ME course file

VISAKHA
INSTITUTE OF ENGINEERING & TECHNOLOGY
Approved by AICTE NEW DELHI
(Affiliated to JNTUK, KAKINADA)
88th Division, Narava, GVMC, Visakhapatnam-530027
DIPLOMA | ENGINEERING | MANAGEMENT

NAAC B++ | ISO 9001:2015 | COLLEGE CODE VSPT

VISAKHA INSISTITUTE OF ENGINEERING AND TECHNOLOGY

VISION

To emerge as a "Centre for Excellence" offering Technical Education and Research opportunities of very high standards to students, develop the total personality of the individual, and instill high levels of discipline and strive to set global standards, making our students technologically superior and ethically strong, who in turn shall contribute to the advancement of society and humankind.

MISSION

To dedicate and commit ourselves to achieve, sustain and foster unmatched excellence in Technical Education. To this end, we will pursue continuous development of infrastructure and enhance state-of-the-art equipment to provide our students a technologically up-to-date and intellectually inspiring environment of learning, research, creativity, innovation and professional activity and inculcate in them ethical and moral values.

Department of Mechanical Engineering UG and PG

VISION

The vision of the Department of Mechanical Engineering is to be Regionally, Nationally and Internationally recognized in providing mechanical engineering education, leading to well qualified engineers who are innovative, immediate contributors to their profession and successful in advanced studies.

MISSION

The mission of the Department of Mechanical Engineering is to educate, prepare, inspire, and mentor students to excel as professionals and to grow throughout their careers in the art, science, and responsibilities of engineering. This is accomplished by:

- Providing the facilities and environment conducive to a high quality education, well grounding the students in the fundamental principles of engineering and preparing them for diverse careers.
- Engaging in academic and scholarly activities, which strengthen the major's Regional, National, and International reputation.

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VISAKHA INSTITUTE OF
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Narava, Visakhapatnam-530 027.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: GURAJADA

VIZIANAGARAM – 535003, Andhra Pradesh, India

MECHANICAL ENGINEERING				
IV Year –I SEMESTER	L	T	P	C
	3	0	0	3
THERMAL ENGINEERING-II				

Course Learning Objectives: To explain the use of standard software package:

1) To understand the basic concepts of thermal engineering and boilers.
2) To gain knowledge about the concepts of steam nozzles and steam turbines.
3) To gain knowledge about the concepts of reaction turbine and steam condensers.
4) To understand the concepts of reciprocating and rotary type of compressors.
5) To acquire knowledge about the centrifugal and axial flow compressors

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: GURAJADA

VIZIANAGARAM – 535003, Andhra Pradesh, India

MECHANICAL ENGINEERING				
IV Year –I SEMESTER	L	T	P	C
	3	0	0	3
THERMAL ENGINEERING-II				

Course Outcomes: At the end of the course the student will be able to:

CO1: Explain the basic concepts of thermal engineering and boilers.

CO2: Discuss the concepts of steam nozzles and steam turbines.

CO3: Gain knowledge about the concepts of reaction turbine and steam condensers.

CO4: Discuss the concepts of reciprocating and rotary type of compressors.

CO5: Acquire knowledge about the centrifugal and axial flow compressors.

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III Year-I Semester		L	T	P	C
		3	0	0	3
THERMAL ENGINEERING-II (R203103PC03)					

(Use of steam tables and Mollier chart is allowed)

Course objectives:

The Students will acquire the knowledge:

1. To understand the basic principles of vapour power cycles
2. To understand combustion phenomenon and identify the functions of boilers and draught systems and evaluate their performance.
3. To analyze the performance of the steam nozzles and steam turbines in a steam power plant.
4. To study the basic principles of reaction turbines and steam condensers.
5. To understand the classification and basic principles of compressors.

UNIT – I

VAPOUR POWER CYCLES: Carnot,Rankine cycle - schematic layout, thermodynamic analysis, concept of mean temperature of heat addition, methods to improve cycle performance – regeneration & reheating.

UNIT II

COMBUSTION: Fuels and combustion, concepts of heat of reaction, adiabatic flame temperature, Stoichiometry, flue gas analysis.

BOILERS : Classification – working principles of L.P & H.P boilers with sketches – 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.

UNIT – III

STEAM NOZZLES: Function of a nozzle – applications - types, flow through nozzles, thermodynamic analysis – assumptions -velocity of fluid at nozzle exit-Ideal and actual expansion in a nozzle, velocity coefficient, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape: Super saturated flow - its effects, degree of super saturation and degree of under cooling, Wilson line.

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 - methods to reduce rotor speed-velocity compounding, pressure compounding and velocity & pressure compounding, velocity and pressure variation along the flow – combined velocity diagram for a velocity compounded impulse turbine, condition for maximum efficiency.

UNIT IV

REACTION TURBINE: Mechanical details – principle of operation, thermodynamic analysis of a stage, degree of reaction –velocity diagram – Parson's reaction turbine – condition for maximum efficiency – calculation of blade height.

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.

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57th Division, Narava, Visakhapatnam
DIPLOMA | ENGINEERING | MANAGEMENT

B++

Department of
MECHANICAL

III B.Tech ME Students Roll List

S N	REG.NO.	STUDENT NAME
1	20NT1A0301	CHUKKA KISHORE
2	20NT1A0302	DASARI RABIN KUMAR
3	20NT1A0303	EPPILI KUMAR
4	20NT1A0304	GANDEPALLI CHANDRAMOULI
5	20NT1A0307	ISARAPU SAI CHARAN APPAJI
6	20NT1A0308	KARRI HARI SAI CHARAN
7	20NT1A0310	KONDALA YOGENDRA KUMAR
8	20NT1A0311	KORADA HEMANTH
9	20NT1A0313	SEERA UPENDRA
10	21NT5A0301	ABDUL MANNAN
11	21NT5A0302	ADAARI RAKESH
12	21NT5A0303	ADARI JAI SIVA RAM DEV
13	21NT5A0304	ADARI PAVAN KUMAR
14	21NT5A0305	ALLADA GOWRI SANKAR
15	21NT5A0306	ALLU UDAY SIVA SAI
16	21NT5A0307	ANAPARTHI VARAVISWESWARA RAO
17	21NT5A0309	ANDRA VENKATA DHARMA ARUNA TEJA
18	21NT5A0310	ANGARI GANESH
19	21NT5A0311	ANNU PRASANNA KUMAR
20	21NT5A0312	ARIGA LOKESH
21	21NT5A0313	ATTI SATEESH
22	21NT5A0316	BANDARU SAI SURESH
23	21NT5A0317	BARLA VENKAT NARASIMHA KARTHIK
24	21NT5A0318	BASA ASHOK
25	21NT5A0319	BATCHALA SIVA
26	21NT5A0320	BATHINA KIRAN

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62	21NT5A0358	GODE SRINIVASA MANIKANTA VENKATA SUBBARAO
63	21NT5A0359	GONDESI REDDY
64	21NT5A0361	GOPI NAGABABU
65	21NT5A0362	GUNTA RAVITEJA
66	21NT5A0363	HARISH SEERA
67	21NT5A0364	ILAPANDA VASANTHA KUMAR
68	21NT5A0365	INDALA PAVAN DILEEP
69	21NT5A0366	JAGARAPU PRAVEEN KUMAR
70	21NT5A0367	JAMI JOSHI
71	21NT5A0368	JERRIPOTHULA SANJAI
72	21NT5A0369	JERRIPOTHULA VENKATA KUSHWANTH RATNA
73	21NT5A0371	JONNAPALLI KIRAN KUMAR
74	21NT5A0372	KAKUMANU N S V BRAHMACHARI
75	21NT5A0374	KANCHIPATI YASWANTH
76	21NT5A0376	KANDREGULA JASWANTH
77	21NT5A0378	KANKATA JAYA KARTHIK SAI
78	21NT5A0380	KAPU VAMSI KRISHNA
79	21NT5A0381	KARAKANI TEJA KIRAN
80	21NT5A0382	KARAKAVALASA SIVANARAYANA
81	21NT5A0383	KARRI JASWANTH
82	21NT5A0384	KARRI VENKAT KISHORE
83	21NT5A0385	KASIREDDI JAYABABU
84	21NT5A0386	KILLI MOHAN
85	21NT5A0387	KINTHADA SAMPATH PAVAN SAI
86	21NT5A0389	KODIGUDLA RAJA
87	21NT5A0390	KOLA VEMA SAI
88	21NT5A0391	KOLAGANI AJAY
89	21NT5A0392	KOLLIPAKA NARASINGA RAO
90	21NT5A0394	KONATHALA JAGAN
91	21NT5A0395	KONCHADA JASWANTH RAM
92	21NT5A0396	KONCHADA MITHUN NIKETHAN
93	21NT5A0398	KOTA NAVEEN
94	21NT5A0399	KOTANA DHANUNJAYA
95	21NT5A03A1	KOTYADA CHANDRA MOULI
96	21NT5A03A2	KULAPAKA SAIMANIKANTA

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132	21NT5A03E0	PALLI DILEEP KUMAR
133	21NT5A03E2	PAPPALA NANAJEE
134	21NT5A03E3	PARAPATI GANESH
135	21NT5A03E7	PENUGONDA CHANDRA SEKHAR
136	21NT5A03E8	PINISETTI VAMSI
137	21NT5A03E9	PITHANI MANOJ
138	21NT5A03F0	POOTHI PREM KUMAR
139	21NT5A03F1	POTHABATTINA PRABHU RAJU
140	21NT5A03F2	PUDI PUNEETH
141	21NT5A03F3	RAAVI LAXMANA KUMAR
142	21NT5A03F4	RAAVI TIRUMALA RAO
143	21NT5A03F5	RAJANA KRISHNA
144	21NT5A03F6	RAPAKA SANKAR
145	21NT5A03F7	RAPARTHY VINAY SAI KUMAR
146	21NT5A03F9	REDDY RAVI SANKAR
147	21NT5A03G0	S SATYA TANUSH
148	21NT5A03G1	SADA BHANU PRAKASH
149	21NT5A03G2	SAIRAM DOLAI
150	21NT5A03G3	SALADI VAMSI
151	21NT5A03G4	SAMMINGI YERNI VASU DEVA
152	21NT5A03G6	SHAIK USMAN
153	21NT5A03G7	SETTI ASHOK
154	21NT5A03G8	SRIKAKULAPU JANARDHAN
155	21NT5A03G9	SUGGU MANISH
156	21NT5A03H0	TALABATTULA APPALA RAJU
157	21NT5A03H1	TALLURI BALAJI
158	21NT5A03H3	TAMARANA VIJAY KUMAR
159	21NT5A03H4	TANGUDU VAMSIKRISHNA
160	21NT5A03H5	TEDLAPU HEMANTH
161	21NT5A03H6	TERUKUTI MAHESH
162	21NT5A03H7	THAMARANA DORABABU
163	21NT5A03H9	THUTA HEMASUNDAR
164	21NT5A03I0	TIKKADA KANAKA RAJU
165	21NT5A03I1	UDDAGIRI GANESH
166	21NT5A03I2	UGGINA GANESH

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202	21NT5A03M0	KANITHI JOHNSON
203	21NT5A03M1	KAPARAPU SANDEEP
204	21NT5A03M2	KARANAM GANESH
205	21NT5A03M3	KARANAM MANOJ
206	21NT5A03M4	KARE NOOKARAJU
207	21NT5A03M5	KILLARI SAI TARUN
208	21NT5A03M6	KODAMANCHILI BHASKARA RAO
209	21NT5A03M7	KOMMANAPALLI DHEERAJ KUMAR
210	21NT5A03M8	KONATHALA LAKSHMI SUMANTH
211	21NT5A03M9	KORUPOLU VENKATA NAIDU
212	21NT5A03N0	KOSURI AKHIL VINAY
213	21NT5A03N1	LADI VENKATA SAI
214	21NT5A03N2	MADAKA RAVI
215	21NT5A03N3	MAHANTHI LAKSHMAN MANOHAR
216	21NT5A03N4	MAKIREDDY HARISH
217	21NT5A03N5	MALLA LOHIN KRISHNA
218	21NT5A03N6	MANDA BHASKAR SAI NAGENDRA
219	21NT5A03N7	NADITHOKA GAYATRI
220	21NT5A03N9	NEELAMSETTI YASWANTH
221	21NT5A03O0	PENTAKOTA VINAY KUMAR
222	21NT5A03O1	PERLA SRIDHAR
223	21NT5A03O2	PUDI AJAY
224	21NT5A03O3	SAMBANGI KARTHIK
225	21NT5A03O4	SANTOSH KUMAR PONNADA
226	21NT5A03O5	SHARUKHAN
227	21NT5A03O6	TEEGELA SRAVANTH
228	21NT5A03O8	ULLI APPARAO
229	21NT5A03O9	UPPULURI BALA RAJU
230	21NT5A03P0	VANTHALA AJAY KUMAR
231	21NT5A03P1	VEMURI PAVAN VENKAT RAM
232	21NT5A03P2	VYDESI SRAVANKUMAR
233	21NT5A03P3	YELAMA YASHWANTH
234	21NT5A03P4	VUTAPALLI CHANDRA MOULI
235	21NT5A03P5	KOVVURU SAI ROHITH VARMA
236	21NT5A03P6	GODABA VARSHITH

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NAAC B++

COLLEGE CODE **VSPT**

Department	:	ME		
Course	:	**B.Tech**	**Academic year** :	2022-23
Year/Semester	:	III/I		
Class Coordinator	:	Vahini/Rangacharyulu	**Room No** :	**w. e. f.: 01/08/2022**

Timing	**Periods**							
	1	**2**	**3**	**4**		**5**	**6**	**7**
Start Time	**09 : 10 AM**	**10 :00 AM**	**10 :50 AM**	**11 : 40 AM**	**Lunch Break (12:30 -1: 30)**	**1 : 30 PM**	**02 :20 PM**	**03:10 PM**
End Time	**10 :00 AM**	**10 : 50 AM**	**11 : 40 AM**	**12 : 30 AM**		**02 : 20 PM**	**03 : 10 PM**	**04:00 PM**
Monday	TE-2	TE-2	SET	MMM		TE LAB		
Tuesday	SET	AM	Soft skills			MT LAB		
Wednesday	TE-2	DMM-1	MMM	AM		SET	SET	LIB
Thursday	MMM	SET	DMM-1	DMM-1		TE2	T.E.2	SPORTS
Friday	DMM1	DMM1	AM	MMM		ACS LAB		
Saturday	AM	TE-2	DMM-1	DMM-1		AM	MMM	LIB

Sl. No.	**SUBJECT NAME**	**CREDIT**	**FACULTY**
1	Thermal Engineering-II		Mr. D. Demudu Naidu
2	Design of Machine Members-I		Mr. A.Murali Krishna
3	Machining, Machine Tools & Metrology		Mr. Ch Kiran Kumar
4	Sustainable Energy Technology (OE-1)		Mrs.B.Bhuvaneswari
5	Advanced Materials		Mr. A.Narendra.
6.	Soft Skills		Mrs. Keerthi Vijay
7	Machine Tools Lab		Mr.Ch Kiran Kumar, Mrs.B.Bhuvaneswari
8	Thermal Engineering Lab		Mr. D. Demudu Naidu, Ch.Veeru Naidu
9	Advanced Communication Skills Lab		Mr. Bhargav

Approved by	**Signature with Date**
Class Coordinator	Vahini
Principal	

Head of the Department

Website: www.jntuk.edu.in
Email: dap@jntuk.edu.in

Phone: 0884-2300991

Directorate of Academic Planning

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA-533003, Andhra Pradesh, INDIA
(Established by AP Government Act No. 30 of 2008)

Lr. No. DAP/AC/III Year /B. Tech/B. Pharmacy/2022 *Date 14.09.2022*

Dr. KVSG Murali Krishna,
M.E, Ph.D.,
Director, Academic Planning
JNTUK, Kakinada

To
All the Principals of Affiliated Colleges,
JNTUK, Kakinada.

