	MT/TE LAB		
FRI	DMM-I	DOM	DOM		AE	TE-II	MTM	PDBS
SAT	DMM-I	TE-II	TE-II		TECHNICAL SEMINAR	DOM	AE	SPORTS

SL.NO	SUBJECT	FACULTY
1	THERMAL ENGINEERING-II (TE-II)	Mr.K.Srinivas Rao
2	DYNAMICS OF MACHINES(DOM)	Mr.J.Pradeep Kumar
3	MACHINE TOOLS & METROLOGY (MTM)	Mr.Raghuram Reddy
4	DESIGN OF MACHINE MEMBER-I(DMM-I)	Mr.G.Rajesh Babu
5	AUTOMOBILE ENGINEERING(AE)	Mr.S.Ramakrishna
6	PDBS	Mr.Surender
7	THERMAL ENGINEERING LAB	Mr.K.SrinivasRao,G.Sowmya / Mr.K.Ashok chary,G.Ambika
8	MACHINE TOOLS LAB	Mr.Raghuram Reddy,Mr.J.Pradeep Kumar/ Mr.Bhupal Reddy,Mr.G.Rajesh Babu
9	VALUE ADDED COURSE	Mr.Pavankumar/Mr.Ramakrishna
10	TECHNICAL SEMINAR	Mrs.Emeema
11	LIBRARY/SPORTS	Mr.K.Srinivas Rao

H.O.D

Dr.G.Sreeram Reddy

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DEPARTMENT OF MECHANICAL ENGINERRING
TIMETABLE

A.Y- 2019-20

III B.Tech I Sem **SECTION-C** **w.e.f. 22/07/2019**

TIME/ DAY	9.00- 9.55	9.55-10.50	10.50.11-45	11.45-12.30	12.30-1.25	1.25-2.20	2.20-3.15	3.15-4.05
MON	AE	DOM	MTM	LUNCH BREAK	PDBS	TE-II	DMM-I	LIBRARY
TUE	DMM-I	OE			DOM	TE-II	TECHNICAL SEMINAR	AE
WED	MTM	OE			DMM-I	TE/MT LAB		
THU	DOM	TE-II	AE		VAC-III		MTM	DMM-I
FRI	MT/TE LAB				TE-II	DOM	AE	TECHNICAL SEMINAR
SAT	PDBS	AE	TE-II		DOM	MTM	DMM-I	SPORTS

SL.NO	SUBJECT	FACULTY
1	THERMAL ENGINEERING-II (TE-II)	Mr.Chirra Ravi
2	DYNAMICS OF MACHINES(DOM)	Mr.C.Naveen Raj
3	MACHINE TOOLS & METROLOGY (MTM)	Dr. Dareddy Ramana Reddy
4	DESIGN OF MACHINE MEMBER-I(DMM-I)	Mr.Mallesh
5	AUTOMOBILE ENGINEERING(AE)	Mr.S.Ramakrishna
6	PDBS	Mr.Surender
7	THERMAL ENGINEERING LAB	Mr.Chirra Ravi ,Mr.C.Naveen Raj/Dr. Dareddy Ramana Reddy,Mrs.J.Emeema
8	MACHINE TOOLS LAB	Mr.S.Ramakrishna,Mr.J.Pradeep/Mr.Mallesh,Mr.Ashok Chary
9	VALUE ADDED COURSE	Mr.J.Pradeep/Mr.Ashok Chary
10	TECHNICAL SEMINAR	Mr.C.Naveen Raj
11	LIBRARY/SPORTS	Mr.Chirra Ravi

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Dr.G.Sreeram Reddy

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DEPARTMENT OF MECHANICAL ENGINERRING

TIMETABLE

A.Y- 2019-20

III B.Tech I Sem **SECTION-D** **w.e.f. 22/07/2019**

TIME/ DAY	9.00- 9.55	9.55-10.50	10.50.11-45	11.45-12.30	12.30-1.25	1.25-2.20	2.20-3.15	3.15-4.05
MON	DMM-I	TE-II	AE	LUNCH BREAK	DOM	TE/MT LAB		
TUE	MTM	OE			PDBS	TE-II	DMM-I	TECHNICAL SEMINAR
WED	TE-II	OE			AE	DOM	VAC-III	
THU	MT/TE LAB				MTM	AE	DOM	DMM-I
FRI	AE	DOM	MTM		DMM-I	PDBS	TE-II	LIBRARY
SAT	DOM	DMM-I	TE-II		AE	MTM	TECHNICAL SEMINAR	SPORTS

S.NO	SUBJECT	FACULTY
1	THERMAL ENGINEERING-II (TE-II)	Mrs.Malathi
2	DYNAMICS OF MACHINES(DOM)	Mr.Hasan
3	MACHINE TOOLS & METROLOGY (MTM)	Mr.Raghuram Reddy
4	DESIGN OF MACHINE MEMBER-I(DMM-I)	Mr.G.Rajesh Babu
5	AUTOMOBILE ENGINEERING(AE)	Mr. Shaik Ismail
6	PDBS	Mr.Surender
7	THERMAL ENGINEERING LAB	Mrs.Malathi,Mr.Raghuram Reddy/Mr. Shaik Ismail,G.Ambika
8	MACHINE TOOLS LAB	Mrs.P.Pavani ,Mr.Hasan/ Mr.Mallesh,Mr.G.Rajesh Babu
9	VALUE ADDED COURSE	Dr.G.Sreeram reddy/Mr. P.Chandra kumar
10	TECHNICAL SEMINAR	Mr.Shaik Ismail
11	LIBRARY/SPORTS	Mr.Raghuram Reddy

H.O.D

Dr.G.Sreeram Reddy

4. PROGRAM OUTCOMES (PO'S) & PROGRAM SPECIFIC OUTCOMES (PSO'S)

PO's	STATEMENT
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO'S	STATEMENT
PSO1	Analyze and solve problems of thermal and manufacturing by comprehensive design of mechanical engineering components.
PSO2	An ability to design, develop and implement mechanical engineering solutions keeping in view, sustainability and environmental issues with social responsibility.

5. COURSE OUTCOMES

(CO'S)

Course Outcomes:

At the end of the course, the students should be able to:

CO1 Unit1	Understand the basic concepts of Rankine cycle and analyze improvements in Rankine cycle, types of fuels and combustion, analysis of fuels and combustion, Stoichiometry.
CO2 Unit2	Know the working principles of different types of boilers, mountings and accessories. Perform Thermodynamic analysis of nozzles
CO3 Unit3	Analyze impulse and reaction steam turbines and subsequently apply to real time scenarios.
CO4 Unit4	Understand the working of different types of condensers and gas turbines, efficiency improvements,
CO5 Unit5	Appreciate different types of propulsive engines, thrust augmentation methods, rockets, propellant types.

6. MAPPING OF CO'S WITH PO'S & PSO'S

Thermal Engineering-II/ A15318

CO-PO/PSO mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	3	3		3		2				3		1
CO2	3	3	2	3				2				3		2
CO3	3	2	2	3			3					3		2
CO4	3	3	1	3			3					2		2
CO5	3	3	2	3		3	2	2				2		3
AVG	**3**	**2.6**	**2**	**3**		**3**	**2.67**	**2**				**2.6**		**2**

7. ACADEMIC CALENDAR

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II/III/IV B.Tech I & II Semester Academic Calendar for the Academic Year 2019-20

II/III/IV YEAR I SEMESTER		Commencement of Class Work 17.06.2019	
	From	To	Duration
I Spell of Instruction	17.06.2019	10.08.2019	8 WEEKS
I Mid Examinations	13.08.2019	17.08.2019	4 DAYS
II Spell of Instruction	19.08.2019	05.10.2019	7 WEEKS
Dussehra Holidays	07.10.2019	19.10.2019	2 WEEKS
II Spell of Instruction Continuation	21.10.2019	26.10.2019	1 WEEK
II Mid Examinations	28.10.2019	31.10.2019	4 DAYS
Practical Examinations	01.11.2019	03.11.2019	3 DAYS
End Semester Examinations	04.11.2019	20.11.2019	2 WEEKS 3 DAYS
Betterment Examinations	21.11.2019	23.11.2019	3 DAYS
Supplementary Examinations	25.11.2019	07.12.2019	2 WEEKS
II/III/IV YEAR II SEMESTER		**Commencement of Class Work 09.12.2019**	
I Spell of Instruction	09.12.2019	10.01.2020	5 WEEKS
Sankranthi Holidays	11.01.2020	15.01.2020	5 DAYS
Technical/Sports fest	16.01.2020	18.01.2020	3 DAYS
I Spell of Instruction Continuation	20.01.2020	08.02.2020	3 WEEKS
I Mid Examinations	10.02.2020	15.02.2020	1 WEEK
II Spell of Instruction	17.02.2020	11.04.2020	8 WEEKS
II Mid Examinations	13.04.2020	17.04.2020	4 DAYS
Practical Examinations	18.04.2020	22.04.2020	4 DAYS
Betterment Examinations	23.04.2020	25.04.2020	4 DAYS
End Semester Examinations	27.04.2020	12.05.2020	2 WEEKS 2 DAYS
Supplementary Examinations	13.05.2020	30.05.2020	2 WEEKS 4 DAYS
Commencement of classes will be from	**15.06.2020**		

Vidya Jyothi Institute of Technology, Himayatnagar Vil., C.B.Post, Hyderabad-75

DIRECTOR

8. TEACHING SCHEDULE

Lecture No. as per period	Topic
	UNIT-I RANKINE CYCLE AND FUELS & COMBUSTION
LH 1	Basic Concepts:
LH 2	Rankine cycle - Schematic layout, Thermodynamic Analysis,
LH 3	Concept of Mean Temperature of Heat addition,
LH 4	Methods to improve cycle performance — Regeneration.
LH 5	Reheating
LH 6	Tutorial 1
LH 7	Tutorial 2
LH 8	Tutorial 3
LH 9	Fuels and combustion: Introduction, types of fuels, Chemical Equations
LH 10	Concept of heat of reaction and Adiabatic flame temperature
LH 11	Flue gas analysis
LH 12	Tutorial 4
	UNIT-II BOILERS AND NOZZLES
LH 13	Boilers: Classification
LH 14	Working principles with sketches
LH 15	Working principles with sketches-continued
LH 16	H.P. Boilers
LH 17	Mountings— Working principle
LH 18	Accessories— Working principle
LH 19	Boiler horse power, equivalent evaporation
LH 20	Efficiency and Heat balance
LH 21	Tutorial 5
LH 22	Draught, classification
LH 23	Height of chimney for given draught and discharge, condition for maximum discharge
LH 24	Steam Nozzles: Function of nozzle — Applications and Types
LH 25	Flow through nozzles- Thermodynamic analysis
LH 26	Tutorial 6
LH 27	Tutorial 7
	UNIT-III STEAM TURBINES
LH 28	Steam Turbines: Classification
LH 29	Impulse turbine; Mechanical details Velocity diagram
LH 30	Effect of friction, Power developed, Axial thrust
LH 31	Efficiencies in impulse turbines, Condition for maximum efficiency
LH 32	Tutorial 7

LH 33	Tutorial 8
LH 34	Tutorial 9
LH 35	Methods to reduce rotor speed
LH 36	Reaction Turbine: Mechanical details Principle of operation,
LH 37	Thermodynamic analysis of a stage, Degree of reaction, Velocity diagram
LH 38	Parson's reaction turbine
LH 39	Condition for maximum efficiency, Blade height
LH 40	Tutorial 10
LH 41	Tutorial 11
LH 42	Tutorial 12
UNIT-IV STEAM CONDENSERS AND GAS TURBINES	
LH 43	Steam Condensers: Requirements of steam condensing plant
LH 44	Classification of condensers and working principle of different types
LH 45	working principle of different types of condensers- continued
LH 46	Thermodynamic analysis, Sources of air leakage, Air Pumps
LH 47	Tutorial 13
LH 48	Tutorial 14
LH 49	Gas Turbines: Introduction, Simple gas turbine cycle
LH 50	Brayton cycle, Actual gas turbine cycle,
LH 51	Methods to improve performance- Regenerative gas turbine cycle
LH 52	Gas turbine with Intercooling and Gas turbine with Reheating
LH 53	Closed and Semi closed gas turbine cycles
LH 54	Tutorial 15
LH 55	Tutorial 16
LH 56	Tutorial 17
UNIT-V JET & ROCKET PROPULSION	
LH 57	Jet Propulsion- Introduction, classification
LH 58	Working of different gas turbine engines
LH 60	Working of different gas turbine engines- continued
LH 61	Performance parameters for jet engines, Thrust Augmentation- Methods
LH 62	Rocket prolusion- Introduction, Classification
LH 63	Working of different rockets, Propellants
LH 64	Tutorial 18
LH 65	Tutorial 19

9. ASSIGNMENT QUESTIONS

ASSIGNMENT I

Q.No	Question	Bloom's Taxonomy Level	Course Outcomes
1	Explain Regenerative and Reheat Rankine cycle.	L3	CO1
2	A steam power plant working on theoretical reheat cycle. Steam at boiler pressure of 150bar and 550^0C expands through the high pressure turbine. It is reheated at constant pressure of 40bar to 550^0C and expands through the low pressure turbine to condenser pressure of 0.1 bar. Find 1. Quality of steam at turbine exhaust 2. Cycle efficiency 3. Steam rate in kg/kwhr	L4	CO1
3	Derive the condition for maximum discharge in nozzle flow. Explain the significance of critical pressure ratio	L3	CO2
4	Find the percentage increase in discharge from a convergent- divergent nozzle expanding steam from 8.75 bar dry to 2 bar when a) Expanding taking place under thermal equilibrium b) Steam is in meta stable state during part of its expansion	L4	CO2
5	Explain with the help of neat sketch a single stage impulse turbine. Also explain the pressure and velocity variation along the axis direction.	L3	CO3

ASSIGNMENT II

Q.No	Question	Bloom's Taxonomy Level	Course Outcomes
1	A reaction turbine the fixed and moving blades are of the same shape but reversed in direction. The angle of receiving tip is 25^0 and the discharging tip is 18^0. Find the power developed per pair of blades for the steam consumption of 5.5 kg/s, when the blade speed is 80 m/s. If the enthalpy drop in the pair is 20 kJ/kg. Also find the efficiency of the pair.	L4	CO3
2	The following data were obtained from the test of a surface condenser: Condenser vacuum =715 mm of Hg; Hot water Temp=42^0C; Inlet temp of circulating water = 16^0C Outlet temp of circulating water is 28^0C, Barometer reading is 760 mm of Hg. Calculate the vacuum efficiency and efficiency of condenser.	L3	CO4
3	A simple gas turbine plant operating on brayton cycle has air entering the compressor at 100kPa and 27°C. The pressure ratio is 9 and maximum cycle temperature is 727°C. What will be the percentage change in cycle efficiency and net work output if the expansion in the turbine is divided into two stages, each of pressure ratio 3, with the intermediate reheating to 727°C. Assume compression and expansion to be isentropic.	L3	CO4
4	A turbo-jet engine consumes air at a rate of 60.2 Kg/s when flying at a speed of 1000 Km/h. Calculate i. Exit velocity of jet when the enthalpy change for nozzle is 230 kJ/Kg and velocity coefficient is 0.96. ii. Fuel flow rate in Kg/s when air-fuel ratio is 70:1. iii. Thermal efficiency of the plant when combustion efficiency is 92% and calorific value of the fuel used is 42000 kJ/Kg. iv. Propulsive power v. Propulsive efficiency vi. Overall efficiency.	L3	CO5
5	Explain the working principle of liquid propellant rocket engine with suitable sketch.	L3	CO5

10. MID QUESTION PAPERS I & II

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III Year B.Tech 1st Semester 1st Mid Examination

Branch: Mechanical Engineering	Duration: 90Min
Sub: Thermal Engineering -II	Marks: 20
Date: 14.08.2019	Session: FN

Course Outcomes:

1.Understand the basic concepts of rankine cycle and analyze improvements in rankine cycle, types of fuels and combustion, analysis of fuels and combustion, stoichiometry.
2.Know the working principles of different types of boilers, mountings and accessories. Perform Thermodynamic analysis of nozzles.
3.Analyze impulse and reaction steam turbines and subsequently apply to real time scenarios.

Bloom's Level:

Remember	I	Analyze	IV
Understand	II	Evaluate	V
Apply	III	Create	VI

PART-A (3Q×2M =6Marks)		Outcomes		B.L	Marks
ANSWER ALL THE QUESTIONS		CO	PO		
1	What do you understand by theoritical air and excess air?	1	1,2,3,4,6,7,8,9,10	II	2
2	Define equivalent evaporation and boiler efficiency.	2	1,2,3,4,6,8,9,10,12	I	2
3	Classify steam turbines.	3	1,2,3,4,6,7,8,9,10,12	II	2

PART-B (5+5+4= 14 Marks)		Outcomes		B.L	Marks
ANSWER ALL THE QUESTIONS		CO	PO		
4.i.a)	Why Carnot cycle is not practicable for steam power plant?	1	1,2,3,4,6,7,8,9,10	II	2
b)	Obtain an expression for thermal efficiency of Rankine cycle.	1	1,2,3,4,6,7,8,9,10	III	3
	[OR]				
ii)	The steam is supplied to a turbine at a pressure of 32 bar and a temperature of 410°C. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction of steam at the end of expansion and thermal efficiency of the cycle. If the steam is reheated at 5.5 bar to a temperature of 395°C and then expands isentropically to 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle?	1	1,2,3,4,6,7,8,9,10	III	5
5. i)	Explain the working of cochran boiler with a neat sketch.	2	1,2,3,4,6,8,9,10,12	III	5
	[OR]				
ii)	Derive an expression for condition of maximum discharge of steam through a nozzle.	2	1,2,3,4,6,8,9,10,12	III	5
6.i)	Distinguish between impulse and reaction turbines.	3	1,2,3,4,6,7,8,9,10,12	IV	4
	[OR]				
ii)	Explain the principle of working of an impulse turbine.	3	1,2,3,4,6,7,8,9,10,12	III	4

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III Year B.Tech I Semester II Mid Examination

Branch: ME	Duration: 90Min
Sub: Thermal Engineering II	Marks: 20
Date: 04-11-2019	Session: FN

Course Outcomes:

1. Analyze impulse and reaction steam turbines and subsequently apply to real time scenarios.

2. Understand working of different types of gas turbines, efficiency improvements. Know the concepts and types of steam condensers.

3. Appreciate different types of propulsive engines, thrust augmentation methods, rockets, propellant types.

Bloom's Level:

Remember	I
Understand	II
Apply	III
Analyze	IV
Evaluate	V
Create	VI

PART-A (3Q×2M =6Marks)		Course		Bloom Levels	Marks
ANSWER ALL THE QUESTIONS		CO	PO		
1.i)	Define blade efficiency.	3	1,2,3,4,6,7,8,9,10,12	I	2
[OR]					
ii)	Why are steam turbines compounded? Explain.	3	1,2,3,4,6,7,8,9,10,12	II	2
2.i)	Define condenser efficiency.	4	1,2,3,4,5,6,7,8,9,10,12	I	2
[OR]					
ii)	Discuss the differences between open and closed gas turbine cycles.	4	1,2,3,4,5,6,7,8,9,10,12	II	2
3.i)	Define propulsive efficiency.	5	1,2,3,4,5,6,7,8,9,10,12	I	2
ii)	What are the desirable requirements of liquid propellants for rockets.	5	1,2,3,4,5,6,7,8,9,10,12	II	2

PART-B (4+5+5= 14 Marks)		Course		Bloom Levels	Marks
ANSWER ALL THE QUESTIONS		CO	PO		
4.i.	Explain the working of reaction turbine.	3	1,2,3,4,6,7,8,9,10,12	III	4
[OR]					
ii.	In a parsons reaction turbine, the angles of receiving tips are 35° and discharging tips, 20°. The blade speed is 100 m/s. Calculate the tangential force, power developed, diagram efficiency, and axial thrust of the urbine, if its steam consumpion is 1 Kg/min.	3	1,2,3,4,6,7,8,9,10,12	III	4
5. i.a)	Explain the principle of working of a surface condenser.	4	1,2,3,4,5,6,7,8,9,10,12	III	2

b)	Steam enters a condenser at 35°C. The barometer reading is 760 mm of Hg. If the vaccum of 690 mm of Hg is recorded, calculate the vaccum efficiency.	4	1,2,3,4,5,6,7,8,9,10,12	III	3
	[OR]				
ii.	In a gas turbine plant, the compressor takes in air at a temperature of 15°C and compresses it to four times the initial pressure with an isentropic efficiency of 85%. The air is then passed through a heat exchanger, heated by the turbine exhaust before reaching the combustion chamber. The turbine inlet temperaure is 600°C and its efficiency is 80%. Neglecing all losses except those mentioned , treating the working fluid has the properties of air through out the cycle, calculate thermal efficiency and work ratio of the cycle if a) heat exchanger is perfect and b) heat exchanger gives 85% of available heat to the air.	4	1,2,3,4,5,6,7,8,9,10,12	III	5
6.i.a)	Explain the methods effecting thrust augmentation.	5	1,2,3,4,5,6,7,8,9,10,12	II	5
	[OR]				
ii.a)	Expalain the working of liquid bipropelant rocket engine with a neat sketch.	5	1,2,3,4,5,6,7,8,9,10,12	III	5

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Controller of Examinations **DIRECTOR**

11. RUBRICS FOR MID EVALUATION

RUBRICS FOR MID EXAMINATION EVALUATION

Criteria of Evaluation	Poor (1)	Satisfactory (2)	Good (3)	Very Good (4)	Excellent (5)
Interpretation	Answer reflects that the question was not understood at all.	Answer reflects that the question was somewhat understood	Answer reflects that the Question was understood to a reasonable level	Answer reflects that the Question was understood to an appreciable level	Answer reflects that the Question was completely understood
Presentation	No proper presentation	Presentation was marginal with issues in legibility and grammar	Presentation was clear but with grammatical errors	Presentation was explicitly good and clear with minor grammatical errors	Presentation was excellent and clear with no grammatical errors
Solution	Solution has more errors	Solution has moderate amount of errors	Solution was complete but with minor errors	Solution was complete but with no clear mention of entire procedure	Solution was accurate/ complete with clear mention of the entire procedure.

12. LECTURE NOTES

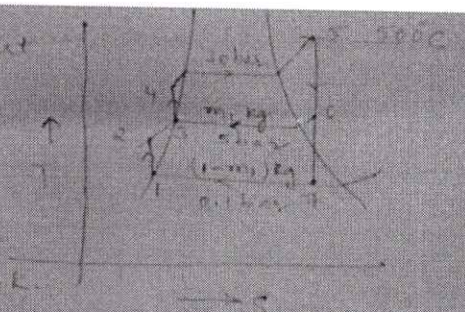
4) An ideal regenerative rankine cycle operates with steam entering the turbine at 30 bar and 500°C and is exhausted at 0.1 bar. A feed water heater is used, which operates at 5 bar, calculate a) thermal efficiency b) steam rate c) Average temperature of heat addition.

From Mollier chart

At point 5, corresponding to 30 bar and 500°C

$h_5 = 3455$ kJ/kg

$s_5 = 7.234$ kJ/kg K.



At point 6, corresponding to 5 bar

$t_6 = 240°C$, $h_6 = 2940$ kJ/kg

$s_6 = 7.234$ kJ/kg K

At point 7, for wet steam corresponding to 0.1 bar

$x_7 = 0.88$, $h_7 = 2300$ kJ/kg

From steam tables at point 1 corresponding to 0.1 bar; $v_{f_1} = 0.001010$ m³/kg

$h_1 = h_{f_1} = 191.83$ kJ/kg

At point 3, corresponding to 5 bar from steam tables $h_3 = h_{f_3}$

$= 641.21$ kJ/kg

$v_3 = v_{f_3} = 0.001094$ m³/kg

$s_3 = s_{f_3} = 1.8606$ kJ/kg K

High pressure pump work input per kg of steam, $w_{p1} = v_3(30-5)100$

$= 2.735$ kJ/kg

Also $w_{p1} = h_4 - h_3$

$\Rightarrow h_4 = h_3 + w_{p1} = 643.94$ kJ/kg

Low pressure pump work input per kg of steam

$w_{p2} = v_1(5-0.1)100$

$= 0.5$ kJ/kg

Also $w_{p2} = h_2 - h_1 \Rightarrow h_2 = h_1 + w_{p2}$

$\Rightarrow h_2 = 192.32$ kJ/kg

Mass of steam (m_1) extracted from the turbine at 5 bar, $m_1 = \frac{h_3 - h_2}{h_6 - h_2} = 0.163$ kg

i.e, 0.163 kg of steam is extracted from the turbine for each kg of steam entering the turbine

Turbine work, $W_t = (h_5 - h_6) + (1-m_1)(h_6 - h_7)$

$\xrightarrow{sub} W_t = 1050.68$ kJ/kg

Total pump work, $W_p = W_{p1} + W_{p2}(1-m_1)$

$\Rightarrow W_p = 3.1$ kJ/kg

Net work done per kg of steam, $W_{net} = W_t - W_p$

$\Rightarrow W_{net} = 1047.58 \text{ kJ/kg}$

Heat supplied in the boiler per kg of steam

$q_s = h_3 - h_2 = 2811 \text{ kJ/kg}$

i) $\eta_{rank} = \frac{W_{net}}{q_s} = \frac{1047.58}{2811} = \boxed{37.25\%}$ Ans

ii) $\text{steam rate} = \frac{3600}{W_{net}} = \frac{3600}{1047.58} = \boxed{3.436 \text{ kg/kWh}}$ Ans

iii) Average temperature of heat addition $= T_{mean} = \frac{q_s}{s_5 - s_4} = \frac{2811}{7.234 - 1.8606}$

$\Rightarrow \boxed{T_{mean} = 523.13 \text{ K}}$ Ans

1) The following data was taken during the test on a boiler for a period of 1 hour.

Steam generated = 5000 kg
Coal burnt = 700 kg
C.V of fuel = 31402 kJ/kg
quality of steam = 0.92
Boiler pressure = 1.2 Mpa
feedwater temperature = 45°C.

Find Equivalent evaporation and boiler efficiency.

<u>sol</u> We know that

equivalent evaporation $m_e = \dfrac{m_a(h - h_{f1})}{2257}$

$m_a = \dfrac{\text{mass of steam generated per hr}}{\text{mass of fuel burnt per hr}} = \dfrac{5000}{700}$

$\Rightarrow m_a = 7.14$ kg/kg of fuel

Enthalpy of steam $h = h_f + x h_{fg}$ at 1.2 Mpa i.e, 12 bar from steam tables

$\Rightarrow h = 798.4 + 0.92(1984.3)$

$\Rightarrow h = 2623.96$ kJ/kg

h_{f1} = Enthalpy of feedwater at 45°c from steam tables = 188.4 KJ/kg

$$\therefore m_e = \frac{m_a(h - h_{f1})}{2257}$$

$$= \frac{7.14(2623.96 - 188.4)}{2257}$$

$$\Rightarrow \boxed{m_e = 7.7 \text{ kg of steam/kg of coal}}$$

Boiler efficiency, $\eta_b = \frac{m_a(h - h_{f1})}{C.V}$

$$= \frac{7.14(2623.96 - 188.4)}{31402}$$

$$\Rightarrow \boxed{\eta_b = 55.4\%}$$

2) A boiler produces 200 kg of dry saturated steam per hr at 10 bar and feedwater is heated by an economiser to a temperature of 110°C. 225 kg of coal of calorific value of 30100 KJ/kg is ~~burnt~~ fired per hr. If 10% of coal remains unburnt, find the thermal efficiency of boiler and boiler and grate combined.