Academic Calendar for III Year - B. Tech/B. Pharmacy for the AY 2022-23
(2020-21 Admitted Batch)

I SEMESTER			
Description	From	To	Weeks
Community Service Project	**15.07.2022**	30.07.2022	2W
I Unit of Instruction	01.08.2022	24.09.2022	8W
I Mid Examinations	26.09.2022	01.10.2022	1W
II Unit of Instructions	03.10.2022	26.11.2022	8W
II Mid Examinations	28.11.2022	03.12.2022	1W
Preparation & Practicals	05.12.2022	10.12.2022	1W
End Examinations	12.12.2022	25.12.2022	2W
Commencement of II Semester Class Work	**02.01.2023**		
II SEMESTER			
I Unit of Instructions	**02.01.2023**	25.02.2023	8W
I Mid Examinations	27.02.2023	04.03.2023	1W
II Unit of Instructions	06.03.2023	29.04.2023	8W
II Mid Examinations	01.05.2023	06.05.2023	1W
Preparation & Practicals	08.05.2023	13.05.2023	1W
End Examinations	15.05.2023	27.05.2023	2W

*** As per the APSCHE Guidelines Out of the Total 180 hours of Community Service Project leading to 4 Credits, two weeks will be offline and remaining project work can be done during the III-I semester weekends and holidays. The summer internship can be done in online cum offline during III-I and III-II semesters.**

KVSG 14/9/22

Director,
Academics & Planning, JNTUK

Director
Academic Planning
JNTUK Kakinada

Copy to the Secretary to the Hon'ble Vice Chancellor, JNTUK
Copy to Rector, Registrar, JNTUK
Copy to Director Academic Audit, JNTUK
Copy to Director of Evaluation, JNTUK

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UNIT - 1

Rankine Cycle

(i) Simple Rankine cycle

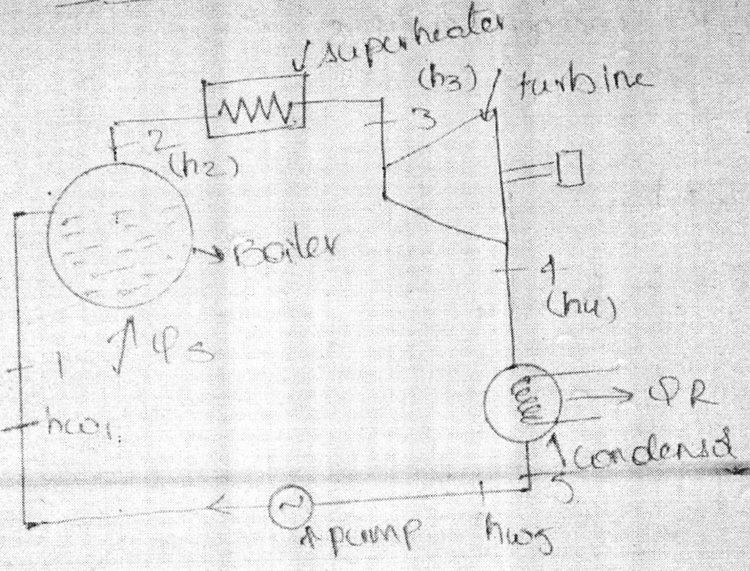
(ii) Reheat Rankine cycle

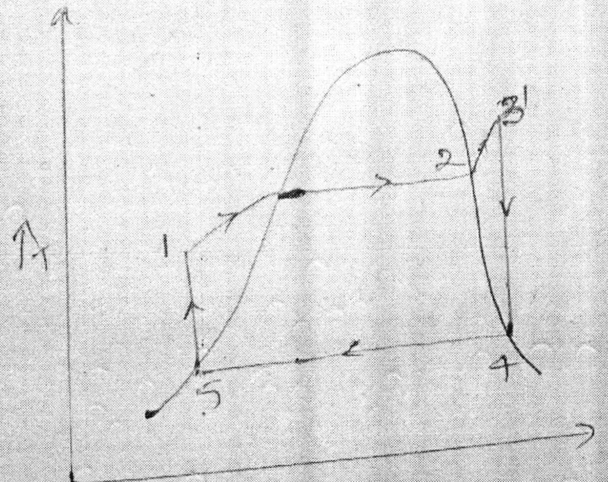
(iii) Regenerative Rankine cycle

(iv) combined Reheat & regenerative Rankine cycle

(v) modified Rankine cycle

1. Simple Rankine cycle :-





1 - 2 : heat addition to boiler

2 - 3 : superheating

3 - 4 : turbine expansion

4 - 5 : const press. heat rejection

5 - 1 : Isentropic compr.

$$W_{HPT} = (h_3 - h_4)$$

$$W_{LPT} = (h_5 - h_6)$$

$$W_P = (h_1 - h_7) = v_7 (P_1 - P_7)$$

$$Q_B = (h_2 - h_{w1})$$

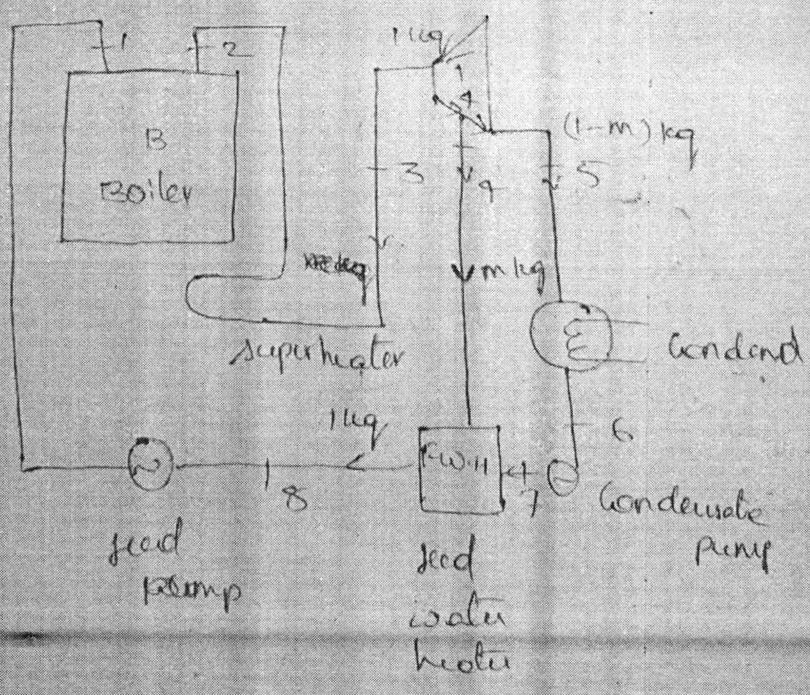
$$Q_R = (h_5 - h_4)$$

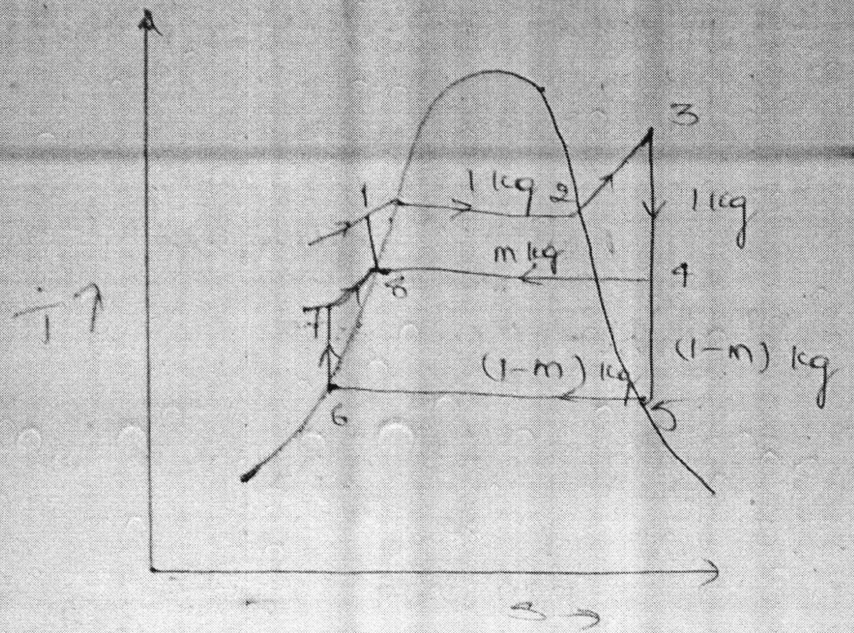
$$\eta_{th} = \frac{[(h_3 - h_4) + (h_5 - h_6)] - (h_1 - h_7)}{(h_2 - h_{w1}) + (h_5 - h_4)}$$

Specific steam consumption

$$S.S.C = \frac{3600}{W_{net}} \text{ kg/kW.h}$$

3. Regenerative cycle with single feed water heater :-





$$\eta_{th} = \frac{W_{net}}{Q_S} \times 100$$

$$= \frac{W_T - (W_{CP} + W_{FP})}{(h_3 - h_{w1})} \times 100$$

$$W_T = 1(h_3 - h_4) + (1-m)(h_4 - h_5)$$

$$W_{CP} = (h_7 - h_6) = v_6 (P_7 - P_6)$$

$$W_{F.P} = (h_1 - h_8) = v_8 (p_1 - p_8)$$

$$\eta_{th} = \frac{\left[(h_3 - h_4) + (1-m)(h_4 - h_5)\right] - \left[(h_7 - h_6) + (h_1 - h_8)\right]}{(h_3 - h_{w1})}$$

specific steam consumption

$$S.S.C = \frac{3600}{W_{net}} \text{ kg/kWh}$$

Scanned by CamScanner

heat supplied $Q_s = (h_2 - h_{11})$

$$\eta_{th} = \frac{\left[1(h_2-h_3) + (1-m_1)(h_3-h_4) + (1-m_1-m_2)(h_4-h_5)\right] - \left((h_7-h_6) + (h_9-h_8) + (h_{11}-h_{10})\right)}{h_2 - h_{11}}$$

specific steam consumption

$$S.S.C = \frac{3600}{W_{net}} \text{ kg/kW.h}$$

→ mass of the steam exerted for H.P feed water heater (m_1) :-

consider energy balance of HP FWH

$$m_1 h_3 + (1-m_1) h_{w9} = 1 \times h_{w10}$$

$$m_1 h_3 + h_{w9} - m_1 h_{w9} = h_{w10}$$

$$m_1 (h_3 - h_{w9}) = h_{w10} - h_{w9}$$

$$\boxed{m_1 = \frac{h_{w10} - h_{w9}}{h_3 - h_{w9}}}$$

→ mass of the steam extracted for LP feed water (m_2).

consider energy balanced for LP FWH.

$$m_2 h_4 + (1-m_1-m_2) h_{w7} = (1-m_1) h_{w8}$$

$$m_2 h_4 + h_{w7} - m_1 h_{w7} - m_2 h_{w7} = (1-m_1) h_{w8}$$

Scanned by CamScanner

$\phi_3 = \phi_4$

$\phi_{sup_3} = \phi_{wet\,4}$

$$\phi_{s3} + c_p \ln\left[\frac{T_{sup_3}}{T_{s3}}\right] = \phi_{w4} + x_4\,\phi_{e4}$$

$$6.337 + 2.1 \ln\left[\frac{360+273}{212.4+273}\right] = 0.593 + x_4 \times 7.637$$

$x_4 = 0.82.$

enthalpy of wet exhaust steam

$$h_4 = h_{wet_4} = h_{w4} + x_4 l_4$$

$$= 173.9 + 0.82 \times 2403.2$$

$$= 2144.52 \text{ kJ/kg.}$$

$$W_{net} = W_T - W_P$$

$$W_T = (h_3 - h_4)$$

$$= 3107.1 - 2144.52$$

$$= 962.5 \text{ kJ/kg}$$

$$W_P = (h_{w1} - h_{w5}) = v_5 (P_1 - P_5)$$

$$= 0.00100(20 - 0.08) \times 100$$

$$= 2 \text{ kJ/kg}$$

$$W_{net} = W_T - W_P$$

$$= 962.5 - 2.00$$

$$= 960.5 \text{ kJ/kg}$$

$h_2 = h_{g2} = 2802$ KJ/kg

$\phi_2 = \phi_3$

$\phi_{g2} = \phi_{wet\,3}$

$6.123 = \phi_{w3} + x_3 \phi_{e3}$

$6.123 = 0.832 + x_3(7.077)$

$x_3 = 0.74 < 1.$

enthalpy of exhaust steam

$h_3 = h_{wet\,3} = h_{w3} + x_3 l_3$

$= 251.5 + 0.74 \times 2358.4$

$= 1996.71$ KJ/kg

$h_4 = h_{w4} = 251.5$ KJ/kg

→ Pump work $w_p = v_4 (P_1 - P_4) \times 100$

$= 0.001017 \; (35 - 0.2) \times 100$

$= 3.5$ KJ/kg

$w_p = (h_{w1} - h_{w4}) = 3.5$

$h_{w1} = 3.5 + 251.5$

$= 255$ KJ/kg

→ turbine work $w_T = (h_2 - h_3)$

$= \dot{m}\,(h_2 - h_3)$

$= 9.5\,(2802 - 1996.71)$

$= 7652$ kW

BOILER MOUNTINGS

INTODUCTION TO BOILER

Definition:

- ✓ A boiler is a closed vessel in which water is converted in to steam by burning of fuel in presence of air at desired temperature, pressure and at desired mass flow rate.
- ✓ According to the Indian Boiler Act 1923, a boiler is a closed pressure vessel with capacity more than 23 liters and used for generating steam under pressure and includes all the mountings fitted to a closed vessel.
- ✓ According to American society of Mechanical Engineers (A.S.M.E.), a steam generator or a boiler is defined as "a combination of apparatus for producing, finishing or recovering heat together with the apparatus for transferring the heat so made available to the fluid being heated and vaporized.