Sol:- We know that $\eta_b = \frac{m_a(h - h_{f_1})}{C.V}$

where $m_a = \frac{m_s}{m_f} = \frac{2400 \text{ kg/hr}}{225 \times 0.9 \text{ kg/hr}} = 9.88$ kg/kg of fuel

Enthalpy of steam, $h = h_g$ from steam tables at 10 bar pressure $= 2776.2$ KJ/kg

h_{f_1} = enthalpy of feedwater at 110°C from steam tables $= 461.3$ KJ/kg

$$\therefore \eta_b = \frac{9.88(2776.2 - 461.3)}{30100} = 76\%$$

Combined efficiency of grate and boiler

$$\eta_{comb} = \frac{m_a(h - h_{f_1})}{C.V}$$

$$m_a = \frac{m_s}{m_f} = \frac{2400}{225} = 8.88 \text{ kg/kg of fuel}$$

$$\therefore \eta_{comb} = \frac{8.88(2776.2 - 461.3)}{30100}$$

$$\eta_{comb} = 68.3\%$$

13. PPT MATERIAL

INTRODUCTION

- A **steam generator** or **boiler** is a closed vessel made of steel. Its function is to transfer the heat produced by combustion of fuel to water and ultimately to produce steam.

- The steam produced may be supplied

  i) to an external combustion engine i.e., steam engines and turbines.

  ii) at low pressure for industrial process work in cotton mills, sugar factories, breweries etc.

  iii) for producing hot water which can be used for heating installations at much lower pressures.

IMPORTANT TERMS FOR STEAM BOILERS

i)**Boiler shell:** It is made of steel plates bent into cylindrical shell and riveted or welded together. The ends of the shell are closed by means of end plates. A boiler shell should have sufficient capacity to contain water and steam.

ii)**Combustion chamber:** It is the space generally below the boiler shell meant for burning fuel in order to produce steam from water present in the shell.

iii) **Grate**: It is a platform in combustion chamber upon which fuel (coal or wood) is burnt. The grate usually consists of cast iron bars which are spaced apart so that so that air (required for combustion) can pass through them. The surface area of the grate over which fire takes place is called **grate surface.**

iv) **Furnace**: It is the space above the grate and below the boiler shell in which fuel is actually burnt. The furnace is also called as **fire box**.

v) **Heating surface**: It is a part of boiler surface which is exposed to fire (or hot gases from the fire).

vi) **Mountings**: These are the fittings which are mounted on the boiler for its proper functioning. They include water level indicator, pressure gauge, safety valve etc. A boiler can not function safely with out the mountings.

vii) **Accessories**: These are the devices which form an integral part of the boiler but are not mounted on it. They include super heater, economizer, feed pump etc. The accessories help in controlling and running the boiler efficiently.

REQUIREMENTS OF A GOOD STEAM BOILER

- It should produce maximum quantity of steam with the minimum fuel consumption.
- Economical to install and should require little attention during operation.
- Rapidly meet the fluctuation of load.
- Capable of quick starting.
- It should be light in weight.

- Should occupy a small space.
- Joints should be few and accessible for inspection.
- Mud and other deposits should not collect on the heating plates.
- Tubes should not accumulate soot or water deposits and should have a reasonable margin of strength to allow wear or corrosion.
- Should comply with the safety regulations as laid in the Boilers Act.

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R15

Subject Code: A15318

B.Tech III Year I Semester Examinations, MAY 2019

THERMAL ENGINEERING-II

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 question in Part A.
Part B consists of 5 Units. Answer all the questions.

Bloom Levels:

Remember	L1
Understand	L2
Apply	L3
Analyze	L4
Evaluate	L5
Create	L6

PART - A ANSWER ALL THE QUESTIONS 25 M		Bloom Levels	Marks
1	State the essential differences between carnot and Rankine cycles.	L2	2M
2	Explain the classification of fuels.	L2	3M
3	Define equivalent evaporation of a steam boiler.	L1	2M
4	Explain super saturated flow of steam in steam nozzles.	L2	3M
5	Draw velocity triangle for 50% reaction steam turbine.	L3	2M
6	Write significance of governers used in steam turbine.	L2	3M
7	Discuss the merits and demerits of surface condensers over jet condensers	L2	2M
8	What are the different types of combustion chambers used in gas turbines?	L2	3M
9	Explain thrust augmentation used in jet and rocket propulsion.	L2	2M
10	Why propeller engines are not recommended now a days in aircrafts?	L2	3M

PART - B ANSWER ALL THE QUESTIONS 5X10 = 50 M		Bloom Levels	Marks
11. i.	Explain adiabatic flame temperature.	L3	10M
[OR]			
ii.	Calculate the air fuel ratio on boh mass and molar basis for the completee combustion of C8H18 with theoretical air and 150% theoretical air.	L3	10 M
12.i.	Explain the working of Babcock and Wilcox boiler with a neat sketch.	L3	10M
[OR]			
ii.	Derive the equation for critical pressure ratio of nozzle for different conditions.	L3	10M
13.i.	Derive the equation for optimum workoutput in impulse turbine.	L3	10M
[OR]			
ii.	In a delaval turbine, steamissues from the nozzle with a velocity of 1200 m/s, the nozzle angle is 20^o, mean blade velocity s 400 m/s and the inlet and outlet blade anglesa re equal. The mass of steam flowing through the turbine per hour is 1000 Kg. Calculate blade angle, power developed and blade efficiency.	L4	10M
14.i.	Derive an expression for the efficiency as a function of temperature ratio and pressure ratio for a ideal gas turbine cycle.	L3	10M
[OR]			

ii.	Explain with neat sketch the working of a low level jet condenser and down flow type surface condenser.	L3	10M
15.i.	Derive the expressions for thrust and thrust power of a propulsive engine.	L3	10M
[OR]			
ii.a)	Explain the working of turbojet engine with a neat sketch.	L3	10M

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Roll No- 17911A0304

5/5

1Q:- Explain regenerative and reheat rankine cycle?

* Re-heat rankine cycle:

Ans:- → As the boiler pressure increases the ~~then~~ thermal efficiency of the cycle increases, but the moisture content in the steam also increases to acceptable levels.

→ The two possibilities to solve this problem are;

(i) Super heat the steam at very high ~~pressure~~ temp. before it enters the turbine. This would a desirable solution. Since avg. temperature of heat addition increases and thus the thermal efficiency of cycle increases. But however this cannot be viable solution from metallurgical point of view.

(ii) Expand the steam in two stages and reheat it in between. In other words, modify the simple rankine cycle with reheat process.

→ Reheating is a practical solution to excessive moisture problem in steam turbines and ~~hence~~ is commonly used modren steam power plants.

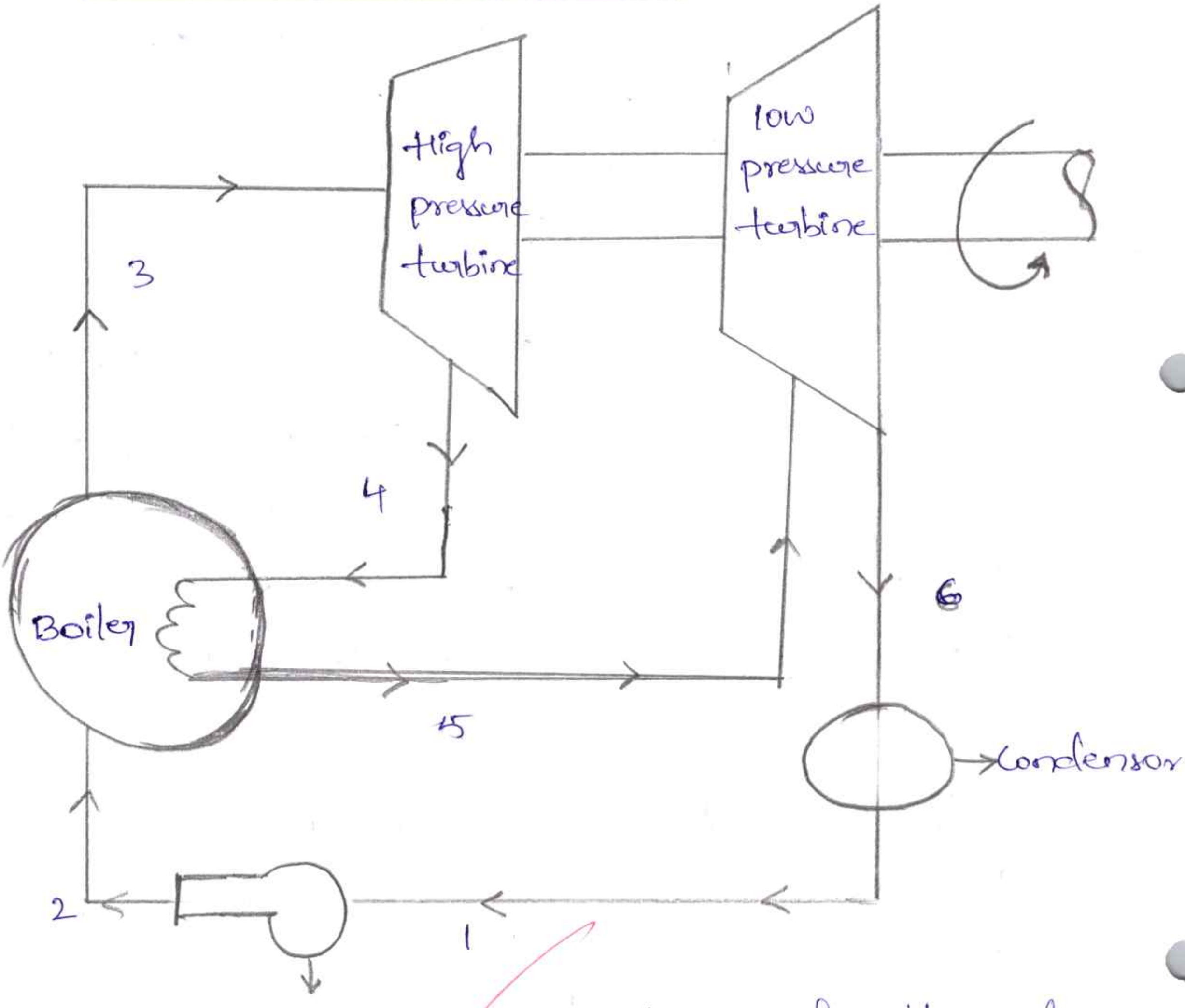
→ Total heat input in the cycle is, $q_s = q_{(2-3)} + q_{(4-5)}$

$$\Rightarrow \boxed{q_s = (h_3 - h_2) + (h_5 - h_4)}$$

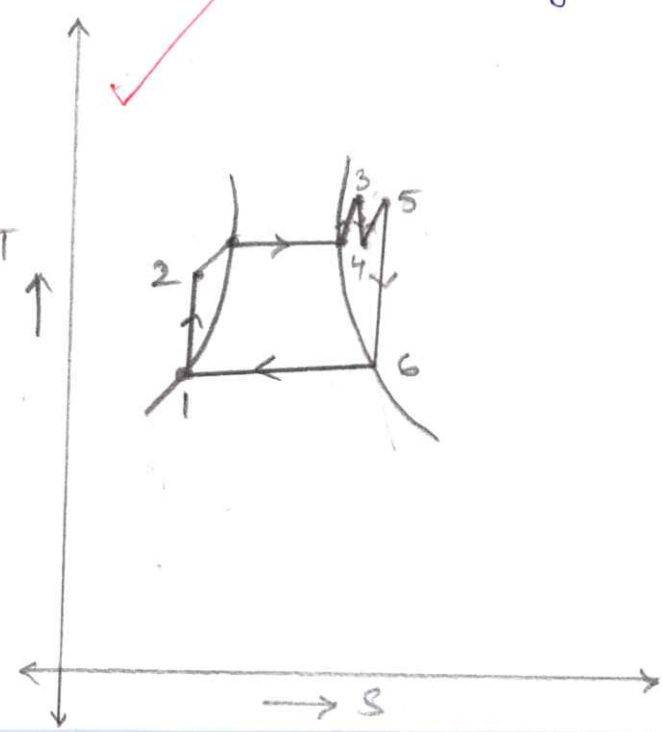
→ Total work output from the cycle;