PRINCIPAL OF WORKING

In case of boiler, any type of fuel burn in presence of air and form flue gases which are at very high temperature (hot fluid). The feed water at atmospheric pressure and temperature enters the system from other side (cold fluid). Because of exchanges of heat between hot and cold fluid (water) temperature raises and it form steam. The flue gases (hot fluid) temperature decreases and at lower temperature hot fluid is thrown in to the atmosphere via stack/chimney.

FUNCTION OF A BOILER

The steam generated is employed for the following purposes:

- ➢ Used in steam turbines to develop electrical energy.
- ➢ Used to run steam engines.
- ➢ In the textile industries, sugar mills or in chemical industries as a cogeneration plant.
- ➢ Heating the buildings in cold weather.
- ➢ Producing hot water for hot water supply.

IBR AND NON-IBR BOILERS

- ✓ Boiler generating steam at working pressure below 10 bar and having water storage capacity less than 22.75 liters are called non-IBR boilers. (INDIAN BOILER REGULATION).
- ✓ Boilers outside these limits are covered by the IBR and have to observe certain specified conditions before being operated.

6. According to furnace position:

- Internally fired (Simple vertical boiler Lancashire boiler, Cochran boiler.)
- Externally fired boilers (Babcock and Wilcox boiler.)

When the furnace of the boiler is inside its drum or shell, the boiler is called internally fired boiler. If the furnace is outside the drum the boiler is called externally fire boiler.

7. According to Fuel Used.

- Solid
- Liquid
- Gaseous
- Electrical
- Nuclear energy fuel boilers

The boiler in which heat energy is obtained by the combustion of solid fuel like coal or lignite is known as solid fuel boiler. A boiler using liquid or gaseous fuel for burning is known as liquid or gaseous fuel boiler. Boilers in which electrical or nuclear energy is used for generation of heat are respectively called as electrical energy headed boilers and nuclear energy heated boiler.

8. According to number of tubes

- Single tube (Cornish boiler, Vertical boiler.)
- Multi-tube boiler (Lancashire boiler, Locomotive boiler, Babcock and Wilcox.)

A boiler having only one fire tube or water tube is called a single, tube boiler. The boiler having two or more, fire or water tubes is called multi-tube boiler.

9. According to boiler mobility

- Stationary (Lancashire, Babcock and Wilcox boiler, Vertical boiler.)
- Portable (Locomotive boiler, Marine boiler)
- Marine boilers

When the boiler is fixed at one location and cannot be transported easily it is known as stationary boiler. If the boiler can be moved from one location to another it is known as portable boiler. The boiler which work on surface of water are called marine boilers.

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1. Dead-weight safety valves

Figure 01 shows the schematic of a dead weight safety valve. It is similar to dead weight (whistle) loaded on a pressure cooker and functions in a similar way. A gunmetal valve rests on gunmetal seat. The gunmetal seat is mounted on a steel steam pipe. The valve is fastened to a weight carrier. The dead weight is in the form of cylindrical discs are placed on the carrier so it acts downward. When the force due to steam pressure exceeds the total dead weight acting downward, the valve lifts up from the seat and some quantity of steam left the atmosphere, thus reducing the steam pressure in the boiler shell, and the valve is again closed. The dead weight safety valve is used on stationary boilers.

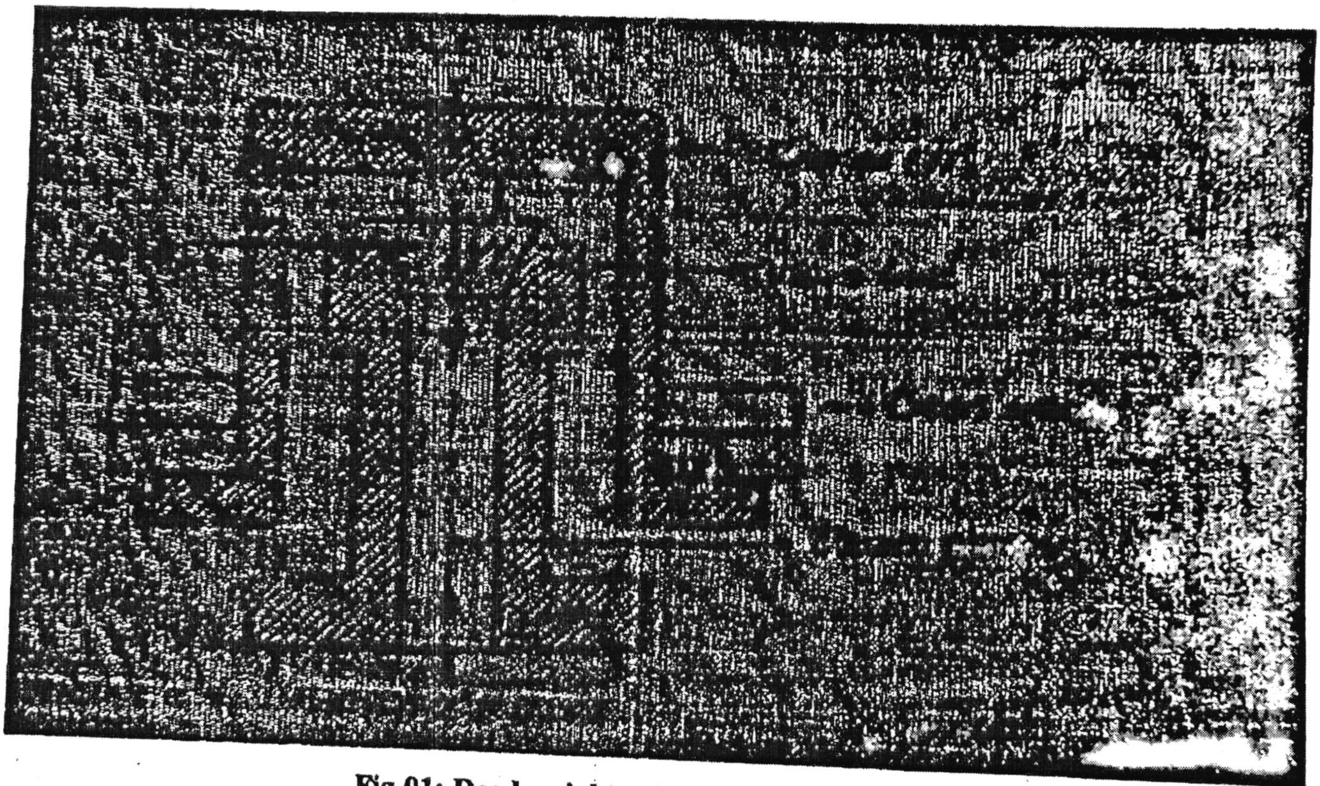

Fig.01: Dead weight safety valve

2. Spring- loaded safety valve

The dead weight safety valve cannot be used on locomotive and marine boilers. The spring loaded safety valve is used on locomotive marines and on high –pressure valve. Fig shows the valve close the steam passages under the action of a central helical spring. When the upward force of steam exceeds the down ward spring tension, the valves open and some steam escape to the atmosphere. Thus lower the steam pressure in the boiler and the valves are closed again under the spring force.

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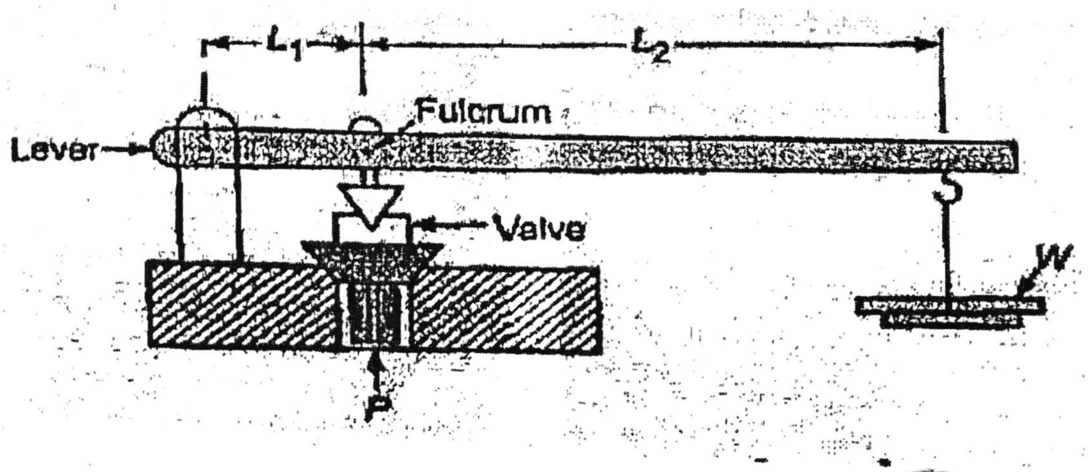

Fig.03: Lever-loaded safety valve

4. High steam and low water safety valve

This valve is combination of two valves as shown in fig 4. It is used in Cornish and Lancashire boilers. One of the valves is lever loaded and is operated when steam pressure in the boiler exceeds the working pressure. The second valve operates and blows off steam with a louder noise, when water level in the boiler falls below the normal level.

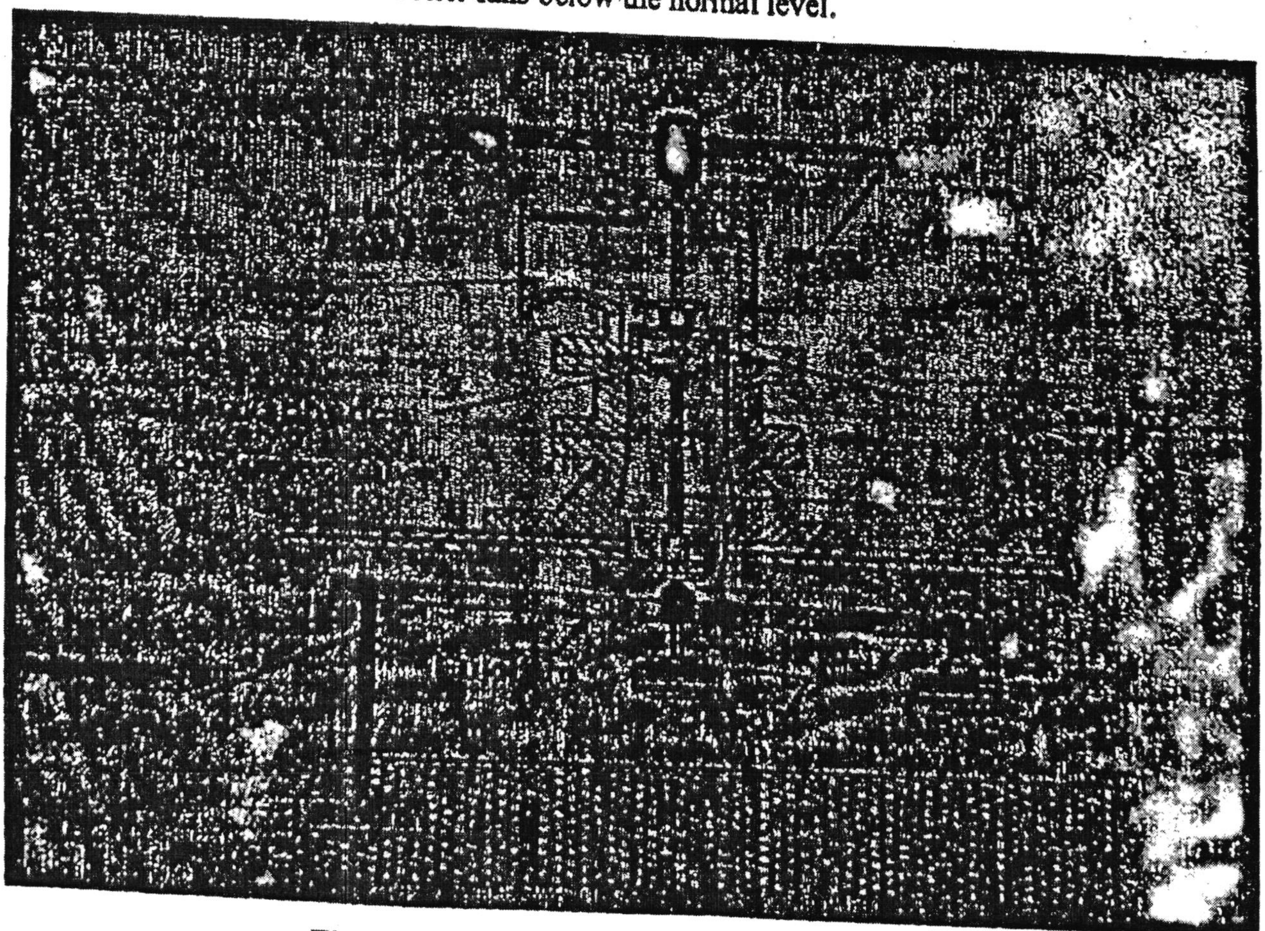

Fig.04: High steam and low steam safety valve

7

PRESSURE GAUGE

A pressure gauge is fitted in front of the boiler in such a position that the operator can conveniently read it. It read the pressure of steam in the boiler and is connected to the steam space by a siphon tube.

The most commonly used gauge is the bourdon pressure gauge. Fig 6. Illustrates the bourdon pressure gauge. It consists of an elliptical spring bourdon tube. One end of the tube is connected to the siphon tube and other end is connected by levers and gears to pointer.

When fluid pressure acts on the bourdon tube, it tries to make its cross section change from elliptical to circular. In this process, the lever end of the tube moves out as indicated by an arrow. The tube movement is magnified by the mechanism and given to pointer to move over a circular scale indicating the pressure.

The siphon tube is shown in Fig.07. It connects the steam space of the boiler to the bourdon gauge is filled with water in order to avoid the effect of high temperature steam on the gauge components. The steam pressure is transferred by water to the bourdon gauge.

Fig.06: Bourdon pressure gauge

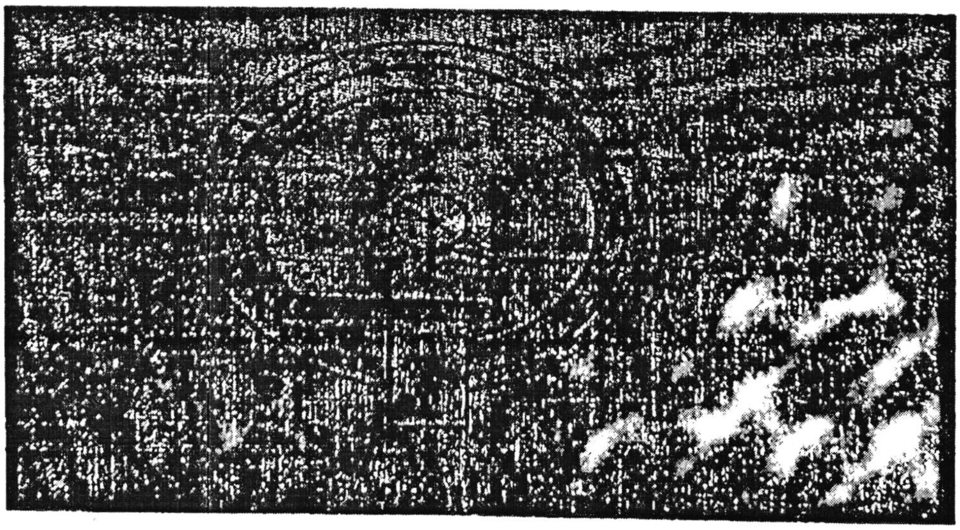

Fig.07: pressure gauge with siphon tube.

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Unit - IV

M

Reaction turbines

The reaction turbines which are ~~used these days~~ are really impulse - reaction turbine. pure reaction turbines are not in general use. The expansion of steam and heat drop occur both fixed and moving blades.

Mech - A

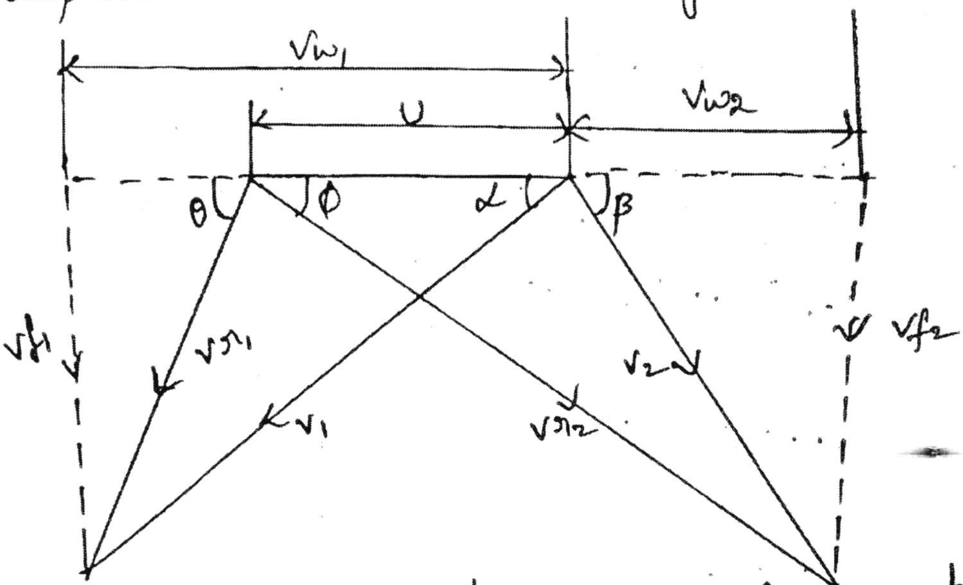
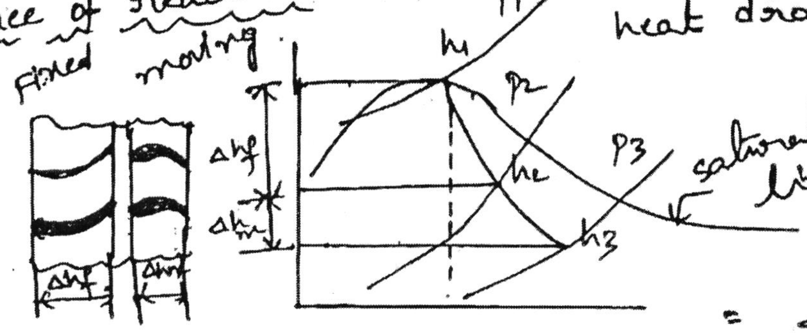


Fig. shows the velocity diagram for reaction turbine blade Incase of an impulse turbine blade the relative velocity of steam either remains constant. As the steam glides over the blades V_r is reduced slightly due to friction In reaction turbine blades, the steam continuously expands as it flows over the blades. The effect of the continuous expansion of steam during the flow over the blade is to increase the relative velocity velocity of steam.

$V_{r2} > V_{r1}$ for reaction turbines.

Degree of reaction :- It is the ratio of ~~reaction~~ heat drop over moving blades to the total heat drop in the stage.



$$= \frac{\Delta h_m}{\Delta h_f + \Delta h_m}$$

the inlet angle of moving blade is equal to the inlet angle of fixed blade. Since the blades are symmetrical the velocity diagram also symmetrical. In such a case the degree of reaction is 50%. Applying the steady flow energy equation to the fixed blades and assuming that the velocity of steam leaving the previous moving row

$$\Delta h_f = \frac{V_1^2 - V_2^2}{2}, \quad \Delta h_m = \frac{V_{r2}^2 - V_{r1}^2}{2}, \quad V_1 = V_{r2}, \quad V_2 = V_{r1}, \quad \Delta h_f = \Delta h_m$$

$$\text{Degree of reaction} = \frac{\Delta h_m}{\Delta h_f + \Delta h_m} = \frac{1}{2}$$

Condition for maximum efficiency :- The following assumptions.

1. Degree of reaction is 50%.
2. The moving blades and fixed blades are symmetrical.

workdone / kg of steam

$$W = u(V_{w1} + V_{w2}) = u[V_1 \cos\alpha + (V_{r2}\cos\phi - u)]$$

$\phi = \alpha$, $V_{r2} = V_{r1}$ as per the assumptions

$$W = u[2V_1\cos\alpha - u] \qquad \rho = \frac{u}{V_1}$$

$$W = V_1^2\left[\frac{2uV_1\cos\alpha}{V_1^2} - \frac{u^2}{V_1^2}\right]$$

$$= V_1^2\left[2\rho\cos\alpha - \rho^2\right]$$

K.E supplied to fixed blade $= \frac{V_1^2}{2g}$

" " " moving blade $= \frac{V_{r2}^2 - V_{r1}^2}{2}$

Total energy supplied to stage $= \Delta h_f + \Delta h_m$

$$= \frac{V_1^2}{2} + \frac{V_{r2}^2 - V_{r1}^2}{2}$$

$$V_{r2} = V_1 \Rightarrow \Delta h = \frac{V_1^2}{2} + \frac{V_{r2}^2 - V_{r1}^2}{2}$$

$$= V_1^2 - \frac{V_{r1}^2}{2}$$

But $V_{r1}^2 = V_1^2 + u^2 - 2V_1 \cdot u\cos\alpha$ [from fig of velocity diagram]

substitute the value of V_{r1}^2 value in above equation

Total energy supplied to the stage

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Blade or diagram efficiency :- It is the ratio of workdone on the blade/sec to the energy entering the blade/second.

Stage efficiency :- $\frac{\text{Networkdone on shaft / stage / kg of steam}}{\text{Adiabatic heat drop / stage.}}$

Internal efficiency :- $\frac{\text{Heat converted into useful work}}{\text{Total adiabatic heat drop}}$

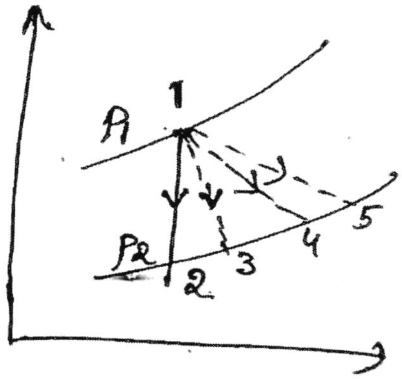
Overall efficiency :- $\frac{\text{work delivered at the turbine coupling}}{\text{Total adiabatic heat drop.}}$

Net efficiency :- $\frac{\text{Heat converted into useful work}}{\text{Total adiabatic heat drop.}}$

Adiabatic power :- It is the power based on the total internal steam flow and adiabatic heat drop.

Shaft power :- It is the actual power transmitted by the turbine.

$m_s(h_1 - h_5)$



Rim power :- It is the power developed at the rim. It is also called blade power.

$m_s(h_1 - h_4)$

$A.P = m_s(h_1 - h_2)$

In one stage of reaction steam turbine both the fixed and moving blades have inlet and outlet blade tip angles of 35° and 20° respectively. The mean blade speed is 80m/s and the steam consumption is 22500 kg/hr. Determine power developed and stage efficiency if the isentropic heat drops in both fixed and moving rows is 23.5 kJ/kg in the pair.

Given :- Inlet blade angle $\theta = 35° = \beta$

outlet " " $\phi = 20° = \alpha$

Blade Speed $(u) = 80 m/s$

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unit-6

UNIT – 6 *Steam Condensers*

Elements of a condensing plant, Types of condensers, Comparison of jet and surface condensers, Condenser vacuum, Sources of air leakage & its disadvantages, Vacuum efficiency, Condenser efficiency

- **Steam Condenser:** It is a device or an appliance in which steam condenses and heat released by steam is absorbed by water.

- **Elements of a steam condensing plant:**

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

2. **Condensate pump:** It is a pump, which removes condensate (i.e. condensed steam) from the condenser to the hot well.

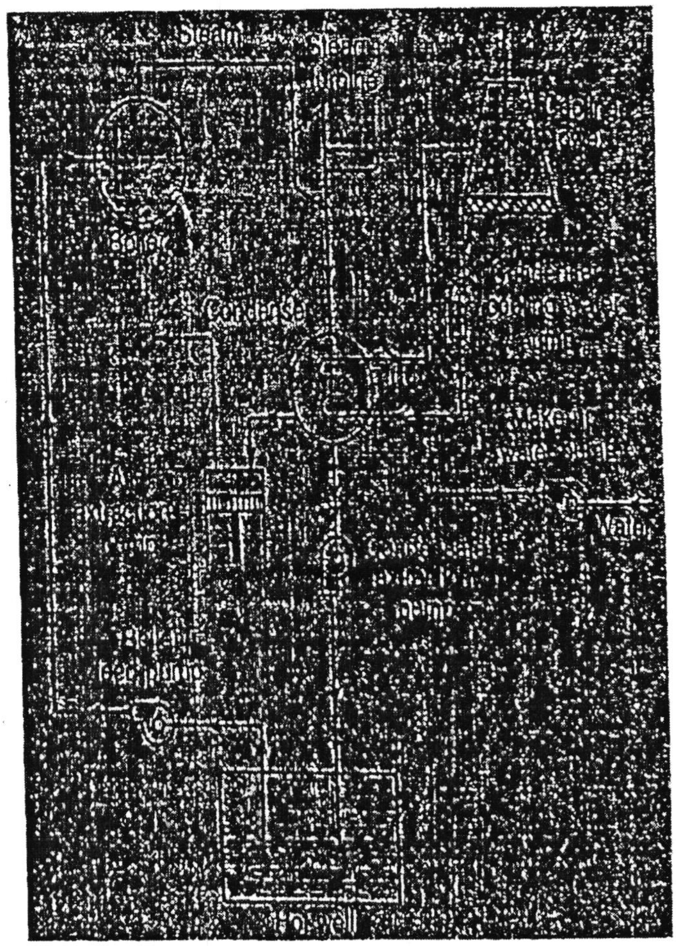
3. **Hot well:** It is a sump between the condenser and boiler, which receives condensate pumped by the condensate pump.

4. **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 condensate above the boiler pressure.

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

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

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



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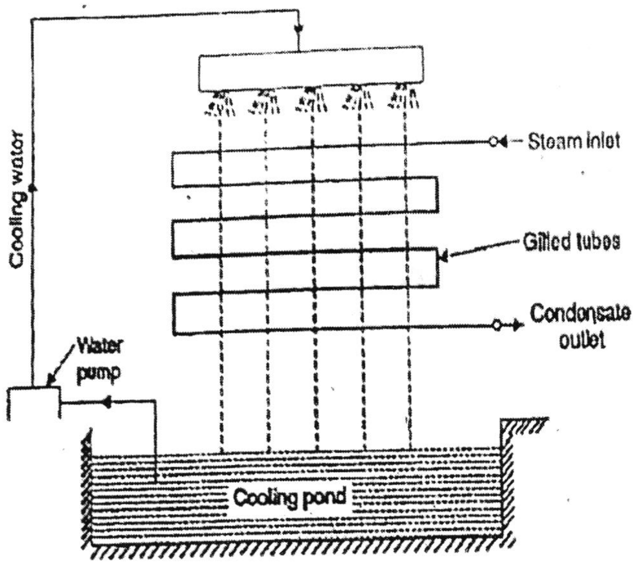


Fig. Evaporative Type

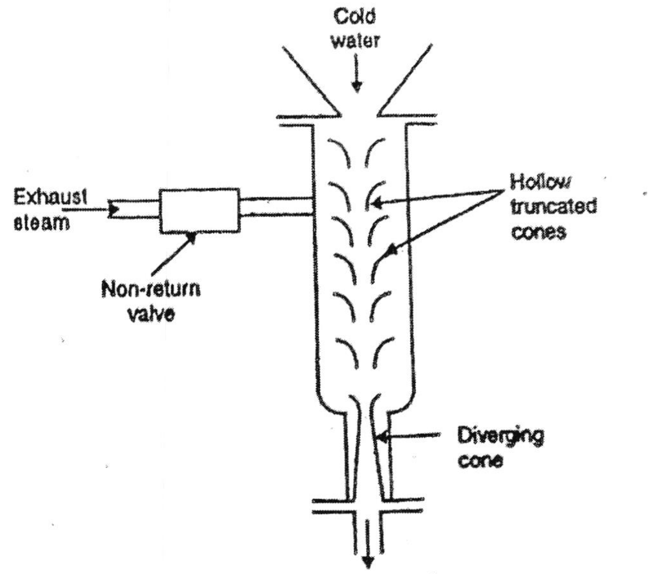


Fig. Ejector flow type condenser

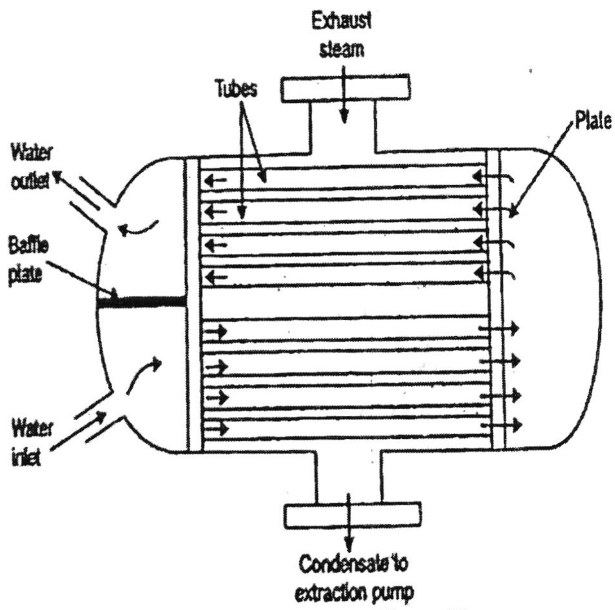


Fig. Down-Flow Type

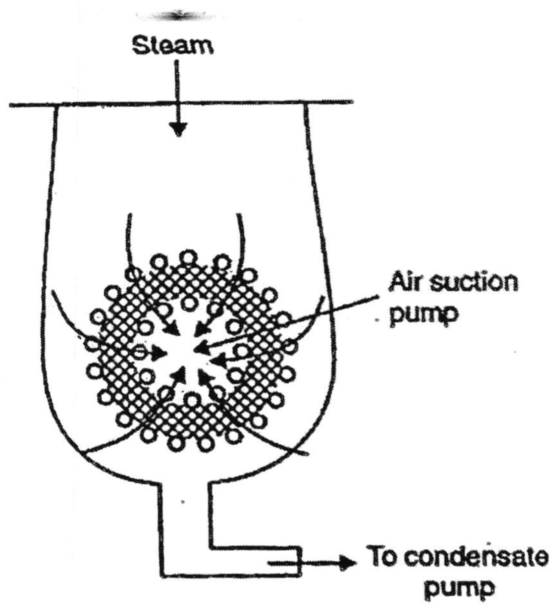


Fig. Central Flow Type

7. **Inverted Flow Type:** This type of condenser has the air suction at the top; the steam after entering at the bottom rises up and then again flows down to the bottom of the condenser, by following a path near the outer surface of the condenser. The condensate extraction pump is at the bottom.