$W_t = W_{(3-4)} + W_{(5-6)}$

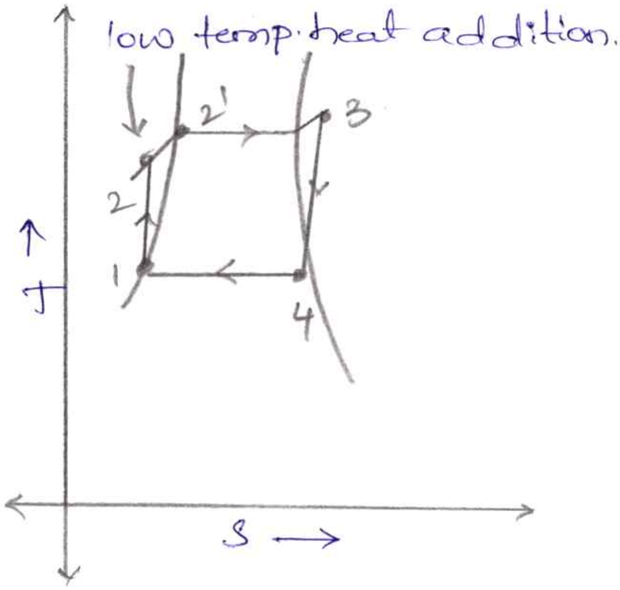
$$W_t = (h_3 - h_4) + (h_5 - h_6)$$



→ Rankine cycle with single reheat



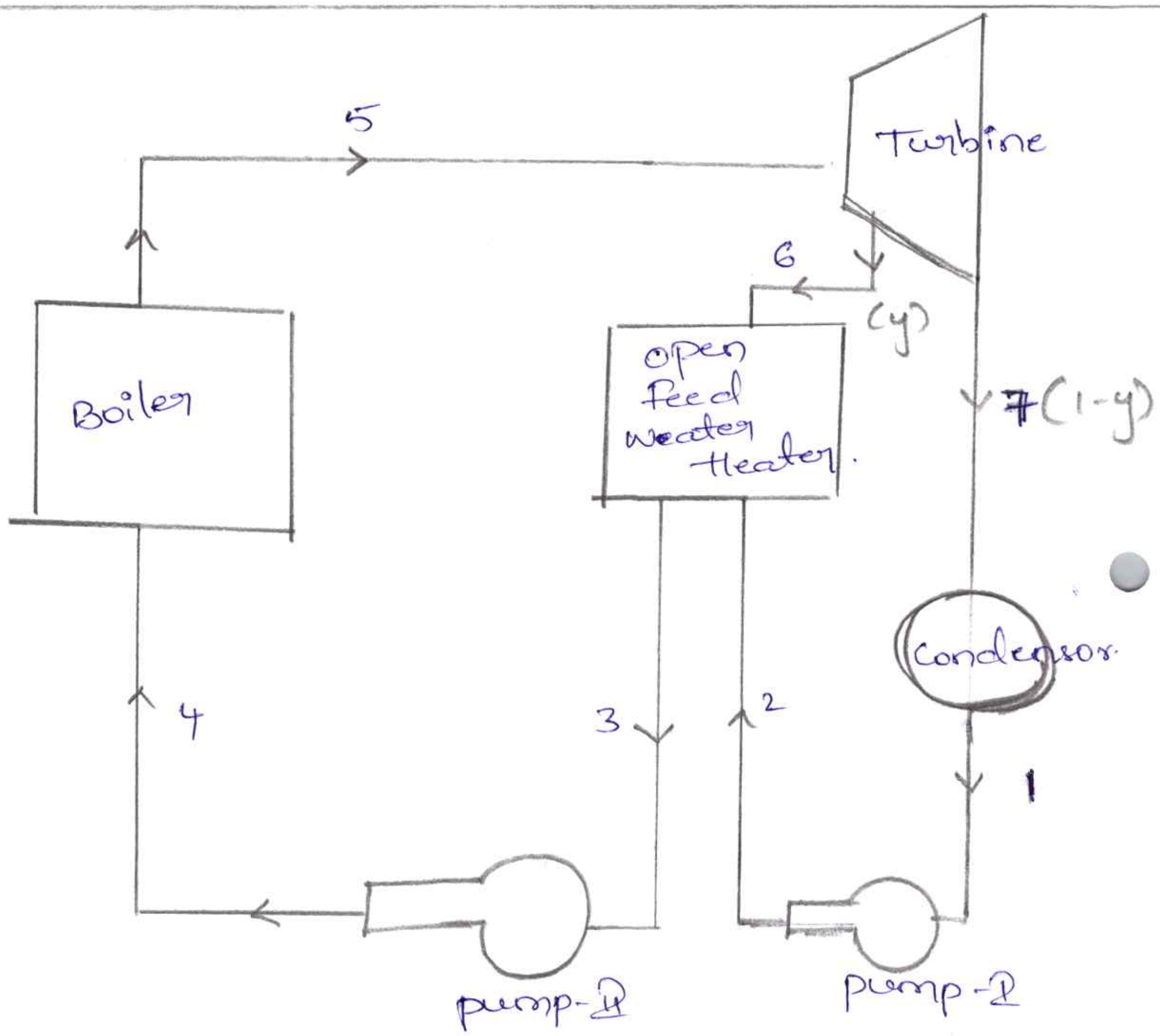
* Re-generative rakine Cycle :-



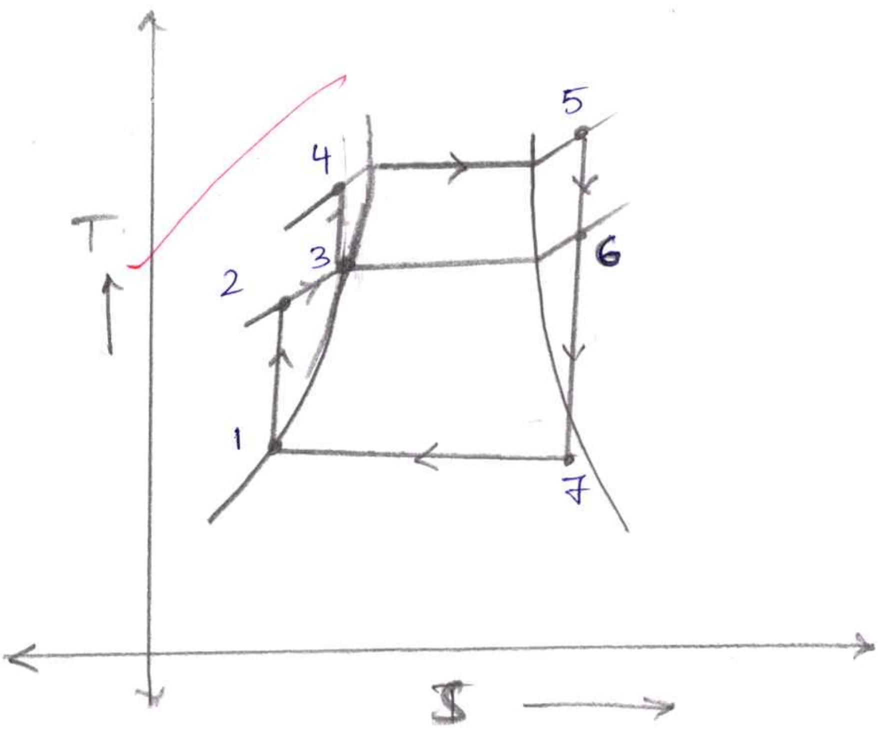
→ from TS diagram it is clear that heat is transferred to the working fluid during process 2 to 2' at relatively low temperature. This lowers the mean temperature of heat addition & thus the cycle efficiency. To overcome this problem we can raise the temperation of the liquid living the pump before it enters the boiler.

→ A practical regeneration process in steam power plants is accomplised by extracting (or) Bleeding steam from turbine at various points.

→ The device were the feed water is heated by regeneration is called "feed water heater" (or). "Regenerator".



5
Turbine
6
(y)
7(1-y)
Boiler
Open Feed Water Heater.
Condensor.
4
3
2
1
pump-II
pump-I



T
5
4
3
2
6
1
7
S

38:- Derive the condition for maximum discharge in nozzle flow. Explain the significance of critical pressure ratio?

Ans:-

* Discharge through the nozzle and condition for its maximum value:-

Here; $P_1 \rightarrow$ Initial pressure of steam.

$V_1 \rightarrow$ Initial volume of 1kg of steam at pressure "P_1".

W.K.T; $PV^n = C$.

Were, $n = 1.135$ (for saturated steam flow).

$n = 1.3$ (for super heated steam flow).

$n = 1.035 + 0.1x$ (for wet steam),

$n = 1.4$.

work done $= -\int v\, dp$ $\quad \because V = \left(\frac{C}{P}\right)^{1/n}$.

$\Rightarrow -\int \left(\frac{C}{P}\right)^{1/n} dp$

$\Rightarrow -(C)^{1/n} \int \left(\frac{1}{P}\right)^{1/n} dp$.

$W.D = \frac{n}{n-1}(P_1V_1 - P_2V_2)$.

$\therefore \boxed{W.D = \frac{n}{n-1}(P_1V_1 - P_2V_2)}$

$\Rightarrow$ Gain in kinetic energy = Adiabatic heat drop

Were, $\frac{C_2^2}{2} = \frac{n}{n-1}(P_1V_1 - P_2V_2)$

$\Rightarrow \left(\frac{n}{n-1}\right)(P_1V_1)\left(1 - \frac{P_2V_2}{P_1V_1}\right)$

$$\Rightarrow \frac{n}{n-1}(P_1V_1)\left[1-\left(\frac{P_2}{P_1}\right)\left(\frac{P_1}{P_2}\right)^{1/n}\right].$$

$$\Rightarrow \frac{n}{n-1}(P_1V_1)\left[1-\left(\frac{P_2}{P_1}\right)\left(\frac{P_2}{P_1}\right)^{-1/n}\right].$$

$$\frac{C^2}{2} \Rightarrow \frac{n}{n-1}(P_1V_1)\left[1-\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}\right].$$

$$\therefore \boxed{C_2 = \sqrt{2\left(\frac{n}{n-1}\right)(P_1V_1)\left[1-\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}\right]}}$$

And, $m = \int AC$.

$$\Rightarrow A\frac{C_2}{V_2}.$$

$$\Rightarrow \frac{A_2}{V_2}\sqrt{\left(\frac{2n}{n-1}\right)(P_1V_1)\left[1-\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}\right]}.$$

$$\Rightarrow \frac{A_2}{(V_1)\left(\frac{P_1}{P_2}\right)^{1/n}}\sqrt{\frac{2n}{n-1}(P_1V_1)\left[1-\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}\right]}.$$

$$\Rightarrow m = \frac{A_2}{V_1}\sqrt{\frac{2n}{n-1}(P_1V_1)\left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{n}}-\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}\times\left(\frac{P_2}{P_1}\right)^{\frac{2}{n}}\right]}.$$

$$\Rightarrow m = \frac{A_2}{V_1}\sqrt{\frac{2n}{n-1}\cdot(P_1V_1)\left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{n}}-\left(\frac{P_2}{P_1}\right)^{\frac{n+1}{n}}\right]}.$$

from above equation;

→ there is only one value of ratio i.e; "$\frac{P_2}{P_1}$" will produce the maximum discharge.

$$\Rightarrow \frac{dm}{d\left(\frac{P_2}{P_1}\right)} = \frac{dm}{d(P_2/P_1)}\left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{n}}-\left(\frac{P_2}{P_1}\right)^{\frac{n+1}{n}}\right] = 0.$$

$$\Rightarrow \frac{2}{n}\left[\frac{P_2}{P_1}\right]^{\frac{2}{n}-1}-\left(\frac{n+1}{n}\right)\left(\frac{P_2}{P_1}\right)^{\frac{n+1}{n}} = 0.$$

$$\Rightarrow \left(\frac{2}{n}\right)\left(\frac{P_2}{P_1}\right)^{\frac{2-n}{n}} = \left(\frac{n+1}{n}\right)\left(\frac{P_2}{P_1}\right)^{\frac{n+1-n}{n}}.$$

$$\Rightarrow \left(\frac{2}{n}\right)\left(\frac{P_2}{P_1}\right)^{\frac{2-n}{n}} = \left(\frac{n+1}{n}\right)\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}}.$$

$$\Rightarrow \left(\frac{2}{n}\right)\left(\frac{P_2}{P_1}\right)^{\frac{2-n}{n}} = \left(\frac{n+1}{n}\right)\left(\frac{P_2}{P_1}\right)^{1/n}.$$

$$\Rightarrow \frac{\left(\frac{P_2}{P_1}\right)^{\frac{2-n}{n}}}{\left(\frac{P_2}{P_1}\right)^{1/n}} = \frac{n+1}{\cancel{n}} \times \frac{\cancel{n}}{2}.$$

$$\Rightarrow \left(\frac{P_2}{P_1}\right)^{\frac{2-n}{n} - \frac{1}{n}} = \frac{n+1}{2}.$$

$$\cancel{\Rightarrow \left(\frac{P_2}{P_1}\right)^{\frac{2+n-1}{n}} = \frac{n+1}{2}.}$$

$$\Rightarrow \left(\frac{P_2}{P_1}\right)^{\frac{1-n}{n}} = \frac{n+1}{2}.$$

$$\Rightarrow \left(\frac{P_2}{P_1}\right) = \left(\frac{n+1}{2}\right)^{\frac{n}{1-n}}.$$

$$\therefore \boxed{\frac{P_2}{P_1} = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}}.$$

for, $n = 1.135$

$$\Rightarrow \frac{P_2}{P_1} = \left(\frac{2}{1.135+1}\right)^{\frac{1.135}{1.135-1}}$$

$$\therefore \boxed{\frac{P_2}{P_1} = 0.58.}$$

for, $n = 1.3$.

$$\Rightarrow \frac{P_2}{P_1} = \left(\frac{2}{1.135+1}\right)^{\frac{1.3}{1.3-1}}$$

$$\therefore \boxed{\frac{P_2}{P_1} = 0.546}$$

for, $n = 1.4$.

$$\Rightarrow \frac{P_2}{P_1} = \left(\frac{2}{1.135+1}\right)^{\frac{1.4}{1.4-1}}$$

$$\therefore \boxed{\frac{P_2}{P_1} = 0.528}$$

⇒ maximum discharge;

$$m_{max} = \frac{A_2}{V_1}\sqrt{\left[\frac{2n}{n-1}\right](P_1V_1)\left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{n}} - \left(\frac{P_2}{P_1}\right)^{\frac{n+1}{n}}\right]}$$

$$m_{max} = \frac{A_2}{V_1}\sqrt{\frac{2n}{n-1}\cdot P_1V_1\left[\left[\left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}\right]^{\frac{2}{n}} - \left[\left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}\right]^{\frac{n+1}{n}}\right]}$$

$$m_{max} = \frac{A_2}{V_1}\sqrt{\frac{2n}{n-1}\cdot P_1V_1\left[\left(\frac{2}{n+1}\right)^{\frac{2}{n-1}} - \left(\frac{2}{n+1}\right)^{\frac{n+1}{n-1}}\right]}$$

$$m_{max} = A_2\sqrt{\left(\frac{2n}{n-1}\right)\cdot P_1V_1\left[\left(\frac{2}{n+1}\right)^{\frac{2}{n-1}} - \left(\frac{2}{n+1}\right)^{\frac{n+1}{n-1}}\right]}$$

$$m_{max} = A_2\sqrt{\left(\frac{2n}{n-1}\right)\cdot\frac{P_1}{V_1}\cdot\left(\frac{2}{n+1}\right)^{\frac{n+1}{n-1}}\left[\frac{\left(\frac{2}{n+1}\right)^{\frac{2}{n-1}}}{\left(\frac{2}{n+1}\right)^{\frac{n+1}{n-1}}} - 1\right]}.$$

$$m_{max} = A_2\sqrt{\left(\frac{2n}{n-1}\right)\left(\frac{P_1}{V_1}\right)\left(\frac{2}{n+1}\right)^{\frac{n+1}{n-1}}\left[\left(\frac{2}{n+1}\right)^{\frac{2}{n-1}-\frac{n+1}{n-1}}\right]}.$$

$$m_{max} = A_2\sqrt{\left(\frac{2n}{n-1}\right)\left(\frac{P_1}{V_1}\right)\left(\frac{2}{n+1}\right)^{\frac{n+1}{n-1}}\left[\left(\frac{2}{n+1}\right)^{\frac{1-n}{n-1}} - 1\right]}.$$

$$m_{max} = A_2\sqrt{\left(\frac{2n}{n-1}\right)\left(\frac{P_1}{V_1}\right)\left(\frac{2}{n+1}\right)^{\frac{n+1}{n-1}}\left(\frac{n+1-2}{2}\right)}.$$

$$\therefore \boxed{m_{max} = A_2\cdot\sqrt{n\left(\frac{P_1}{V_1}\right)\left(\frac{2}{n+1}\right)^{\frac{n+1}{n-1}}}}$$

49:- Find the percentage increase in discharge from a convergent-divergent nozzle expanding steam from 8.75 bar dry to 2 bar when a) Expanding taking place under thermal equilibrium.

b) Steam is in meta stable state during part of its expansion.