8. **Regenerative Type:** This type is applied to condensers adopting a regenerative method of heating of the condensate. After leaving the tube nest, the condensate is passed through the entering exhaust steam from the steam engine or turbine thus raising the temperature of the condensate, for use as feed water for the boiler.

➢ **Vacuum Efficiency**: The minimum absolute pressure (also called ideal pressure) at the steam inlet of a condenser is the pressure corresponding to the temperature of the condensed steam. The corresponding vacuum (called ideal vacuum) is the maximum vacuum that can be obtained in a condensing plant, with no air present at that temperature. The pressure in the actual condenser is greater than the ideal pressure by an amount equal to the pressure of air present in the condenser. The ratio of the actual vacuum to the ideal vacuum is known as vacuum efficiency. Mathematically, vacuum efficiency

$$\eta = \text{Actual Vacuum} / \text{Ideal Vacuum}$$

Where, η = Vacuum efficiency

Actual vacuum = Barometric pressure - Actual pressure

And Ideal vacuum = Barometric pressure - Ideal pressure

➢ **Condenser Efficiency**

It is defined as the ratio of the difference between the outlet and inlet temperatures of cooling water to the difference between the temperature corresponding to the vacuum in the condenser and inlet temperature of cooling water, i.e.,

$$\text{Condenser efficiency} = \frac{\text{Rise in temperature of cooling water}}{\begin{bmatrix}\text{Temp. corresponding to vacuum} \\ \text{in the condenser}\end{bmatrix} - \begin{bmatrix}\text{Inlet temp. of} \\ \text{cooling water}\end{bmatrix}}$$

$$= \frac{\text{Rise in temperature of cooling water}}{\begin{bmatrix}\text{Temp. corresponding to the absolute} \\ \text{pressure in the condenser}\end{bmatrix} - \begin{bmatrix}\text{Inlet temp. of} \\ \text{cooling water}\end{bmatrix}}$$

➢ **Sources of air into the condensers:**

1. The dissolved air in the feed water enters into the boiler, which in turn enters into the condenser with the exhaust steam.
2. The air leaks into the condenser, through various joints, due to high vacuum pressure in the condenser.
3. In case of jet condensers, dissolved air with the injection water enters into the condenser.

➢ **Effects of Air Leakage:**

1. It reduces the vacuum pressure in the condenser.
2. Since air is a poor heat conductor, particularly at low densities, it reduces the rate of heat transmission.
3. It requires a larger air pump. Moreover, an increased power is required to drive the pump.

➢ Cooling Towers

In a cooling tower water is made to trickle down drop by drop so that it comes in contact with the air moving in the opposite direction. As a result of this some water is evaporated and is taken away with air. In evaporation, the heat is taken away from the bulk of water, which is thus cooled.

➢ Types of Cooling Tower

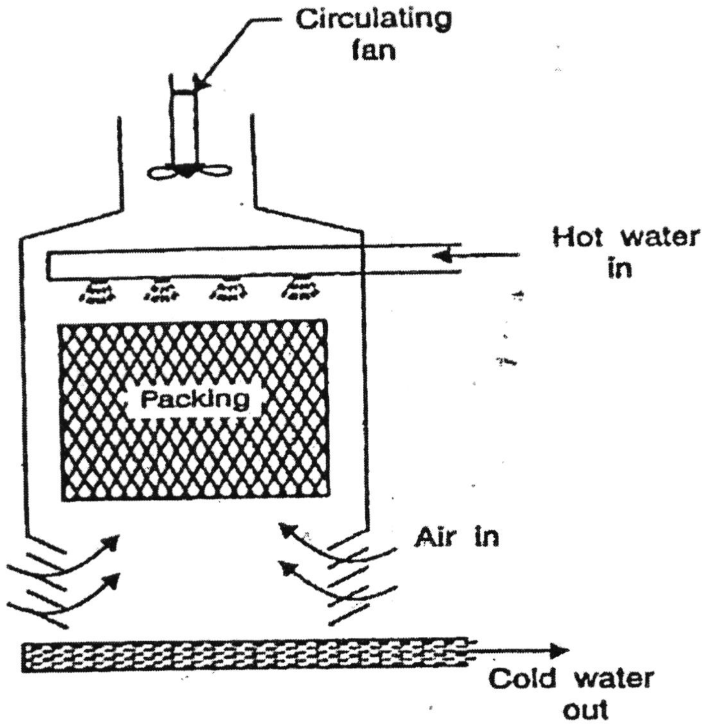


Fig. Natural draught cooling tower

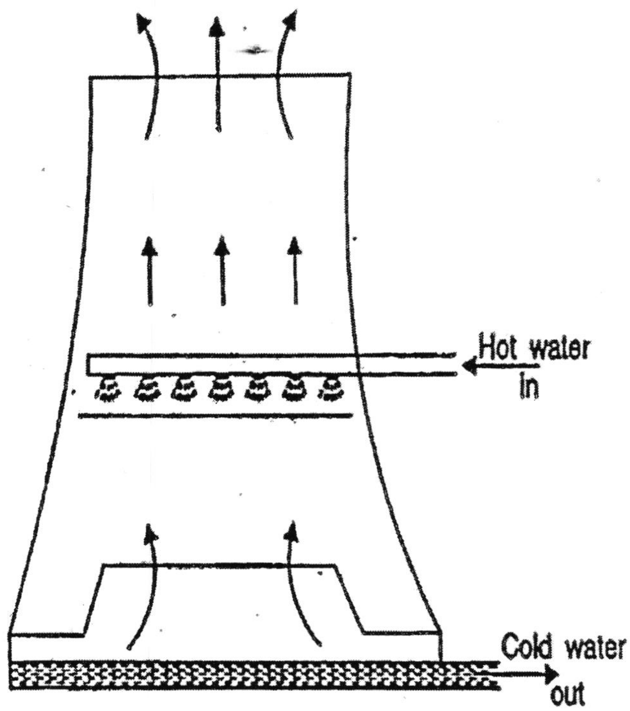


Fig. Forced draught cooling tower

Student Notes:

from steam tables at 0.073 bar $(t_v) = 39.83°c$

$$\eta_c = \frac{\text{Temp rise of cooling water}}{\text{vaccum temp} - \text{Inlet cooling temp}}$$

$$= \frac{t_o - t_i}{t_v - t_i}$$

$$= \frac{25-10}{39.83-10} = 50.3\%$$

at 0.073 bar

$h_f = 166.7$ KJ/kg, $h_{fg} = 2407.4$ KJ/kg

$h = h_f + x h_{fg}$

$h = 166.7 + x(2407.4)$ KJ/kg

mass of cooling water

$$60{,}000 = \frac{m_s(h - h_{f1})}{C_w(t_o - t_i)} = \frac{2000(166.7 + x \times 2407.4 - 117.3)}{4.2(25-10)}$$

$x = 0.76$

from Dalton's law

$$P_a = P_c - P_s = 0.073 - 0.0562$$

$$= 0.0168 \text{ bar}$$

$$= 1680 \text{ N/m}^2$$

$$m_a = \frac{P_a V}{RT} = \frac{1680 \times 1}{287 \times 308} = 0.019 \text{ Kg}$$

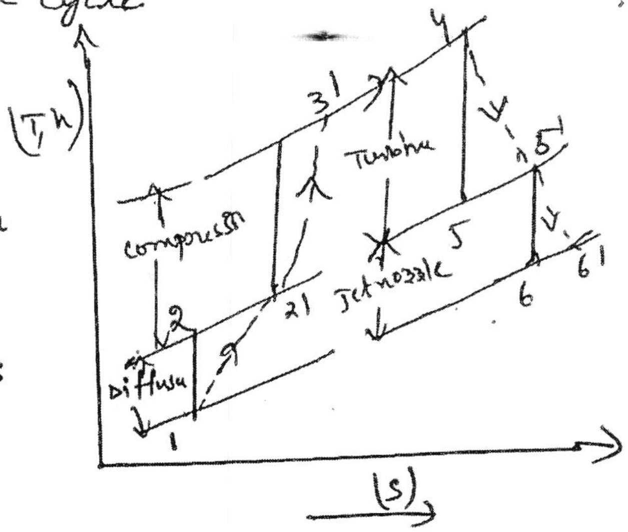
at mean temperature 35°c, $v_g = 25.245$ m³/kg

$$m_g = \frac{P_a v_g}{RT} = \frac{1680 \times 25.245}{287 \times 308}$$

$$= 0.48 \text{ Kg}$$

The air leakage into a surface condenser operating with a steam turbine is estimated as 84 kg/h. The vaccum near the inlet of air pump is 70mm of Hg when barometer reads 760mm of Hg. The temperature at inlet of vaccum pump 20°c calculate. The minimum capacity of the air pump m3/h, The dimensions of the recipro

Turbo-jet engine :- The basic cycle for turbo jet engine is the Joule or Brayton cycle



Process 1-2 :- The air entering from atmosphere is diffused isentropically from velocity C_1. This indicates that the diffuser has an efficiency of 100%. This is termed as ram compression.

process 2-3 :- 2'-3' process shows the actual compression of air

process 3-4 :- 3'-4 shows the actual addition of heat at constant process $P_3 = P_4$

process 4-5 :- 4'-5' shows actual expansion in the turbine

process 5-6 :- 6'-6' shows actual expansion of gas in the nozzle.

Diffuser :- $\frac{C_a^2}{2} + h_1 + Q_{1-2} = \frac{C_2^2}{2} + h_2 + W_{1-2}$

In an ideal diffuser $C_2 = Q_{1-2} = W_{1-2} = 0$

$h = C_p T$

$$h_2 = h_1 + \frac{C_a^2}{2}$$

$$T_2 = T_1 + \frac{C_a^2}{2C_p}$$

$$\eta_d = \frac{h_2 - h_1}{h_2' - h_1} \Rightarrow \frac{T_2 - T_1}{T_2' - T_1}$$

$$T_2' = T_1 + \frac{C_a^2}{2 \times C_p \times \eta_d}$$

Compressor :- Energy equation between states 2 and 3 gives

$$h_2 + \frac{C_2^2}{2} + Q_{2-3} + W_c = h_3 + \frac{C_3^2}{2}$$

change in P.E and K.E negligible

$$W_c = h_3 - h_2 = C_p (T_3 - T_2)$$

$$\text{actual work} = h_3' - h_2 = \frac{h_3 - h_2}{\eta_c} = \frac{C_p (T_3 - T_2)}{\eta_c}$$

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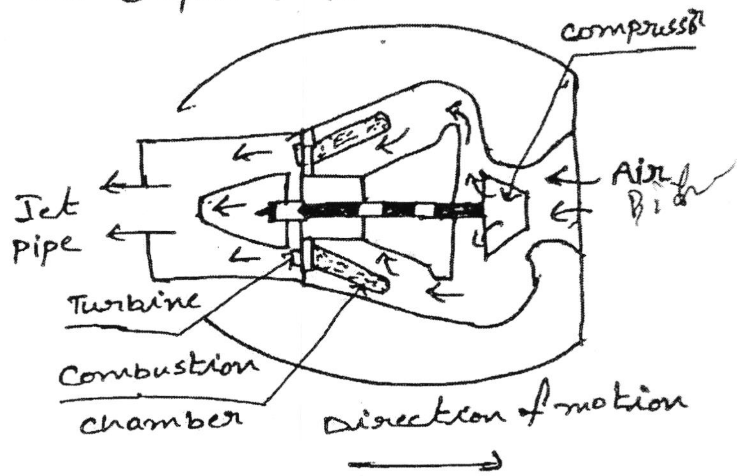
of combustion are forced into the gas turbine. The power produced in the turbine is used to drive the compressor and propeller. A set of reduction gears is used to reduce the speed of rotation of the propeller. The jet of exhaust gases leave the unit from its rear end. Approximately 80 to 90% of the thrust of the turboprop engine is produced by propeller and about 10 to 12% of the thrust is produced by the reaction of the jet at exit.

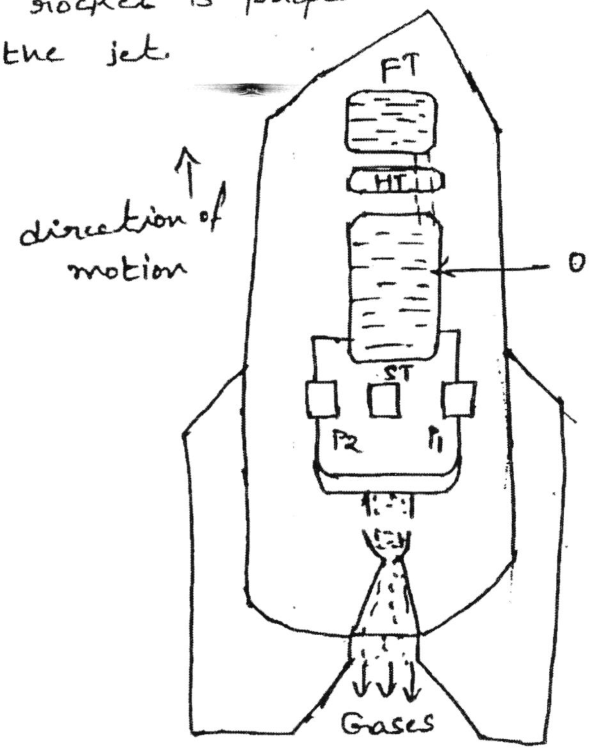
Turbo - Jet unit :- It consists of a open cycle gas turbine with a diffuser infront of the compressor and an exit nozzle added to the turbine end.