Sol: Given,

State 1; $P_1 = 8.75$ bar. ; Dry Saturated.

State 2; $P_2 = 2$ bar.

Case ①:- Expansion is taking place under thermal equilibrium.

Velocity of steam at exit $(C_2) = \sqrt{2000(h_1 - h_2)}$.

$$C_2 = \sqrt{2000(2770 - 2510)}$$

$\Rightarrow h_1 = h_{g1} = 2770$ kJ/kg

$\Rightarrow h_2 = 2510$ kJ/kg.

$$\boxed{C_2 = 721.11 \text{ m/sec}}$$

Mass flow rate of steam $(m^\circ) = \frac{A_2 \times C_2}{v_2}$

$$\Rightarrow (m^\circ) = \frac{A_2 \times 721.11}{0.8}$$

$C_2 = 721.11$ m/sec

$v_2 = 0.8 \, m^3/kg$.

$$\boxed{\therefore (m^\circ) = 901.38 A_2}$$

Case ②:- Steam is in the metastable state during part of its expansion.

At the flow of metastable;

$\Rightarrow n = 1.3$.

$V_1 = 0.23 \, m^3/kg$

$P_1 = 8.75$ bar $= 8.75 \times 10^5 \, N/m^2$

$P_2 = 2$ bar.

Velocity of steam at exit of nozzle (C_2').

$$= \sqrt{\frac{2n}{n-1}(P_1V_1)\left(1-\left(\frac{P_2}{P_1}\right)^{\left(\frac{n-1}{n}\right)}\right)}$$

$$\Rightarrow C_2' = \sqrt{\frac{2\times1.3}{1.3-1}\times 8.75\times10^5\times(0.23)\left(1-\left(\frac{2}{8.75}\right)^{\left(\frac{1.3-1}{1.3}\right)}\right)}$$

$$\therefore \boxed{C_2' = 709.54 m/sec}$$

we got, $n = 1.3$.

$V_1 = 0.2 m^3/kg$.

$P_1 = 8.75 bar = 8.75\times10^5 N/m^2$.

$P_2 = 2 bar = 2\times10^5 N/m^2$.

W.K.T; $P_1V_1^n = P_2V_2^n$.

$$\Rightarrow (8.75)(10^5)(0.23^{(1.3)}) = 2\times10^5\times V^{\frac{1}{2}.3}.$$

$$\therefore \boxed{V_2 = 0.715 m^3/kg}.$$

mass flow rate of steam (m°) $= \frac{A_2\times C_2'}{V_2}$.

$$(m^\circ)' = \frac{A_2\times 709.54}{0.715}$$

$\Rightarrow C_2' = 709.54 m/sec$

$\Rightarrow V_2 = 0.715 m^3/kg$.

$$\therefore \boxed{(\dot{m}') = 992.36 A_2}$$

percentage increase in discharge $= \frac{m' - m^\circ}{m^\circ}\times 100\%$.

$\Rightarrow m^\circ = 901.38 A_2$.

$\dot{m}' = 992.36 A_2$.

percentage increase in discharge $= \frac{992.36 A_2 - 901.38 A_2}{901.38 A_2}\times 100\%$

$\therefore$ percentage increase in discharge $= 10.09\%$.

5Q:- Explain with the help of neat sketch a single stage impulse turbine. Also explain the pressure and velocity variation along the axis of rotation.

Ans:- ***Impulse turbine:-**

→ It consists of nozzle (or) a set of nozzles, a rotor mounted on a shaft set of moving blades attached to the rotor and a casing.

→ A simple impulse turbine is also called De-Laval turbine, after the name of its inventor.

→ This turbine is called impulse turbine because the expansion of the steam takes place in one set of nozzles by impulsive force

→ In Impulse turbine, steam coming out through a fixed nozzle at a very high velocity (about 1100m/sec). strikes the blades mounted on the periphery of a rotor.

→ The force due to change of momentum cause the rotation of the turbine shaft.

→ The impulse turbine consists of a rotor mounted on a shaft that is free to rotate in a set of bearing.

→ Nozzles direct steam against the blades and turn the rotor.

(2) Q:- A steam power plant that operates on the ideal reheat Rankine cycle is considered. The turbine work output and the thermal efficiency of the cycle are to be determined.

Sol:- From steam tables;

$h_1 = h_f = 251.42 \, kJ/kg$.

$v_1 = v_f = 0.001017 \, m^3/kg$.

$w_{p,in} = v_1 (P_2 - P_1)$.

$= (0.001017 \, m^3/kg)(6000 - 20 kPa)\left[\frac{1 kJ}{1 kPa.m^3}\right]$.

$= 6.08 \, kJ/kg$.

$h_2 = h_1 + w_{p,in} = 251.42 + 6.08 = 257.50 \, kJ/kg$.

$\left.\begin{array}{l} P_3 = 6 MPa \\ T_3 = 400°C \end{array}\right\} \begin{array}{l} h_3 = 3178.3 \, kJ/kg. \\ S_3 = 6.5432 \, kJ/kg.K. \end{array}$

$h_4 = 2901.0 \, kJ/kg$.

$h_5 = 3248.4 \, kJ/kg$.

$S_5 = 7.1292 \, kJ/kg.K$.

$x_6 = \frac{S_6 - S_f}{S_{fg}} = \frac{7.1292 - 0.8320}{7.0752} = 0.8900$.

$h_6 = h_f + x_6 h_{fg} = 251.42 + (8900)(2357.5) = 2349.7 \, kJ/kg$.

The turbine work output and the thermal efficiency are determined from;

$$w_{T.out} = (h_3 - h_4) + (h_5 - h_6).$$

$$= 3178.3 - 2901.0 + 3248.4 - 2349.7.$$

$$\Rightarrow 1176 \text{ kJ/kg}.$$

and, $q_{in} = (h_3 - h_2) + (h_5 - h_4) = 3178.3 - 257.50 + 3248.4 - 2901.0$

$$= 3268 \text{ kJ/kg}$$

$$w_{net} = w_{T.out} - w_{p.in} = 1176 - 6.08 = 1170 \text{ kJ/kg}$$

Thus;

$$\eta_{th} = \frac{w_{net}}{q_{in}} = \frac{1170 \text{ kJ/kg}}{3268 \text{ kJ/kg}}.$$

$$\therefore \eta_{th} = 31.68\%.$$

Roll NO:17911A0313

5/5

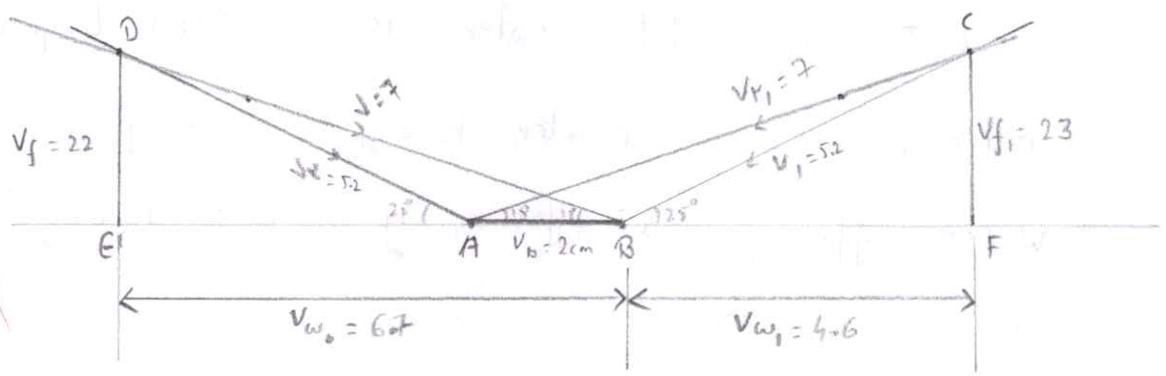
1Q) A reaction turbine the fixed and moving blades are of the same shape but reversed in direction. The angle of receiving tip is 25° and the discharging tip is 18°. Find the power developed per pair of blades for the steam consumption of 5.5 kg/s, when the blade speed is 80 m/s. If the enthalpy drop in the pair is 20 kJ/kg. Also find the efficiency of pair.

Sol:-

Given, $\theta = 25° = \beta$, $\dot{m} = 5.5$ kg/s , $V_b = 80$ m/s , $H = 20$ kJ/kg

$\alpha = 18° = \phi$

Assume 40 m/s = 1 cm , ⇒ ∴ 80 m/s = 2 cm



From the diagram, $(V_w + V_{w_1}) = EF$

$= 452$ m/s

$V = 7 \Rightarrow 7 \times 40 = 280$

$V_{r_1} = 7 \Rightarrow 7 \times 40 = 280$

$V_r = 5.2 \Rightarrow 5.2 \times 40 = 208$

$V_1 = 5.2 \Rightarrow 5.2 \times 40 = 208$

$V_w = 6.7 \Rightarrow 6.7 \times 40 = 268$

$V_{w_1} = 4.6 \Rightarrow 4.6 \times 40 = 184$

Work done per pair per kg of steam =

$V_b (V_w + V_{w_1})$

$= 80 (452)$

$= 36160$ Nm (or) Joules

Power developed per pair $= \dfrac{m \times V_b (V_w + V_{w_1})}{1,000}$

$= \dfrac{5.5 \times 36160}{1,000}$

$= 198.88$ KW

Efficiency $= \dfrac{\text{Work done per pair per kg of steam}}{1,000 \; H}$

$= \dfrac{36160}{1000 \times 20} = 0.808$ (or) 80.8% //

2 a) The following data were obtained from the test of a Surface condenser : Condenser vacuum = 715 mm of Hg ; Hot water Temp = 42°C, Inlet Temp of circulating water = 16°C ; outlet temp of circulating water is 28°C, Barometer reading is 760mm of Hg. Calculate the vaccum efficiency and efficiency of condenser bearing.

Sol :-

Vaccum Efficiency.

$= \dfrac{\text{Actual vaccum in mm of Hg}}{\text{Vaccum corresponding to temperature of condensation in mm of Hg}}$

$= \dfrac{\text{Actual vaccum}}{\text{Ideal vaccum}} = \dfrac{715}{760 - (700 \times 0.06)} = 0.995$

(or)

$= 99.5\%$

Efficiency of condenser :

Absolute of pressure = 760 - 715 = 45 mm of Hg

$= \frac{45}{750} = 0.06$ bar

Saturation temperature corresponding to 0.06 bar is 32°C.

Condenser efficiency,

$$= \frac{\text{Rise in temperature of cooling water}}{\left[\begin{array}{c}\text{Saturation temperature corresponding} \\ \text{to the absolute pressure in condenser}\end{array}\right] - \left[\begin{array}{c}\text{Inlet temperature} \\ \text{of cooling water}\end{array}\right]}$$

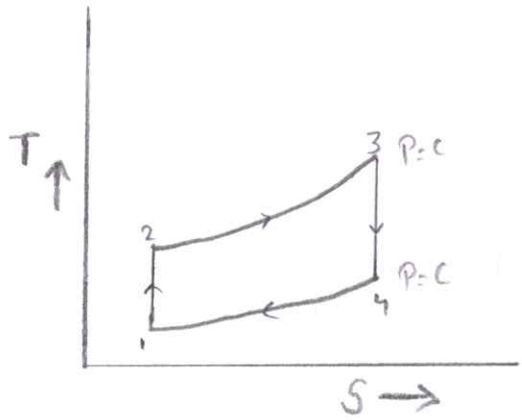
$$= \frac{28 - 16}{32 - 16} = 0.75 \text{ (or) } 75\%$$

3Q) A Simple gas turbine plant operating on Brayton Cycle has air entering the compressor at 100kPa and 27°C. The pressure ratio is 9.0 and maximum cycle temperature is 727°C. What will be Percentage change in Cycle η and net work output if the expansion in the turbine is divided into two stages each of pressure ratio 3, with intermediate reheating to 727°C? Assume compression and expansion are ideal isentropic.

Sol:-

Case -(i)

Simple gas turbine



$T_1 = 300\,K$

$P_1 = 1$ bar

$P_2 = 9$ bar

$T_3 = 727 + 273 = 1000\,K$.

We have, $T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} = 562\,K$.

And $T_4 = T_3 \left(\frac{P_3}{P_4}\right)^{\frac{\gamma-1}{\gamma}} = 533.7\,k$

$\therefore \quad W_{net} = W_T - W_c$

$= C_p\left[(T_3 - T_4) + (T_2 - T_1)\right]$

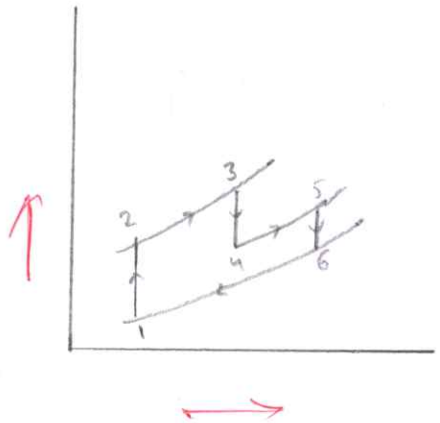
$= 205\ kJ/kg.$

$Q_H = C_p (T_3 - T_2) = 440.19\ kJ/kg$

$\therefore \quad \eta_{cycle} = \frac{W_{net}}{Q_H} = \frac{205}{440.19} = 0.466$ (or) 46.6%

Case (ii)

With reheat :



from Case (i) , $T_2 = 562\,K$.

$$\frac{P_3}{P_4} = \frac{P_5}{P_6} = 3 \quad \text{and} \quad P_4 = P_5$$

We have, $T_4 = T_3 \left(\frac{P_3}{P_4}\right)^{\frac{\gamma-1}{\gamma}} = 730.6\,K$

$$T_6 = T_5 \left(\frac{P_5}{P_6}\right)^{\frac{\gamma-1}{\gamma}} = 730.6\,K$$

$$W_{net} = \left(W_{T_1} + W_{T_2} - W_c\right)$$

$$= C_p\left(T_3 - T_4\right) + C_p\left(T_5 - T_6\right) - C_p\left(T_2 - T_1\right)$$

$$= 278\ kJ/kg$$

$$\therefore \eta_{cycle} = \frac{W_{net}}{Q_H} = \frac{278}{C_p(T_3 - T_2) + C_p(T_5 - T_4)}$$

$$= 0.391 \text{ (or) } 39.1\%$$

$\therefore$ Increase in net work output $= \frac{278 - 205}{205} = 0.356$ (or) 35.6%

Increase in efficiency $= \frac{39.1 - 46.6}{46.6} = -0.161$ (or) -16.1%

Negative sign indicates there is a decrease in Thermal efficiency.