Air enters into compressor through a diffuser where it is compressed. Small pressure rise in the entering air is caused in the diffuser, but the major part of pressure rise is accomplished in the compressor which is driven by turbine. Compressed air passed into the combustion chamber in which fuel is injected at high pressure. Combustion of fuel takes place at constant pressure. Due to combustion temperature and volume of products of combustion increases considerable. High air fuel ratio limits the temperature of hot gases. The hot gases is then expanded through exit nozzle in which the thermal energy of the hot gases in converted into kinetic energy. The jet of gases is discharged out through the rear end of the unit. The reaction of the jet provides the thrust to move the unit in the direction opposite to that of the jet.

Ram Jet engine :- It consists of an inlet diffuser, a combustion chamber and an exit nozzle. It has no compressor and turbine.

The velocity of air entering the diffuser is decreased and is acompained by an increase in pressure. This pressure rise due to decrease in velocity of incoming air is known as peroxide with calcium permanganate. The oxidiser and fuel burn in the combustion chamber producing high pressure gases. The high pressure gases are passed through the nozzle where pressure is converted into kinetic energy. The gas jet is ejected to the atmosphere at supersonic speed through a nozzle. The jet produce the thrust on the rocket engine and rocket is propelled into sky in the direction opposite to the jet.



FT = Fuel tank
HT = Hydrogen peroxide tank
O = oxidiser tank
ST = steam turbine
P_1, P_2 = pumps
C.C = combustion chamber
HG = Hot gases
N = Nozzle

Fuels used ~~in~~ jet propulsion :-

1. petrol
2. avitation kerosine
3. Gasoline
4. paraffin
5. Alcohol
6. Natural gas

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mass of fuel is neglected

$$= \frac{(c_j - c_a) c_a}{1000} \text{ kW/kg of air}$$

propulsive power:- The energy required to change the momentum of the mass flow of gas represents the propulsive power. It is expressed as the difference between the rate of kinetic energies of the entering air and exit gases

$$P.P = \Delta K.E = \frac{\left(1 + \frac{m_f}{m_a}\right) c_j^2}{2} - \frac{c_a^2}{2} \text{ W/kg}$$

$$= \frac{c_j^2 - c_a^2}{2} \text{ W/kg}$$

propulsive efficiency:- The ratio of thrust power to propulsive power is called the propulsive efficiency.

$$= \frac{\left[\left(1 + \frac{m_f}{m_a}\right)(c_j - c_a)\right] c_a}{\left[\frac{\left(1 + \frac{m_f}{m_a}\right) c_j^2}{2} - \frac{c_a^2}{2}\right]}$$

$$= \frac{2\left[\left(1 + \frac{m_f}{m_a}\right)(c_j - c_a)\right] c_a}{\left[\left(1 + \frac{m_f}{m_a}\right) c_j^2 - c_a^2\right]}$$

Neglecting mass of fuel.

$$\eta_{prop} = \frac{2(c_j - c_a) c_a}{c_j^2 - c_a^2} = \frac{2(c_j - c_a) c_a}{(c_j + c_a)(c_j - c_a)}$$

$$\eta_{prop} = \frac{2 c_a}{c_j + c_a}$$

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Pressure ratio in the compressor = 5.8
Temperature of gases entering the gas turbine

$T_4 = 1110 + 273 = 1383K$

Pressure drop in the combustion chamber
= 0.168 bar

$\eta_d = \eta_n = \eta_c = 90\%;\ \eta_t = 80\%$

1. Diffuser:-

$h_2 = h_1 + \frac{Ca^2}{2}$

$h_2 - h_1 = \frac{Ca^2}{2}$

$T_2 - T_1 = \frac{Ca^2}{2cp}$

$= 265.87 + \frac{(216)^2}{2 \times 1.005 \times 1000}$

$T_2 = 289K$

$T_2' = T_1 + \frac{Ca^2}{2cp\eta_d}$

$= 265.8 + \frac{216^2}{2 \times 1.005 \times 1000 \times 0.9}$

$T_2' = 291.6K$

$\Rightarrow \frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$

$P_2 = (P_1)^{\frac{\gamma}{\gamma-1}} \times \left(\frac{T_2}{T_1}\right)$

$P_2 = 1.044\ bar$

$\Rightarrow \frac{T_3}{T_2'} = (r_p)^{\frac{\gamma-1}{\gamma}}$

$T_3 = 291.6 \times 1.662 = 484.7K$

$\eta_c = \frac{T_3 - T_2'}{T_3' - T_2'}$

$T_3' = 502.8K$

Heat Supplied:-

$(m_f \times cv) = (m_a + m_f)cp\ T_4 - m_a cp\ T_3'$

$m_a cp(T_4 - T_3') = m_f(cv - cpT_4)$

$\frac{m_a}{m_f} = \frac{cv - cpT_4}{cp(T_4 - T_3')}$

$\frac{m_a}{m_f} = 48.34$

$\Rightarrow$ Specific thrust of the unit

$P_4 = P_3 - 0.168 =$
$= 5.8 \times 1.044 - 0.168$

$P_4 = 5.88\ bar$

Assume turbine drives compressor only.

$cp(T_3' - T_2') = cp(T_4 - T_5')$

$(T_3' - T_2') = T_4 - T_5'$

$T_5' = T_4 - (T_3' - T_2')$

$T_5' = 1171.8K$

$\eta_t = \frac{T_4 - T_5'}{T_4 - T_5}$

$T_5 = T_4 - \frac{T_4 - T_5'}{\eta_t}$

$T_5 = 1119K$

$\frac{T_4}{T_5} = \left(\frac{P_4}{P_5}\right)^{\frac{\gamma-1}{\gamma}}$

$P_5 = 2.8\ bar$

Thrust specific fuel consumption

$= \frac{\text{fuel consumption}}{\text{Thrust}}$

$= \frac{0.86}{\text{Thrust}}$

Thrust $= m_a (C_j - C_a)$

$= 60.2 (651 - 277.8)$

$= 22466.6 N$

$= \frac{0.86}{22466.6}$

$= 3.828 \times 10^{-5}$ kg/N

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

$= \frac{(C_j - C_a) C_a}{\left(\frac{m_f}{m_a}\right) cv \times \eta_{com}}$

$= \frac{(651 - 277.8) 277.8}{\frac{1}{70} \times 42000 \times 0.92} \times 100$

$= 18.78\%$

$\eta_{thermal} = \frac{\text{work output}}{\text{Heat supplied}}$

$= \frac{C_j^2 - C_a^2}{\left(\frac{m_f}{m_a}\right) cv \times \eta_{com} \times 1000}$

$= \frac{(651)^2 - (277.8)^2}{2 \times \frac{1}{70} \times 42000 \times 0.92 \times 1000}$

$= 31.39\%$

propulsive power:

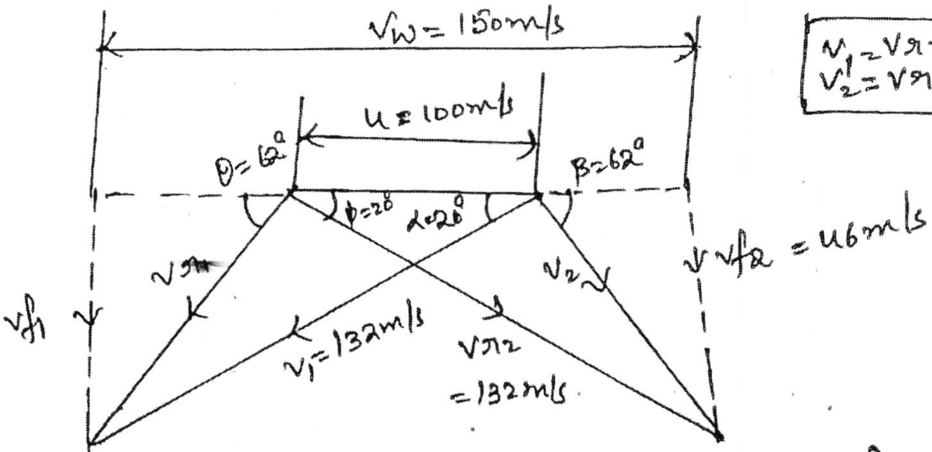
$= \frac{\text{Thrust power}}{\text{propulsive power}}$

$= \frac{2 C_a}{C_j + C_a} = \frac{2 \times 277.8}{651 + 277.8}$

$= 59.8\%$

MECH	PhD	mechanical	2003	Andhara university
BS& H	PhD	physics	2015	Andhara university
BS& H	PhD	physics	2015	Andhara university
CSE	SET	CSE	2012	Osmania university

$V_1 = V_{r2}$
$V_2' = V_{r1}$



$$\Delta h_f = \Delta h_m = \frac{V_1^2 - 0.7V_2^2}{2 \times 1000} \Rightarrow \frac{182^2 - 0.7(52)^2}{2 \times 1000 \times 0.85}$$

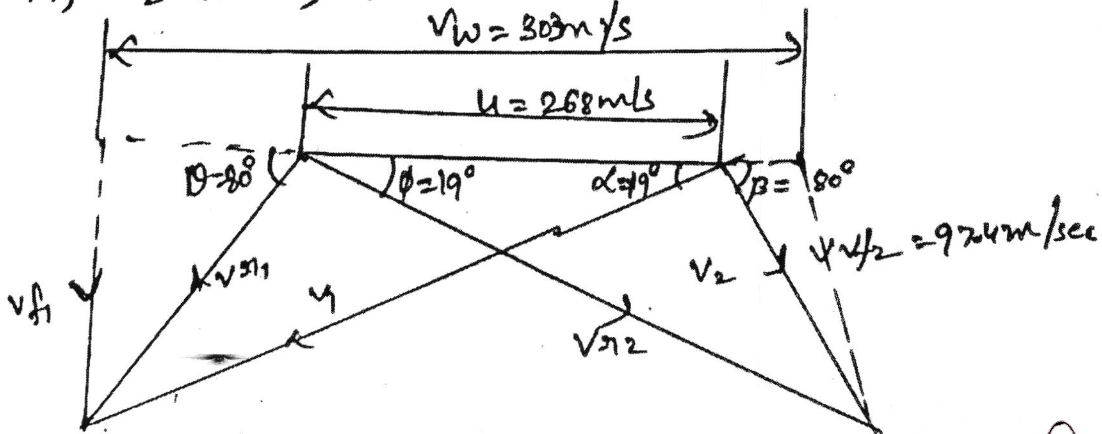
$$= 9.14 \text{ kJ/kg}$$

Total heat drop $= \Delta h_f + \Delta h_m = 18.28$ kJ/kg.

$$\eta_{stage} = \frac{V_w u}{1000 \times \Delta h} = 82.1\%$$

In a stage of impulse reaction turbine operating with 50% Degree of reaction the blades are identical in shape. The outlet angle of moving blades is 19° and the absolute discharge velocity of steam is 100m/s in direction at 100° to the motion of blades. If the rate of flow of steam through the turbine is 15000 kg/hr. Calculate power developed by turbine.

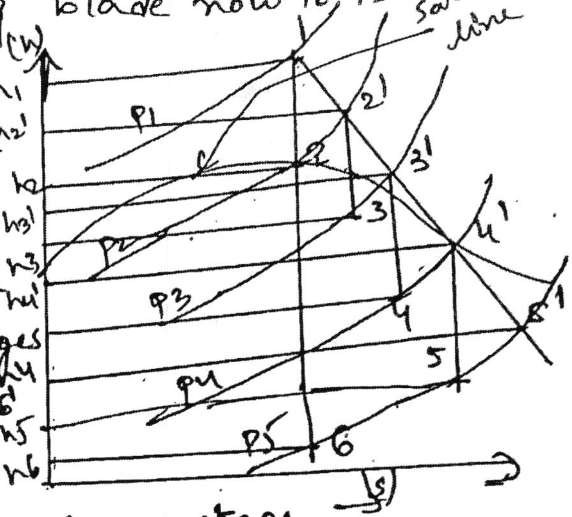
$\phi = 19°$, $V_2 = 100$ m/s, $\beta = 180 - 100 = 80°$, $m = \frac{15000}{3600} = 4.167$ kg/s



$$P = \frac{m(V_w)u}{1000} = \frac{4.167 \times 303 \times 268}{1000} = 338.$$

State point locus and reheat factor:- In multi-stage turbine steam leaving from the first moving blade is made to flow through fixed ring and again it is made to strike on second moving blade now it's completed 2 stages.

After leaving second moving blade it is again made to flow through fixed ring and again it is made to strike on third moving blade. now it completes 3 stages. If the steam passess through many number of stages then the turbine is known as multistage turbine



Let

P_1 = Inlet pressure of steam entering first stage.

P_2 = Exit " " " leaving. first "

P_3 = " " " " " Second "

P_4 = " " " " " third "

P_5 = " " " " " Fourth "

The locus passing through 1, 2', 3', 4' and 5' is known as state point locus

If the friction is neglected then (h_1-h_6) will represent the isentropic heat drop the sum of $(h_1-h_2) + (h_2'-h_3) + (h_3'-h_4) + (h_4'-h_5)$ is known as cumulative heat drop to the isentropic heat drop is known as reheat factor.
The ratio of cumulative heat drop to the isentropic heat drop is known as reheat factor.

$$\text{Reheat factor} = \frac{\text{Cumulative heat drop}}{\text{Isentropic heat drop}}$$

$$= \frac{(h_1-h_2) + (h_2'-h_3) + (h_3'-h_4) + (h_4'-h_5)}{(h_1-h_6)}$$

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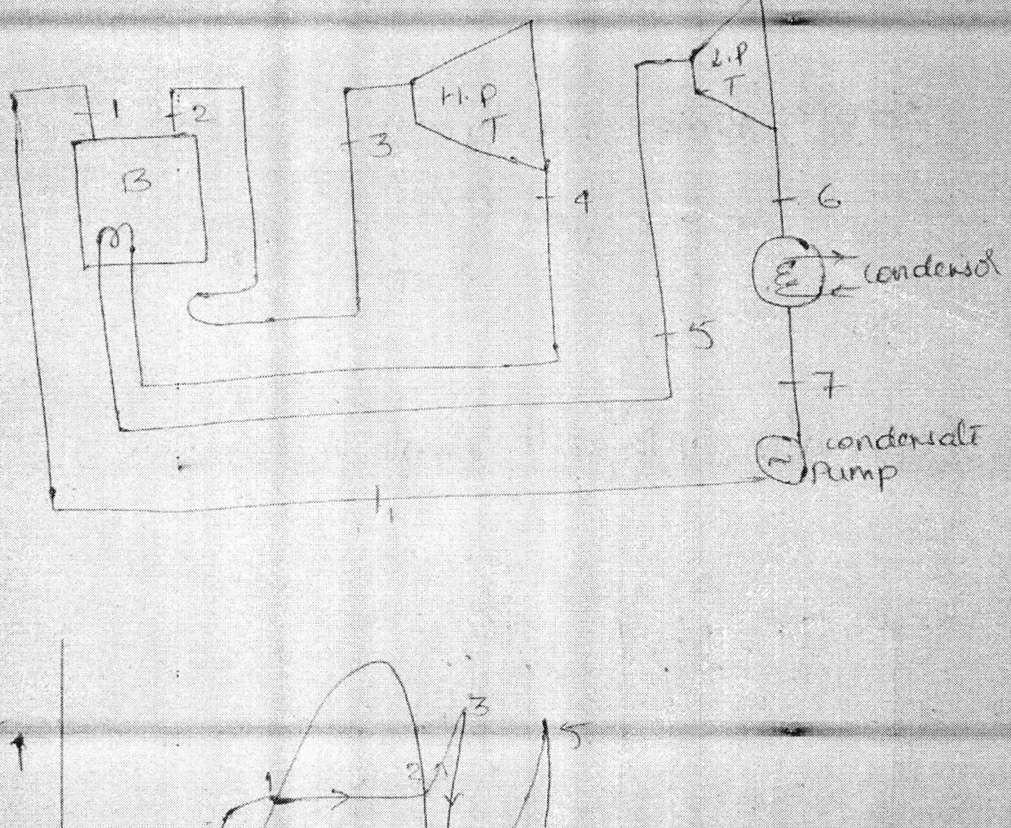
Narava, Visakhapatnam-530 027.