4Q) A turbo-jet engine consumes air in the rate of 60.2 kg/s when flying at a speed of 1000 Km/h. Calculate:

(i) Exit velocity of the jet when the enthalpy change for nozzle is 230 kJ/kg and velocity co-efficient is 0.96.

(ii) Fuel flow rate in kg/s when air-fuel ratio is 70:1

(iii) Thrust specific fuel consumption.

(iv) Thermal efficiency of plant when combustion efficiency is 92% and calorific value of fuel used is 42000 kJ/kg.

(v) propulsive power

(vi) Propulsive efficiency

(vii) Overall efficiency.

Sol:-

Rate of air consumption, $\dot{m}_a = 60.2$ kg/s

Enthalpy change for nozzle, $\Delta h = 230$ kJ/kg

Velocity coefficient, $z = 0.96$

Air-fuel ratio, $= 70:1$

Combustion efficiency, $\eta_{combustion} = 92\%$

Calorific value of fuel, C.V $= 42000$ kJ/kg

Aircraft velocity; $C_a = \dfrac{1000 \times 1000}{60 \times 60} = 277.8$ m/s

(i) Exit velocity of jet, C_j :

$$C_j = Z\sqrt{2\Delta h \times 1000} \quad , \text{ where } \Delta h \text{ is in kJ}$$

$$= 0.96\sqrt{2 \times 230 \times 1000}$$

$$C_j = \cdot 651 \text{ m/s.}$$

(ii) Fuel flow rate :

Rate of fuel consumption,

$$\dot{m}_f = \frac{\text{Rate of air Consumption}}{\text{Air - fuel ratio}}$$

$$= \frac{60.2}{70} = 0.86 \text{ kg/s.}$$

(iii) Thrust specific fuel Consumption :

Thrust is the force produced due to change of momentum.

Thrust produced $= \dot{m}_a (C_j - C_a)$, neglecting mass of fuel.

$$= 60.2\,(651 - 277.8)$$

$$= 22466.6 \text{ N.}$$

$\therefore$ Thrust specific fuel consumption.

$$= \frac{\text{Fuel consumption}}{\text{Thrust}} = \frac{0.86}{22466.6}$$

$$= 3.828 \times 10^{-5} \text{ kg/N of thrusts.}$$

(iv) $\eta_{thermal} = \dfrac{\text{Work output}}{\text{Heat Supplied}}$

$= \dfrac{\text{Gain in kinetic energy per kg of air}}{\text{Heat Supplied by fuel per kg of air}}$

$= \dfrac{(C_j^2 - C_a^2)}{\left(\frac{m_f}{m_a}\right) \times C.V \times \eta_{Combustion} \times 1000}$

$= 0.3139$ (or) 31.39%

Thermal efficiency $= 31.39\%$ //

(v) Propulsive power:

$= \dot{m}_a \times \left(\dfrac{C_j^2 - C_a^2}{2}\right)$

$= \dfrac{60.2}{1000} \times \left(\dfrac{651^2 - 277.8^2}{2}\right)$ kW

$= 10433.5$ kW.

(vi) Propulsive efficiency:

$\eta_{prop} = \dfrac{\text{Thrust power}}{\text{Propulsive power}} = \dfrac{2C_a}{C_j + C_a}$

$= \dfrac{2 \times 277.8}{651 + 277.8} = 0.598$ (or) 59.8%

(vii) Overall efficiency:

$$\eta_o = \frac{\text{Thrust work}}{\text{Heat supplied by fuel}}$$

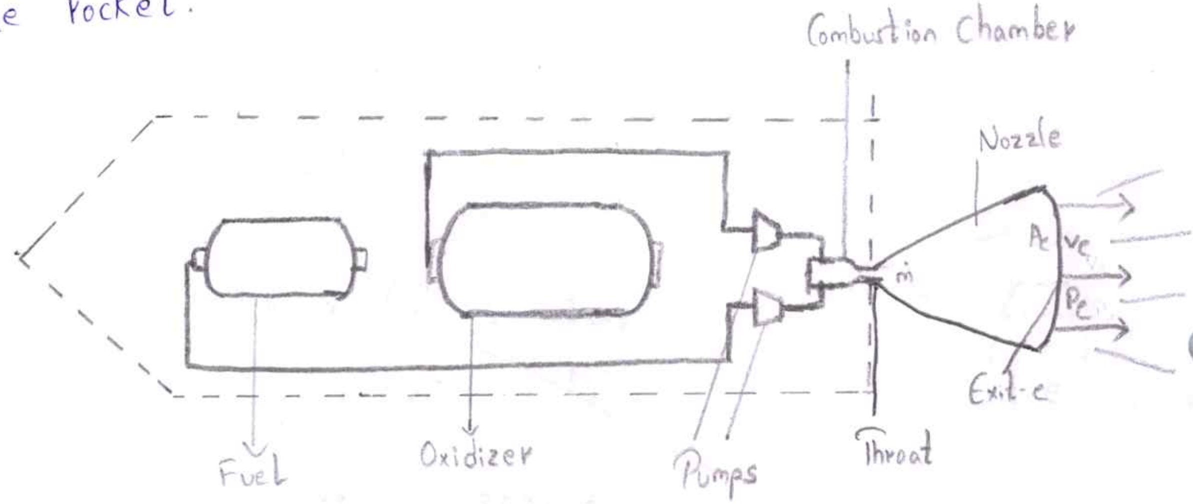
$$= \frac{(C_j - C_a)\, C_a}{\left(\frac{m_f}{m_a}\right) \times C.V \times \eta_{Combustion}}$$

$$= \frac{(651 - 277.8) \times 277.8}{\frac{1}{70} \times 42000 \times 0.92 \times 1000}$$

$$= 0.1878 \text{ (or) } 18.78\%$$

5Q) Explain the working principle of liquid propellant rocket engine with Suitable sketch.

Ans:- A liquid-propellant rocket or liquid rocket utilizes a rocket engine that uses liquid propellants. Liquids are desirable because they have a reasonably high density and high specific impulse (I_{sp}). This allows the volume of propellant tanks to be relatively low. It is also possible to use lightweight centrifugal turbopumps to pump the rocket propellant from tanks into combustion chamber, which means that propellants can be kept under low pressure. This permits the use of low-mass propellant tanks that do not need to resist the high-pressures needed to store significant amounts of gases, resulting in a low mass ratio for the rocket.



V = Velocity , ṁ = mass flow rate , p = pressure

An inert gas stored in a tank at a high pressure is sometimes used instead of pumps in simpler small engines to force the propellants into combustion chamber. Liquid rockets can be ~~pro~~ monopropellant rockets using a single type of propellant, or bipropellant rockets using two types of propellant. Liquid propellants are also used in hybrid rockets, with some of the advantages of a solid rocket.

16. ASSESSMENT SHEET – CO WISE (DIRECT ATTAINMENT)

CO ATTAINMENT		
Batch: 2017-2021	Year-Sem: III-I	Course: TE2

Mid 1												
TE2_M1	Part A			Part B			Assignment					Total Marks
Roll No:	Q1	Q2	Q3	Q4	Q5	Q6	A_Q1	A_Q2	A_Q3	A_Q4	A_Q5	
17911A0301	1	2	2	3	3	4	1	1	1		1	19
17911A0302	1	2		1	1	2	1		1			9
17911A0303	1	2	2	3	3	3	1	1	1		1	18
17911A0304	2	2	2	3	3	3	1	1	1	1	1	20
17911A0305	2	2	2	3	3	3	1	1	1	1	1	20
17911A0306	2	1	2	3	3	3	1	1	1		1	18
17911A0308	2	2	1	3	3	4	1	1	1		1	19
17911A0309	2	2	2	5	4	4	1	1	1	1	1	24
17911A0311	1	2	2	2	2	2	1	1	1		1	15
17911A0312	1	2	2	3	3	4	1	1	1		1	19
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17911A0314	1	2	2	3	3	3	1	1	1		1	18
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17911A0335		1	1						1			3
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17911A0359	2	2		2	2	2	1			1	1	13

17911A0360		2	2	1	1	2	1			1	1	11
17911A0361		2	2	2	2	3	1			1	1	14
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17911A0363		2	2	1	1	3	1			1	1	12
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17911A0384	1	2	2	2	2	4	1	1	1		1	17
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17911A0388	1	2	2	3	3	3	1	1	1		1	18
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17911A03J3	1	2	2	2	2	3	1	1	1		1	16
17911A03J4	2	2	2	5	5	4	1	1	1	1	1	25
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17911A03K7	1	2	2	2	2	4	1	1	1		1	17
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17911A03L0	2	2	2	5	5	4	1	1	1	1	1	25
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17911A03M0	2	2	2	5	4	4	1	1	1	1	1	24
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18915A0301	1	2	2	3	3	3	1	1	1		1	18
18915A0302	1	2	2	3	3	4	1	1	1		1	19
18915A0303	2	2	2	4	3	4	1	1	1	1	1	22
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18915A0313		2	2	2	2	3	1			1	1	14
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18915A0326	2	2		2	2	3	1			1	1	14
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18915A0330	2	2	2	4	3	4	1	1	1	1	1	22
18915A0331	2	2	1	2	2	4	1	1	1		1	17
18915A0332	2	2	2	5	5	4	1	1	1	1	1	25
18915A0333	2	2	2	5	4	4	1	1	1	1	1	24
18915A0334	2	1	2	3	3	3	1	1	1		1	18
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18915A0341	1	2	2	3	3	4	1	1	1		1	19
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18915A0346	1	2	2	2	2	3	1	1	1		1	16
18915A0347	2	2	2	4	3	4	1	1	1	1	1	22
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18915A0349	2	1	2	2	2	3	1	1	1		1	16
18915A0350	2	2	2	4	3	4	1	1	1	1	1	22
18915A0351	2	1	2	3	3	3	1	1	1		1	18
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18915A0353	2	2	2	5	5	4	1	1	1	1	1	25
No of students attempted	228	228	221	241	241	245	250	250	250	250	250	
No of students who scored >= 60% Marks	174	193	200	120	120	238	248	178	195	140	233	
% of students who scored >= 60% Marks	76	85	90	50	50	97	99	71	78	56	93	
Attainment	3	3	3	1	1	3	3	3	3	1	3	

Mid 2												
TE2_M2	Part A			Part B			Assignment					Total Marks
Roll No:	Q1	Q2	Q3	Q4	Q5	Q6	A_Q1	A_Q2	A_Q3	A_Q4	A_Q5	
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17911A0306	2	2	2	3	3	5	1	1	1	1	1	22
17911A0308	2	2	1	3	3	4	1	1	1		1	19
17911A0309	2	2	2	3	3	3	1	1	1	1	1	20
17911A0311	1	2	2	2	2	4	1	1	1		1	17
17911A0312	1	2	2	2	2	2	1	1	1		1	15
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17911A0314	1	2	2	3	3	3	1	1	1		1	18
17911A0315	2	2	2	3	3	3	1	1	1	1	1	20
17911A0316		1	2			1	1		1			6
17911A0317	2	1	2	3	3	3	1	1	1		1	18
17911A0319		2	2	1	1	2	1			1	1	11
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17911A0323	1	2	2	3	3	4	1	1	1		1	19
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17911A0325	1	2	2	3	3	4	1	1	1		1	19
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17911A0328	2	2	1	2	2	4	1	1	1		1	17
17911A0329	2	2	2	3	3	5	1	1	1	1	1	22
17911A0330	2	2	1	3	3	4	1	1	1		1	19

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17911A0332	2	2	1	3	3	4	1	1	1		1	19
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17911A0336	2	2	2	3	3	4	1	1	1	1	1	21
17911A0337	2	2	2	4	5	5	1	1	1	1	1	25
17911A0338	2	2	2	4	4	5	1	1	1	1	1	24
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17911A0346	2		1	1	1	2	1		1			9
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17911A0349	1	2	2	2	2	2	1	1	1		1	15
17911A0350	2	2	2	3	3	5	1	1	1	1	1	22
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17911A0362	2	1	2	2	2	3	1	1	1		1	16
17911A0363	2	1	2	2	2	3	1	1	1		1	16

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17911A0365	2		1	1	1	1	1		1			8
17911A0367	2	2	1	2	2	4	1	1	1		1	17
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17911A0373	1	2	2	2	2	3	1	1	1		1	16
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17911A0377	2	2	2	4	4	4	1	1	1	1	1	23
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17911A0381	2	1	2	2	2	2	1	1	1		1	15
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17911A0394	2	2	1	2	2	2	1	1	1		1	15
17911A0395	2	2	2	3	3	5	1	1	1	1	1	22
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17911A03A1	1	2	2	3	3	4	1	1	1		1	19
17911A03A2	2	2	2	3	3	4	1	1	1	1	1	21
17911A03A3	1	2	2	3	3	4	1	1	1		1	19
17911A03A4	2	2	2	3	3	3	1	1	1	1	1	20
17911A03A5	1	2	2	2	2	4	1	1	1		1	17
17911A03A6	1	2	2	3	3	3	1	1	1		1	18
17911A03A7	1	2	2	2	2	2	1	1	1		1	15
17911A03A8		2	2	2	2	3	1			1	1	14
17911A03A9	2	2	2	3	3	5	1	1	1	1	1	22
17911A03B0	2	2		1	1	3	1			1	1	12
17911A03B1	1	2	2	2	2	3	1	1	1		1	16
17911A03B2	2	2	2	4	4	5	1	1	1	1	1	24
17911A03B3	2	2	2	4	5	5	1	1	1	1	1	25
17911A03B4	2	2	2	4	4	4	1	1	1	1	1	23
17911A03B5	2	2		2	2	3	1			1	1	14
17911A03B6		2	2	1	1	1	1			1	1	10
17911A03B7	2	2	2	4	5	5	1	1	1	1	1	25
17911A03B8	2	2	2	3	3	4	1	1	1	1	1	21
17911A03B9	2	1	2	2	2	3	1	1	1		1	16
17911A03C1	2	2	2	4	4	4	1	1	1	1	1	23
17911A03C2	2	2	2	3	3	5	1	1	1	1	1	22
17911A03C3	2	1	2	3	3	3	1	1	1		1	18
17911A03C4	2		2	1	1	2	1			1	1	11
17911A03C5	2		1	1	1	2	1		1			9
17911A03C6	2		2	1	1	1	1			1	1	10
17911A03C7	2	2	2	3	3	3	1	1	1	1	1	20

17911A03C8	1	2	2	3	3	3	1	1	1		1	18
17911A03C9	2	2		2	2	2	1			1	1	13
17911A03D0	1	2	2	3	3	3	1	1	1		1	18
17911A03D1		2	2	2	2	2	1			1	1	13
17911A03D2			2			1			1			4
17911A03D3	2	2	2	4	4	5	1	1	1	1	1	24
17911A03D4	2	2		2	2	2	1			1	1	13
17911A03D5	2	2		1	1	3	1			1	1	12
17911A03D6	2	2	2	3	3	3	1	1	1	1	1	20
17911A03D7	2		2	2	2	2	1			1	1	13
17911A03D8	2		2	1	1	1	1			1	1	10
17911A03D9	2	2	2	4	5	5	1	1	1	1	1	25
17911A03E0	2	2	1	2	2	3	1	1	1		1	16
17911A03E1	2	2	1	3	3	4	1	1	1		1	19
17911A03E2	2		2	1	1	3	1			1	1	12
17911A03E3	2	2	1	2	2	2	1	1	1		1	15
17911A03E4	2	2	1	2	2	4	1	1	1		1	17
17911A03E5	2	2	1	2	2	2	1	1	1		1	15
17911A03E7	1	2	2	2	2	2	1	1	1		1	15
17911A03E8	2	2	1	3	3	4	1	1	1		1	19
17911A03E9	1	2	2	3	3	4	1	1	1		1	19
17911A03F0	1	2	2	2	2	2	1	1	1		1	15
17911A03F1	1	2	2	3	3	4	1	1	1		1	19
17911A03F2	2	2	2	4	4	4	1	1	1	1	1	23
17911A03F4		2	2	2	2	3	1			1	1	14
17911A03F5	2	1	2	3	3	3	1	1	1		1	18
17911A03F6	2	2	2	3	3	3	1	1	1	1	1	20
17911A03F7		2	2	1	1	3	1			1	1	12
17911A03F8	2	2	2	4	5	5	1	1	1	1	1	25
17911A03F9	1	2	2	2	2	2	1	1	1		1	15

17911A03G0	1	2	2	2	2	4	1	1	1		1	17
17911A03G1	1	2	2	2	2	3	1	1	1		1	16
17911A03G2	2	2		2	2	3	1			1	1	14
17911A03G3	1	2		1	1	2	1		1			9
17911A03G4	2	2		2	2	2	1			1	1	13
17911A03G5	2	1	2	2	2	4	1	1	1		1	17
17911A03G6		2	2	2	2	2	1			1	1	13
17911A03G7	2	2	1	2	2	4	1	1	1		1	17
17911A03G8	2	2	1	3	3	4	1	1	1		1	19
17911A03G9	2		2	2	2	3	1			1	1	14
17911A03H0	2	2	2	3	3	5	1	1	1	1	1	22
17911A03H1	2	2	2	3	3	3	1	1	1	1	1	20
17911A03H2	2		1	1	1	1	1		1			8
17911A03H3	2	2	2	3	3	5	1	1	1	1	1	22
17911A03H4	2	2	2	4	4	4	1	1	1	1	1	23
17911A03H5	1	2	2	3	3	4	1	1	1		1	19
17911A03H6	2	2	2	3	3	5	1	1	1	1	1	22
17911A03H7		1	2			2	1		1			7
17911A03H8	2	1	2	3	3	3	1	1	1		1	18
17911A03H9	2	2	2	3	3	4	1	1	1	1	1	21
17911A03J1	2	2	2	4	4	4	1	1	1	1	1	23
17911A03J2	2	2		1	1	3	1			1	1	12
17911A03J3	1	2	2	3	3	3	1	1	1		1	18
17911A03J4	2	2	2	4	5	5	1	1	1	1	1	25
17911A03J5	2	2	2	3	3	5	1	1	1	1	1	22
17911A03J6	2	2	2	3	3	3	1	1	1	1	1	20
17911A03J7	2	2	1	3	3	3	1	1	1		1	18
17911A03J9	2	2	2	3	3	4	1	1	1	1	1	21
17911A03K0	2	1	2	2	2	3	1	1	1		1	16
17911A03K1	2	1	2	2	2	2	1	1	1		1	15

17911A03K2		2	2	1	1	3	1			1	1	12
17911A03K3	2	2	2	4	5	5	1	1	1	1	1	25
17911A03K5	2	2		1	1	3	1			1	1	12
17911A03K6	2	2	2	3	3	3	1	1	1	1	1	20
17911A03K7	1	2	2	3	3	4	1	1	1		1	19
17911A03K8	2	2	1	3	3	4	1	1	1		1	19
17911A03K9	2	2	2	3	3	3	1	1	1	1	1	20
17911A03L0	2	2	2	4	5	5	1	1	1	1	1	25
17911A03L1	1	2	2	2	2	4	1	1	1		1	17
17911A03L2	2	2		1	1	2	1			1	1	11
17911A03L3	1	2	2	2	2	2	1	1	1		1	15
17911A03L4	2	2	2	4	4	4	1	1	1	1	1	23
17911A03L5		2	2	2	2	2	1			1	1	13
17911A03L6	2	1	2	2	2	3	1	1	1		1	16
17911A03L7	2	1	2	3	3	4	1	1	1		1	19
17911A03L8		2	2	1	1	1	1			1	1	10
17911A03L9		1	2	1	1	2	1		1			9
17911A03M0	2	2	2	3	3	3	1	1	1	1	1	20
17911A03M1	2	2	2	3	3	4	1	1	1	1	1	21
17911A03M2	1	2	2	3	3	3	1	1	1		1	18
17911A03M3	2	2	1	2	2	2	1	1	1		1	15
17915A0342	2	2	2	3	3	4	1	1	1	1	1	21
18915A0301	2	2	2	3	3	3	1	1	1	1	1	20
18915A0302	2	2	2	3	3	4	1	1	1	1	1	21
18915A0303	2	1	2	3	3	3	1	1	1		1	18
18915A0304	2	1	2	2	2	4	1	1	1		1	17
18915A0305	2	2	2	4	4	4	1	1	1	1	1	23
18915A0306	2	2	2	4	4	4	1	1	1	1	1	23
18915A0307	2	1	2	3	3	3	1	1	1		1	18
18915A0308	1	2	2	3	3	4	1	1	1		1	19

18915A0310	2	2	2	3	3	5	1	1	1	1	1	22
18915A0311	2	2	2	4	5	5	1	1	1	1	1	25
18915A0312	2	1	2	3	3	4	1	1	1		1	19
18915A0313	2	2	2	3	3	3	1	1	1	1	1	20
18915A0314		2	2	2	2	3	1			1	1	14
18915A0315	2	1	2	3	3	4	1	1	1		1	19
18915A0316	2	2	2	3	3	3	1	1	1	1	1	20
18915A0317	2	2	2	4	5	5	1	1	1	1	1	25
18915A0318	2	2	2	4	4	5	1	1	1	1	1	24
18915A0319	2	2	2	4	5	5	1	1	1	1	1	25
18915A0320	2	2	2	4	4	4	1	1	1	1	1	23
18915A0321	1	2	2	3	3	4	1	1	1		1	19
18915A0322	1	2	2	2	2	3	1	1	1		1	16
18915A0323	2	2	2	4	4	4	1	1	1	1	1	23
18915A0324	2	2	2	4	4	4	1	1	1	1	1	23
18915A0325	1	2	2	3	3	4	1	1	1		1	19
18915A0326	2	2		1	1	3	1			1	1	12
18915A0327	2	2	2	4	5	5	1	1	1	1	1	25
18915A0328	2	2		2	2	3	1			1	1	14
18915A0329	2	2	2	4	4	4	1	1	1	1	1	23
18915A0330	2	2	1	3	3	3	1	1	1		1	18
18915A0331	2	2	2	4	4	4	1	1	1	1	1	23
18915A0332	2	2	2	3	3	4	1	1	1	1	1	21
18915A0333	2	2	2	3	3	5	1	1	1	1	1	22
18915A0334	2	2	2	3	3	3	1	1	1	1	1	20
18915A0335	2	2	2	3	3	4	1	1	1	1	1	21
18915A0336	2	2	2	3	3	4	1	1	1	1	1	21
18915A0337	1	2	2	3	3	4	1	1	1		1	19
18915A0338	2	2	2	3	3	5	1	1	1	1	1	22
18915A0339	1	2	2	2	2	4	1	1	1		1	17

18915A0340	2	2	2	3	3	3	1	1	1	1	1	20
18915A0341	2	2	2	4	4	4	1	1	1	1	1	23
18915A0342	2	2		2	2	2	1			1	1	13
18915A0343	1	2	2	3	3	3	1	1	1		1	18
18915A0344	1	2	2	3	3	3	1	1	1		1	18
18915A0345	2	2		1	1	3	1			1	1	12
18915A0346	2	2	2	3	3	3	1	1	1	1	1	20
18915A0347	2	2	2	3	3	5	1	1	1	1	1	22
18915A0348	2	2	2	4	4	4	1	1	1	1	1	23
18915A0349	2	2	2	3	3	3	1	1	1	1	1	20
18915A0350	2	1	2	3	3	3	1	1	1		1	18
18915A0351	2	1	2	3	3	3	1	1	1		1	18
18915A0352	2	2	2	4	5	5	1	1	1	1	1	25
18915A0353	2	2	2	4	4	4	1	1	1	1	1	23
No of students attempted	230	236	226	245	245	250	250	250	250	250	250	
No of students who scored >= 60% Marks	184	204	201	149	149	242	249	193	207	146	236	
% of students who scored >= 60% Marks	80	86	89	61	61	97	100	77	83	58	94	
Attainment	3	3	3	2	2	3	3	3	3	1	3	

External	
Roll No:	External Marks
17911A0301	70
17911A0302	10
17911A0303	67
17911A0304	63
17911A0305	63
17911A0306	60
17911A0308	67
17911A0309	59
17911A0311	63
17911A0312	65
17911A0313	26
17911A0314	16
17911A0315	66
17911A0316	4
17911A0317	60
17911A0319	27
17911A0320	58
17911A0321	70
17911A0322	70
17911A0323	35
17911A0324	11
17911A0325	58
17911A0327	59
17911A0328	3
17911A0329	71
17911A0330	59
17911A0331	70

17911A0332	61
17911A0333	61
17911A0334	28
17911A0335	19
17911A0336	63
17911A0337	72
17911A0338	58
17911A0339	66
17911A0340	65
17911A0341	59
17911A0342	65
17911A0343	67
17911A0344	12
17911A0345	27
17911A0346	14
17911A0347	61
17911A0349	58
17911A0350	58
17911A0351	64
17911A0352	61
17911A0354	60
17911A0355	70
17911A0356	67
17911A0358	59
17911A0359	27
17911A0360	0
17911A0361	70
17911A0362	17
17911A0363	26
17911A0364	5

17911A0365	26
17911A0367	64
17911A0368	58
17911A0369	28
17911A0371	66
17911A0372	72
17911A0373	26
17911A0374	68
17911A0375	70
17911A0376	35
17911A0377	60
17911A0379	10
17911A0380	61
17911A0381	60
17911A0382	64
17911A0383	26
17911A0384	70
17911A0385	68
17911A0386	64
17911A0387	71
17911A0388	72
17911A0389	65
17911A0390	27
17911A0391	43
17911A0392	30
17911A0393	65
17911A0394	6
17911A0395	62
17911A0396	68
17911A0397	72

17911A0398	62
17911A0399	63
17911A03A0	68
17911A03A1	62
17911A03A2	61
17911A03A3	12
17911A03A4	62
17911A03A5	67
17911A03A6	16
17911A03A7	0
17911A03A8	3
17911A03A9	59
17911A03B0	15
17911A03B1	65
17911A03B2	70
17911A03B3	66
17911A03B4	58
17911A03B5	19
17911A03B6	29
17911A03B7	58
17911A03B8	9
17911A03B9	68
17911A03C1	66
17911A03C2	65
17911A03C3	11
17911A03C4	15
17911A03C5	AB
17911A03C6	25
17911A03C7	64
17911A03C8	72

17911A03C9	18
17911A03D0	62
17911A03D1	7
17911A03D2	5
17911A03D3	64
17911A03D4	14
17911A03D5	14
17911A03D6	68
17911A03D7	65
17911A03D8	30
17911A03D9	72
17911A03E0	14
17911A03E1	61
17911A03E2	5
17911A03E3	26
17911A03E4	62
17911A03E5	72
17911A03E7	62
17911A03E8	71
17911A03E9	69
17911A03F0	29
17911A03F1	38
17911A03F2	64
17911A03F4	71
17911A03F5	63
17911A03F6	66
17911A03F7	26
17911A03F8	65
17911A03F9	61
17911A03G0	66

17911A03G1	63
17911A03G2	9
17911A03G3	32
17911A03G4	24
17911A03G5	67
17911A03G6	72
17911A03G7	30
17911A03G8	26
17911A03G9	AB
17911A03H0	12
17911A03H1	62
17911A03H2	31
17911A03H3	58
17911A03H4	60
17911A03H5	11
17911A03H6	68
17911A03H7	26
17911A03H8	14
17911A03H9	71
17911A03J1	61
17911A03J2	10
17911A03J3	38
17911A03J4	72
17911A03J5	62
17911A03J6	70
17911A03J7	60
17911A03J9	72
17911A03K0	66
17911A03K1	65
17911A03K2	68