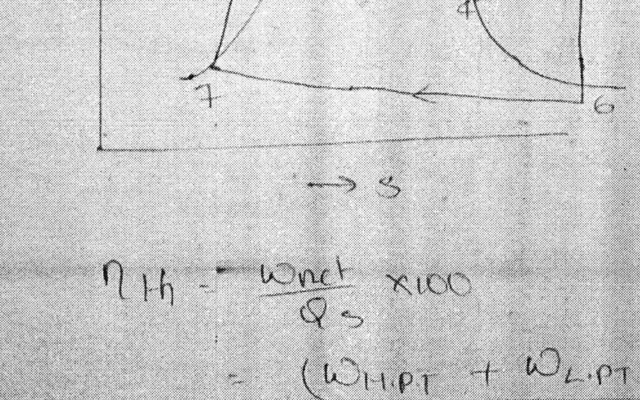
$$\eta_{th} = \frac{W_{net}}{Q_s}$$

$$\eta_{th} = \frac{W_T - W_P}{Q_s} \quad (\because W_P = 0)$$

$$\boxed{\eta_{th} = \frac{h_3 - h_4}{h_3 - h_{w1}}}$$

2 Reheat Rankine cycle :





$$\eta_{th} = \frac{W_{net}}{Q_s} \times 100$$

$$= \frac{(W_{H.P.T} + W_{L.P.T}) - W_P}{Q_B + Q_R} \times 100$$

Mid Exam Question Paper **VISAKHA INSTITUTE OF ENGINEERING & TECHNOLOGY**

Department of Mechanical Engineering				**Mid : I**	
Semester	: I	Program	: III B. Tech	AY	: 2022-23
Date	:	Time	: 90 MIN	Max. Marks	: 15
Course Code	: R20	Course Title	: **THERMAL ENGINEERING -II**		
FACULTY NAME	:D. DEMUDU NAIDU				

Answer ALL the following questions

CO: Course Outcome no. (1-6), LEVEL: Revised Bloom's Taxonomy level no. (1-6)

*** L1 (R): Remembering, L2 (U): Understanding, L3 (P): Applying,**
***L4 (A): Analyzing, L5 (E): Evaluating, L6 (C): Creating.**

UNIT-1:

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO1	L3	1	Schematic layout of ranking cycle and explain.	5 M
CO1	L2	2	Explain the regeneration in power plant and advantages.	5 M
CO1	L3	3	Calculate the height of a chimney required to produce a draught equivalent to 1.6 cm of water if the flue gas temperature is 2500 C and ambient temperature is 270 C and minimum amount of air per kg of fuel is 20 kg.	5 M
CO1	L2	4	What are the boiler mountings and accessories and explain about fusible plug.	5 M
CO1	L3	5	Draw and explain the Babcock and will cock boiler.	5 M

UNIT-2

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO2	L2	1	What are the functions of nozzles and its applications..	5 M
CO2	L3	2	What are the types of nozzles and explain each with diagrams.	5 M
CO2	L2	3	Classification of steam turbines with minimum ten points.	5 M
CO2	L2	4	Draw and explain pressure –velocity compounding impulse turbine.	5 M
CO2	L3	5	A simple impulse turbine has one ring of moving blades running at 120 m/s, absolute velocity of steam at exit is 75 m/s at an angle 800 with the tangent of wheel, friction coefficient is 0.85, rate of steam flowing 2.5 Kg/s. Assuming the moving blades to be a symmetrical, find the i) Blade angles, ii) Nozzle angle, iii) absolute velocity of steam at entrance, and iv) power developed.	5 M

UNIT-3

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO3	L2	1	What are the differences between impulse and reaction turbines?	5 M
CO3	L3	2	A reaction turbine runs at 3000 rpm and the steam consumption is 20000 kg/hr. The pressure of steam at a certain pair is 2 bar, its dryness fraction is 0.93 and the power developed by the pair is 50 kW. The discharge blade angle is 20o for both the fixed and moving blades and the axial velocity of flow is 0.72 times the blade velocity. Find the drum diameter and the blade height. Take the tip leakage steam as 8%. Neglect blade thickness.	5 M

Mid Exam Question Paper — **VISAKHA INSTITUTE OF ENGINEERING & TECHNOLOGY**

Department of Mechanical Engineering				**Mid : II**	
Semester	: I	Program	: III B. Tech	AY	: 2022-23
Date	:	Time	: 90 MIN	Max. Marks	: 15
Course Code	: R20	Course Title	: **THERMAL ENGINEERING -II**		
FACULTY NAME	:D.DEMUDU NAIDU				

Answer ALL the following questions

CO: Course Outcome no. (1-6), LEVEL: Revised Bloom's Taxonomy level no. (1-6)

*** L1 (R): Remembering, L2 (U): Understanding, L3 (P): Applying,**
***L4 (A): Analyzing, L5 (E): Evaluating, L6 (C): Creating.**

UNIT-1:

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO1	L2	1	Sketch and describe the operation of central flow surface condenser.	5 M
CO1	L3	2	Derive the equation for critical pressure ratio in nozzles.	5 M
CO1	L2	3	Define degree of reaction (R_D) And derive it.	5 M
CO1	L2	4	Classification of condensers and write advantages.	5 M
CO1	L3	5	Derive the equation for critical pressure ratio in nozzles.	5 M

UNIT-2

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO2	L2	1	Explain Roots blower compressors with neat sketch.	5 M
CO2	L2	2	What are the differences between fan, blower, compressor.	5 M
CO2	L3	3	Derive maximum work required in multistage reciprocating compressor.	5 M
CO2	L3	4	A two stage single-acting reciprocating compressor takes in air at the rate of 0.2 m^3/s .the intake pressure and temperature of air are 0.1 Mpa and 16^0c.The air is compressed to a final pressure is ideal and intercooling is perfect. The compression index in both the stage is 1.25 and the compressor runs at 600 r.p.m. neglecting clearance, determine (i) intermediate pressure (ii)power required to drive the compressor (iii) heat rejection in intercooler. C_p=1.005 kj/kgk and R= 0.287 Kj / kgk	5 M
CO2	L3	5	A cylinder double acting compressor is required to compress 30 m^3/s of air at 1 bar and 27^0c toa pressure of 16 bar. determine the size of motor required and cylinder dimensions if the following data is given: speed of compressor N=320 r.p.m, clearance volume v_c =4%, stroke to bore ratio L/D =1.2,Mechanical efficiency =82%, value of index n= 1.32	5 M

UNIT-3

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO3	L2	1	Classification of compressors with advantages and applications.	5 M

Mid Exam Question Paper

VISAKHA INSTITUTE OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering				**Mid assignment : I**	
Semester	: I	Program	: III B. Tech	AY	: 2022-23
Date	:	Time	: 90 MIN	Max. Marks	: 15
Course Code	: R20	Course Title	: **THERMAL ENGINEERING -II**		
FACULTY NAME	:D. DEMUDU NAIDU				

Answer ALL the following questions

CO: Course Outcome no. (1-6), LEVEL: Revised Bloom's Taxonomy level no. (1-6)

*** L1 (R): Remembering, L2 (U): Understanding, L3 (P): Applying,**

***L4 (A): Analyzing, L5 (E): Evaluating, L6 (C): Creating.**

UNIT-1:

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO1	L3	1	Schematic layout of ranking cycle and explain.	5 M
CO1	L2	2	Explain the regeneration in power plant and advantages.	5 M
CO1	L3	3	Calculate the height of a chimney required to produce a draught equivalent to 1.6 cm of water if the flue gas temperature is 2500 C and ambient temperature is 270 C and minimum amount of air per kg of fuel is 20 kg.	5 M
CO1	L2	4	What are the boiler mountings and accessories and explain about fusible plug.	5 M
CO1	L3	5	Draw and explain the Babcock and will cock boiler.	5 M

UNIT-2

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO2	L2	1	What are the functions of nozzles and its applications..	5 M
CO2	L3	2	What are the types of nozzles and explain each with diagrams.	5 M
CO2	L2	3	Classification of steam turbines with minimum ten points.	5 M
CO2	L2	4	Draw and explain pressure –velocity compounding impulse turbine.	5 M
CO2	L3	5	A simple impulse turbine has one ring of moving blades running at 120 m/s, absolute velocity of steam at exit is 75 m/s at an angle 800 with the tangent of wheel, friction coefficient is 0.85, rate of steam flowing 2.5 Kg/s. Assuming the moving blades to be a symmetrical, find the i) Blade angles, ii) Nozzle angle, iii) absolute velocity of steam at entrance, and iv) power developed.	5 M

UNIT-3

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO3	L2	1	What are the differences between impulse and reaction turbines?	5 M
CO3	L3	2	A reaction turbine runs at 3000 rpm and the steam consumption is 20000 kg/hr. The pressure of steam at a certain pair is 2 bar, its dryness fraction is 0.93 and the power developed by the pair is 50 kW. The discharge blade angle is 20o for both the fixed and moving blades and the axial velocity of flow is 0.72 times the blade velocity. Find the drum diameter and the blade height. Take the tip leakage steam as 8%. Neglect blade thickness.	5 M

Mid Exam Question Paper	VISAKHA INSTITUTE OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering				Mid assengement : II	
Semester	: I	Program	: III B. Tech	AY	: 2022-23
Date	:	Time	: 90 MIN	Max. Marks	: 15
Course Code	: R20	Course Title	: **THERMAL ENGINEERING -II**		
FACULTY NAME	:D.DEMUDU NAIDU				

Answer ALL the following questions

CO: Course Outcome no. (1-6), LEVEL: Revised Bloom's Taxonomy level no. (1-6)

*** L1 (R): Remembering, L2 (U): Understanding, L3 (P): Applying,**
***L4 (A): Analyzing, L5 (E): Evaluating, L6 (C): Creating.**

UNIT-1:

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO1	L2	1	Sketch and describe the operation of central flow surface condenser.	5 M
CO1	L3	2	Derive the equation for critical pressure ratio in nozzles.	5 M
CO1	L2	3	Define degree of reaction (R_D) And derive it.	5 M
CO1	L2	4	Classification of condensers and write advantages.	5 M
CO1	L3	5	Derive the equation for critical pressure ratio in nozzles.	5 M

UNIT-2

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO2	L2	1	Explain Roots blower compressors with neat sketch.	5 M
CO2	L2	2	What are the differences between fan, blower, compressor.	5 M
CO2	L3	3	Derive maximum work required in multistage reciprocating compressor.	5 M
CO2	L3	4	A two stage single-acting reciprocating compressor takes in air at the rate of 0.2 m^3/s .the intake pressure and temperature of air are 0.1 Mpa and 16^0c.The air is compressed to a final pressure is ideal and intercooling is perfect. The compression index in both the stage is 1.25 and the compressor runs at 600 r.p.m. neglecting clearance, determine (i) intermediate pressure (ii)power required to drive the compressor (iii) heat rejection in intercooler. C_p=1.005 kj/kgk and R= 0.287 Kj / kgk	5 M
CO2	L3	5	A cylinder double acting compressor is required to compress 30 m^3/s of air at 1 bar and 27^0c toa pressure of 16 bar. determine the size of motor required and cylinder dimensions if the following data is given: speed of compressor N=320 r.p.m, clearance volume v_c =4%, stroke to bore ratio L/D =1.2,Mechanical efficiency =82%, value of index n= 1.32	5 M

UNIT-3

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO3	L2	1	Classification of compressors with advantages and applications.	5 M

III B. Tech I Semester Supplementary Examinations, October/November - 2020

THERMAL ENGINEERING – II

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**
4. Use of Steam tables with Mollier diagram is allowed

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PART –A (22 Marks)

1 a) Discuss the advantages of a regenerative feed heating in steam power cycle. [4M]
b) Explain the differences between internally fired and externally fired boilers. [3M]
c) Explain what is meant by critical pressure ratio of a nozzle? [4M]
d) Discuss t the factors which affect the vacuum efficiency of a condenser. [4M]
e) What are the disadvantages of a closed cycle gas turbine over open cycle gas turbine? [3M]
f) Explain thrust power and propulsion efficiency of a rocket engine. [4M]

PART –B (48 Marks)

2 a) What is adiabatic flame temperature? How flame temperature can be calculated? [7M]
b) A power generating plant uses stem as working fluid and operates at boiler pressure of 50bar, dry saturated and a condenser pressure of 0.1 bar. Calculate for thee limits: i) The cycle efficiency; ii) The work ratio and specific steam consumption of Rankine cycle. Take pumping work also into account. [9M]

3 a) What do you understand by feed check valve? Explain the working of a feed check valve with a near sketch. [7M]
b) The equivalent evaporation of boiler from and at 100^0C is 1300 kg/hr. Calculate the actual evaporation if the feed water is supplied at 110^0C and the steam is generated at a pressure of 15 bar and temperature 200^0C. If the efficiency of this boiler is 72% find: i) The fuel consumption per hour taking calorific value of coal as 25500 kj/kg, and ii) The grate area if the rate of evaporation is 100 kg/m^2 per hour. [9M]

4 a) Explain the functions of the convergent portion, the throat and the divergent portion of a convergent-divergent nozzle with reference to flow of steam. [7M]
b) A convergent-divergent nozzle is required to discharge 5 kg of steam per second. The nozzle is supplied with steam at 10bar and 200^0C 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. If the nozzle efficiency is assumed to be 85%, determine the exit area. [9M]