17911A03K3	67
17911A03K5	6
17911A03K6	62
17911A03K7	71
17911A03K8	64
17911A03K9	66
17911A03L0	72
17911A03L1	26
17911A03L2	2
17911A03L3	16
17911A03L4	62
17911A03L5	59
17911A03L6	68
17911A03L7	69
17911A03L8	8
17911A03L9	6
17911A03M0	72
17911A03M1	72
17911A03M2	65
17911A03M3	11
17915A0342	58
18915A0301	65
18915A0302	72
18915A0303	69
18915A0304	27
18915A0305	35
18915A0306	72
18915A0307	70
18915A0308	70
18915A0310	70

18915A0311	72
18915A0312	68
18915A0313	60
18915A0314	26
18915A0315	68
18915A0316	37
18915A0317	60
18915A0318	69
18915A0319	68
18915A0320	67
18915A0321	62
18915A0322	16
18915A0323	70
18915A0324	63
18915A0325	71
18915A0326	9
18915A0327	69
18915A0328	60
18915A0329	35
18915A0330	59
18915A0331	71
18915A0332	64
18915A0333	68
18915A0334	59
18915A0335	64
18915A0336	59
18915A0337	60
18915A0338	68
18915A0339	63
18915A0340	34

18915A0341	60
18915A0342	68
18915A0343	68
18915A0344	68
18915A0345	36
18915A0346	37
18915A0347	70
18915A0348	63
18915A0349	58
18915A0350	67
18915A0351	64
18915A0352	63
18915A0353	69
No of students attempted	246
No: of students who scored more than 60%	168
% of students who scored more than 60%	68
Attainment	2

CO	Method	Value	Average	Attainment Level (Internal)	Attainment Level (External)	CO Direct Attainment (25%Int+75%Ext)
CO1	M1_D_Q1	3	2.50	2.52	2.00	**2.13**
	M1_D_Q4	1				
	M1_A_Q1	3				
	M1_A_Q2	3				
CO2	M1_D_Q2	3	2.00			
	M1_D_Q5	1				
	M1_A_Q3	3				
	M1_A_Q4	1				
CO3	M1_D_Q3	3	2.83			
	M1_D_Q6	3				
	M1_A_Q5	3				
	M2_D_Q1	3				
	M2_D_Q4	2				
	M2_A_Q1	3				
CO4	M2_D_Q2	3	2.75			
	M2_D_Q5	2				
	M2_A_Q2	3				
	M2_A_Q3	3				
CO5	M2_D_Q3	3	2.50			
	M2_D_Q6	3				
	M2_A_Q4	1				
	M2_A_Q5	3				

Direct CO Attainment	2.13
Indirect CO Attainment	2.68
Overall CO Attainment (0.8 * Direct Attainment+ 0.2 * Indirect Attainment)	2.24

17. COURSE END SURVEY FORM

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE INDIRECT ATTAINMENT REPORT

Batch: 2017-21
Year-Sem: III-I
Course: TE2 (C306)

Back

Course Indirect Attainment: 2.68

Students Participated: 166 **Total Students:** 250 **Survey Date:** 19-10-2019

Roll Number	CO1	CO2	CO3	CO4	CO5
Anonymous	2	3	3	3	3
Anonymous	2	3	3	3	3
Anonymous	2	3	3	3	3
Anonymous	2	3	3	3	3
Anonymous	2	3	3	3	3
Anonymous	2	3	3	3	3
Anonymous	2	3	3	2	3
Anonymous	2	3	3	2	3
Anonymous	2	3	3	2	3
Anonymous	2	3	3	2	3
Anonymous	2	3	3	2	3
Anonymous	2	3	3	2	3
Anonymous	2	3	3	2	3
Anonymous	2	3	3	2	3
Anonymous	2	3	3	2	3

18. TOPICS COVERED UNDER CONTENT BEYOND SYLLABUS

COGENERATION

In all the cycles the sole purpose was to convert a portion of the heat transferred to the working fluid to work, which is the most valuable form of energy. The remaining portion of the heat is rejected to rivers, lakes, oceans, or the atmosphere as waste heat, because its quality (or grade) is too low to be of any practical use. Wasting a large amount of heat is a price we have to pay to produce work, because electrical or mechanical work is the only form of energy on which many engineering devices (such as a fan) can operate.

Many systems or devices, however, require energy input in the form of heat, called process heat. Some industries that rely heavily on process heat are chemical, pulp and paper, oil production and refining, steel making, food processing, and textile industries. Process heat in these industries is usually supplied by steam at 5 to 7 atm and 150 to 200°C (300 to 400°F). Energy is usually transferred to the steam by burning coal, oil, natural gas, or another fuel in a furnace.

Now let us examine the operation of a process-heating plant closely. Disregarding any heat losses in the piping, all the heat transferred to the steam in the boiler is used in the process-heating units, as shown in Fig. 10–20. Therefore, process heating seems like a perfect operation with practically no waste of energy. From the second-law point of view, however, things do not look so perfect. The temperature in furnaces is typically very high (around 1400°C), and thus the energy in the furnace is of very high quality. This high-quality energy is transferred to water to produce steam at about 200°C or below (a highly irreversible process). Associated with this irreversibility is, of course, a loss in exergy or work potential. It is simply not wise to use high-quality energy to accomplish a task that could be accomplished with low-quality energy.

Industries that use large amounts of process heat also consume a large amount of electric power. Therefore, it makes economical as well as engineering sense to use the already-existing work potential to produce power instead of letting it go to waste. The result is a plant that produces electricity while meeting the process-heat requirements of certain industrial processes. Such a plant is called cogeneration plant.

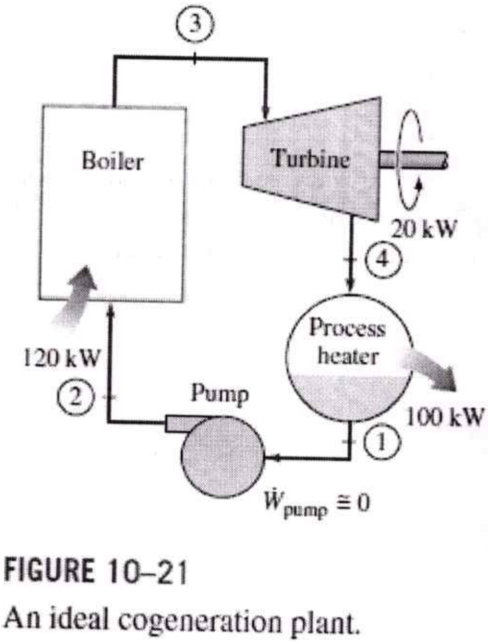


FIGURE 10–21

An ideal cogeneration plant.

In general, cogeneration is the production of more than one useful form of energy (such as process heat and electric power) from the same energy source. Either a steam-turbine (Rankine) cycle or a gas-turbine (Brayton) cycle or even a combined cycle (discussed later) can be used as the power cycle in a cogeneration plant. The schematic of an ideal steam-turbine cogeneration plant is shown in Fig. Let us say this plant is to supply process heat Q_p at 500 kPa at a rate of 100 kW. To meet this demand, steam is expanded in the turbine to a pressure of 500 kPa, producing power at a rate of, say, 20 kW. The flow rate of the steam can be adjusted such that steam leaves the process heating section as a saturated liquid at 500 kPa. Steam is then pumped to the boiler pressure and is heated in the boiler to state 3. The pump work is usually very small and can be neglected. Disregarding any heat losses, the rate of heat input in the boiler is determined from an energy balance to be 120 kW. Probably the most striking feature of the ideal steam-turbine cogeneration plant shown in Fig. is the absence of a condenser. Thus no heat is rejected from this plant as waste heat. In other words, all the energy transferred to the steam in the boiler is utilized as either process heat or electric power.

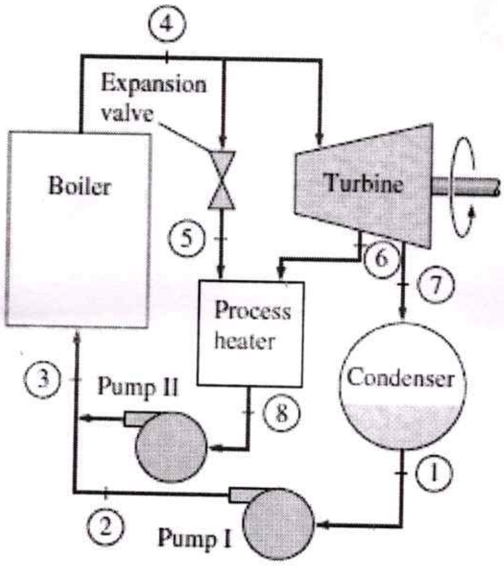


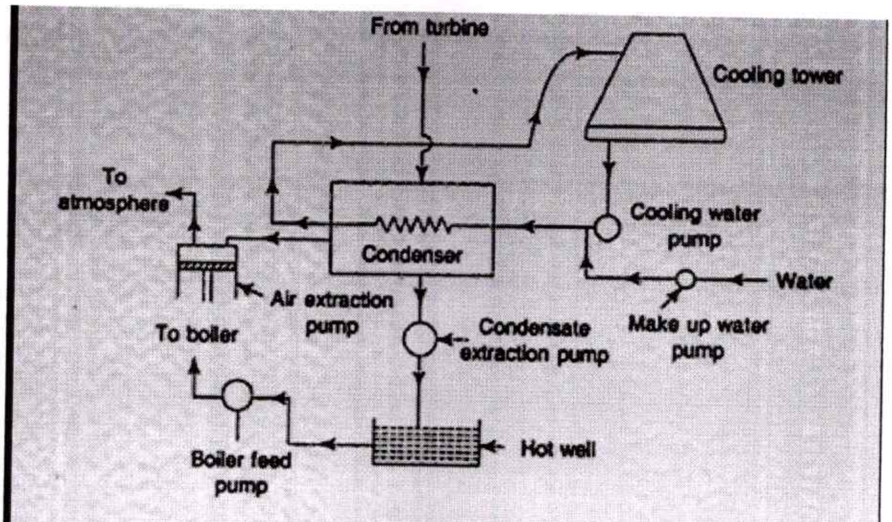
FIGURE 10–22

A cogeneration plant with adjustable loads.

The ideal steam-turbine cogeneration plant described above is not practical because it cannot adjust to the variations in power and process-heat loads. The schematic of a more practical (but more complex) cogeneration plant is shown in Fig. Under normal operation, some steam is extracted from the turbine at some predetermined intermediate pressure P_6. The rest of the steam expands to the condenser pressure P_7 and is then cooled at constant pressure. The heat rejected from the condenser represents the waste heat for the cycle. At times of high demand for process heat, all the steam is routed to the process-heating units and none to the condenser The waste heat is zero in this mode. If this is not sufficient, some steam leaving the boiler is throttled by an expansion or pressure-reducing valve to the extraction pressure P_6 and is directed to the process-heating unit. Maximum process heating is realized when all the steam leaving the boiler passes through the PRV No power is produced in this mode. When there is no demand for process heat, all the steam passes through the turbine and the condenser and the cogeneration plant operates as an ordinary steam power plant. Under optimum conditions, a cogeneration plant simulates the ideal cogeneration plant discussed earlier. That is, all the steam expands in the turbine to the extraction pressure and continues to the process-heating unit. No steam passes through the PRV or the condenser; thus, no waste heat is rejected. This condition may be difficult to achieve in practice because of the constant variations in the process-heat and power loads. But the plant should be designed so that the optimum operating conditions are approximated most of the time. The use of cogeneration dates to the beginning of this century when power plants were integrated to a community to provide district heating, that is, space, hot water, and process heating for residential and commercial buildings. The district heating systems lost their popularity in the 1940s owing to low fuel prices. However, the rapid rise in fuel prices in the 1970s brought about renewed interest in district heating. Cogeneration plants have proved to be economically very attractive. Consequently, more and more such plants have been installed in recent years, and more are being installed.

19. INNOVATION IN TEACHING

REQUIRMENTS OF A STEAM CONDENSING PLANT



Elements of steam condensing plant

i) **Condenser**: It is a closed vessel in which steam is condensed. The steam gives up heat energy to the coolant (which is water) during the process of condensation.

ii) **Condensate pump**: It is a pump which removes condensate from the condenser to the hot well.

iii) **Hot well**: It is a sump between condenser and boiler which receives condensate pumped by the condensate extraction pump.

iv) **Boiler feed pump**: It is a pump, which pumps the condensate from the hot well to the boiler. This is done by increasing the pressure of the condensate above the boiler pressure.

v) **Air extraction pump**: It is a pump which extracts i.e., removes air from the condenser.

vi) **Cooling tower**: It is a tower used for cooling water which is discharged from the condenser.

vii) **Cooling water pump**: It is a pump, which circulates the cooling water through the condenser.

TYPES OF STEAM CONDENSERS

i) Jet condensers
ii) Surface condensers

Jet condensers

- In jet condensers, the exhaust steam and cooling water come in direct contact and mix up together.
- Thus, the final temperature of condensate and cooling water leaving the condenser is same. The cooling water is sprayed on the exhaust steam to cause rapid condensation.

- A jet condenser is very simple in design and cheaper than a surface condenser. It can be used when cooling water is cheaply and easily available.

- However, the condensate can not be reused in the boiler, because it contains impurities like dust, oil, metal particles etc.

- The jet condensers are also classified as

a. Low-level jet condenser

    i. Counter-flow type ii. Parallel-flow type

b. High-level jet condenser

c. Ejector jet condenser

20. COURSE CLOSURE REPORT

Regulation: R15

Academic Year: 2019-20

Program: B.Tech (Mechanical Engineering)

Year/Sem: III/ I

Course Name: Thermal Engineering-II

Course Code: A15318

Contact Hours: 3hrs/3credits

No. of Students: 246

No. of classes taken	49
No. of tutorial classes taken	15
Course delivery modes	Lecture, Demonstration
Technology utilization	Power point Presentation
Assessment Tools	Internal Mid Examinations, Assignments, End Exam

OVERALL ATTAINMENT (80% DIRECT + 20% INDIRECT)	
DIRECT	2.13
INDIRECT	2.68
OVERALL ATTAINMENT	2.24