5 a) What is the fundamental difference between the operation of impulse and reaction turbines? Explain the same with neat sketches. [7M]
b) The vacuum at the bottom of a surface condenser is 65.4 cm of mercury (barometer 75.7 cm), the temperature at the air pump suction is 36.2^0C. If the rate of air leakage into the condenser is 1 kg per 1000 kg of steam, estimate the mass of air and vapour removed by the air pump per minute when the engine consumption is 136000 kg of steam/hr. [9M]
~~~~~~

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

III B. Tech I Semester Supplementary Examinations, May - 2019

THERMAL ENGINEERING – II

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

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

~~~~~~

PART –A

1 a) What is stoichiometry? [3M]
b) Compare force and induced draught. [4M]
c) What is the condition for maximum blade efficiency of a 50% reaction turbine and its value? [4M]
d) Define nozzle velocity coefficient and how it is related to nozzle efficiency. [3M]
e) Draw the line diagram of a closed cycle gas turbine. [4M]
f) What are the different rocket propulsion systems? [4M]

PART –B

2 a) Consider a regenerative vapour power cycle with a feed water heater. The steam enters the first stage turbine at 8 MPa, 500°C and expands to 0.7 MPa, where some of the steam is extracted and diverted to feed water heater operating at 0.7 MPa. The remaining steam expands through the second stage turbine to a condenser pressure of 0.008 MPa. The saturated liquid exits the feed water heater at 0.7 MPa. The isentropic efficiency of each turbine is 85%, while each pump operates isentropically. If the net power output of the cycle is 105 MW, determine [10M]
i) Thermal efficiency of the cycle
ii) The mass flow rate of steam entering the first turbine stage.
b) What is reheating? Write the advantages of reheat rankine cycle. [6M]

3 a) What are the functions of boiler mountings and accessories? Explain any one accessory. [8M]
b) A thermal power station works on natural draught. The height of the chimney is restricted to 40 m. The ambient temperature of the air is 20°C and the temperature of the flue gas passing through the chimney at its base is 300°C. The air fuel ratio is 17:1. Calculate the diameter of the chimney at the base, if head due to friction is 25% of the ideal draught. [8M]

4 a) In a convergent-divergent nozzle, the steam enters at 15 bar and 300°C and leaves at a pressure of 2 bar. The inlet velocity to the nozzle is 150 m/s. Find the required throat and exit areas for a mass flow rate of 1 kg/s. Assume nozzle efficiency to be 90 percent and C_{ps} = 2.4 kJ/kg.K. [8M]
b) What is the need of compounding impulse turbines? Explain any one method in detail. [8M]
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Code No: RT31035 **R13** SET - 1

III B. Tech I Semester Supplementary Examinations, October/November - 2018

THERMAL ENGINEERING – II

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

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

~~~~~~

PART –A

1	a)	What do you understand by mean temperature of heat addition?	[4M]
	b)	Explain `Boiler Draught`?	[3M]
	c)	Explain the principle involved in calculation of the velocity with which fluid issues from a nozzle assuming frictionless adiabatic flow.	[4M]
	d)	Differentiate between Impulse and Reaction turbines.	[4M]
	e)	Discuss the relative advantages and disadvantages of reciprocating I.C. engines and gas turbines.	[3M]
	f)	What is meant by thrust augmentation? Explain. When it is necessary?	[4M]

PART -B

2	a)	What is adiabatic flame temperature? How flame temperature can be calculated?	[7M]
	b)	A power generating plant uses steam as a working fluid and operates at a boiler pressure of 80 bar and a condenser pressure of 0.075 bar. Assuming the operating cycle to be ideal, determine i) The heat transfer per unit mass of steam in the boiler and condenser; ii) The specific work output; iii) The cycle efficiency; iv) The required rate of steam flow to provide a specified power output of 10000 kW and v) Work ratio if the plant operates on The Rankine cycle, taking the pumping work into account.	[9M]
3	a)	What do you mean by high pressure boilers? How do they differ in construction and working from an ordinary boiler?	[7M]
	b)	Describe briefly the advantages which you would expect to be gained from incorporating economizer, air pre-heater and a super heater in a steam plant. By a line diagram, indicate the position of these accessories in a typical boiler plant.	[9M]
4	a)	Describe the changes which occur in pressure and velocity distribution along the length of a i) convergent nozzle ii) convergent-divergent nozzle, as the back pressure is reduced slowly from inlet pressure to below designed back pressure.	[8M]
	b)	Find the optimum ratio of blade speed to steam speed for a two-stage velocity-compounded impulse turbine. How diagram efficiency varies with blade-steam velocity ratio with the increase in number of stages?	[8M]
5	a)	Explain the working of a single-stage reaction turbine. Sketch pressure and velocity variations along the axis of the turbine. Show the expansion on h-s chart.	[8M]
	b)	The vacuum at the bottom of a surface condenser is 65.4 cm of mercury (barometer 75.7cm), the temperature at the air pump suction is 36.2^{0}C. If the rate of air leakage into the condenser is 1kg per 1000 kg of steam, estimate the mass of air and vapour removed by the air pump per minute when the engine consumption is 136000 kg of steam/hr.	[8M]
~~~~~~

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

III B. Tech I Semester Supplementary Examinations, May - 2018

THERMAL ENGINEERING – II

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

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

~~~~~~

PART –A

1 a) What do you understand by heat of reaction? [3M]
b) What are the functions of a boiler chimney? Why chimney is not provided in a locomotive boiler? [4M]
c) Explain the term nozzle efficiency, velocity coefficient and discharge coefficient as applied to nozzles. [3M]
d) Explain degree of reaction. [4M]
e) What are the requirements of a good combustion chamber for a gas turbine? [4M]
f) What is the essential difference between rocket propulsion and turbo-jet propulsion? [4M]

PART -B

2 a) Discuss the effect of dissociation on flame temperature. [7M]
b) A power generating plant uses steam as working fluid and operates at boiler pressure of 50bar, dry saturated and a condenser pressure of 0.1bar. Calculate for these limits: i) The cycle efficiency; ii) The work ratio and specific steam consumption for Rankine cycle. Take pumping work also into account. [9M]

3 a) Discuss the advantages and disadvantages of artificial draught system over natural draught system? [7M]
b) The equivalent evaporation of boiler from and at 100^0C is 1300kg/hr. Calculate the actual evaporation if the feed water is supplied at 110^0C and the steam is generated at a pressure of 15bar and temperature 200^0C. if the efficiency of this boiler is 72%, find i) The fuel consumption per hour taking calorific value of coal as 25500 kJ/kg, and ii) The grate area if the rate of evaporation is 100kg/m^2 per hour. [9M]

4 a) Discuss the process of super saturation in steam nozzles with the help of enthalpy-entropy diagram. Define degree of super-saturation and degree of under-cooling. Explain in detail the physical significance of abrupt change at Wilson`s line. [8M]
b) Derive the condition of maximum blade efficiency in single-stage impulse turbine? What is its value? Sketch how efficiency varies with blade-steam velocity ratio. [8M]

5 a) Deduce an expression for work done per stage of a reaction blading? [8M]
b) A condensing plant condenses 13750kg of steam per hour and the leakage of air in the system is 1kg per 2500kg of steam. The vacuum in the air pump suction is 71.5cm (barometer 76cm) and the temperature 32.9^0C. Compute the capacity of the air pump which removes both air and water in m^3/min, taking the volumetric efficiency as 80%. [8M]
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THERMAL ENGINEERING-II

https://www.youtube.com/watch?v=uOYNCNCg0qc

https://www.youtube.com/watch?v=D0i1E_lE_TE

https://www.youtube.com/watch?v=7DpKkcttQOw

https://www.youtube.com/watch?v=gUWLOQsPzzc

https://www.youtube.com/watch?v=AOk0pEyvypw

https://www.youtube.com/watch?v=4KqTiHMbAQM

https://www.youtube.com/watch?v=HpoilOJ1Ahc

https://www.youtube.com/watch?v=qSchDE4pH4g

https://www.youtube.com/watch?v=NakOoD-G0IY

PRINCIPAL
VISAKHA INSTITUTE OF
ENGINEERING & TECHNOLOGY
Narava, Visakhapatnam-530 027.

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES:

PEO1:
To prepare graduates with a solid foundation in engineering, Science and Technology for a successful career in Mechanical Engineering

PEO2:
To prepare graduates to become effective collaborators / innovators in efforts to address social, technical and engineering challenges

PEO3:
To prepare graduates to get employment in industries or pursue higher studies or research assignments or turn as entrepreneurs.

PEO4:
To prepare graduates to inculcate good communication skills, leadership skills, professional, ethical and social responsibilities.

PROGRAM OUTCOMES (POs) Engineering Graduates will be able to:

- **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **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.
- **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 en vironmental considerations.
- **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.
- **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- **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.

VISAKHA INSTITUTE OF ENGINEERING & TECHNOLOGY
Approved by AICTE NEW DELHI
(Affiliated to JNTUK, KAKINADA)
88th Division, Narava, GVMC, Visakhapatnam-530027
DIPLOMA | ENGINEERING | MANAGEMENT

NAAC B++ | ISO 9001:2015 | COLLEGE CODE VSPT

LESSONPLAN(2022-23)			
Academic Year	:2022-2023	Semester	: I
Name of the Program	:B.Tech(R20-Regulation)	Year	:III
Course/Subject	:THERMAL ENGINEERING -II	Course Code	:
Name of the Faculty	:D.DEMUDU NAIDU	Branch	:MECH
Designation	:Assistant Professor		

Course Objectives:

1) To understand the basic concepts of thermal engineering and boilers.
2) To gain knowledge about the concepts of steam nozzles and steam turbines.
3) To gain knowledge about the concepts of reaction turbine and steam condensers.
4) To understand the concepts of reciprocating and rotary type of compressors.
5) To acquire knowledge about the centrifugal and axial flow compressors.

		BRIDGE COURSE		
	1	We know about basic of engines and classification of engines.		
	2	Introduction to air standard cycles and turbines, boilers, condensers		
	3	Introduction to nozzles and basic knowledge of various compressors		
U-no.	Lecture number	**CONTENTS**	Date	Text/ Reference
U-1	1	**BASIC CONCEPTS:** Rankine cycle - schematic layout		
	2	thermodynamic analysis, concept of mean temperature of heat addition		
	3	Methods to improve cycle performance – regeneration & reheating. combustion		
	4	fuels and combustion, concepts of heat of reaction		
	5	adiabatic flame temperature, Stoichiometry, flue gas analysis.		
	6	**BOILERS :** Classification working principles of L.P & H.P boilers with sketches		
	7	mountings and accessories, working principles, boiler horse power, equivalent evaporation		
	8	efficiency and heat balance		
	9	Draught: classification – height of chimney for given draught and discharge		
	10	condition for maximum discharge, efficiency of chimney, artificial draught, induced and forced		
U-2	11	Function of a nozzle – applications - types, flow through nozzles		
	12	thermodynamic analysis – assumptions -velocity of fluid at nozzle exit-Ideal and actual expansion in a nozzle, velocity coefficient		
	13	condition for maximum discharge, critical pressure ratio,		
	14	criteria to decide nozzle shape: Super saturated flow - its effects		
	15	degree of super saturation and degree of under cooling, Wilson line.		
	16	Introduction - principle of working –.		
	17	**STEAM TURBINES:** Classification		
	18	impulse turbine; mechanical details – velocity diagram		
	19	effect of friction – power developed, axial thrust, blade or diagram efficiency		
	20	condition for maximum efficiency.		
	21	De-laval turbine - methods to reduce rotor speed-velocity compounding		
	22	pressure compounding and velocity & pressure compounding		
	23	velocity and pressure variation along the flow		
	24	combined velocity diagram for a velocity compounded impulse turbine		

S.NO	GRADUATE ATTRIBUTION	ACTION VERBS	LEVEL
1	ENGINEERING KNOWLEDGE	APPLY	K3
2	PROBLEM ANALYSIS	ANALYZE	K4
3	DESIGN DEVELOPMENT OF SOLUTIONS	EVALUATE	K5
4	INVESTIGATION OF COMPLEX PROBLEMS	APPLY,ANALYZE,EVALUATE	K3,K4,K5
5	MODERN TOOL USAGE	APPLY, EVALUATE	K3,K5
6	ENGINEER AND SOCIETY	APPLAY	
7	ENVIRONMENT AND SUSTAINABILITY	APPLAY	
8	ETHICS		
9	INDIVIDUALS AND TEAM WORK		
10	COMMUNICATION	APPLAY	
11	PROJECT MANAGEMENT AND FINANCE	APPLY	K3
12	LIFE LONG LEARNING	CREATE	K6

Course Outcomes:

Discuss the concepts of machining processes.

CO1: Explain the basic concepts of thermal engineering and boilers.

CO2: Discuss the concepts of steam nozzles and steam turbines.

CO3: Gain knowledge about the concepts of reaction turbine and steam condensers.

CO4: Discuss the concepts of reciprocating and rotary type of compressors.

CO5: Acquire knowledge about the centrifugal and axial flow compressors.

Textbooks:

1.A Textbook of Thermal Engineering: Mechanical Technology" by R S Khurmi. ...

2.Thermodynamics and Heat Engines/R.Yadav, Volume -II /Central Publishing House

REFERENCEBOOKS:

1) Thermal Engineering-M.L.Mathur & Mehta/Jain bros. Publishers
2) Thermal Engineering-P.L.Ballaney/ Khanna publishers.
3) Thermal Engineering / RK Rajput/ Lakshmi Publications
4) Thermal Engineering-R.S Khurmi, &J S Gupta/S.Chand.

Department of MECHANICAL Engineering				Mid : II	
Semester	: I	Program	: III B. Tech	AY	: 2022-23
Date	:28-11-2022	Time	: 90 MIN	Max. Marks	: 30M
Course Code	: **R2031031**	Course Title	: **THERMAL ENGINEERING -II**		
FACULTY NAME	: **D. DEMUDU NAIDU**				

Answer ALL the following questions

CO: Course Outcome no. (1-6), LEVEL: Revised Bloom's Taxonomy level no. (1-6)

*** L1 (R): Remembering, L2 (U): Understanding, L3 (P): Applying,**

***L4 (A): Analyzing, L5 (E): Evaluating, L6 (C): Creating.**

CO	LEVEL	Q.N.	Question (s)	Max. Marks
CO1	**L3**	1	Derive the equation for critical pressure ratio in nozzles.	**10 M**
CO2	**L3**	2	A cylinder double acting compressor is required to compress 30 m^3/s of air at 1 bar and 270c to a pressure of 16 bar. determine the size of motor required and cylinder dimensions if the following data is given: speed of compressor N=320 r.p.m, clearance volume vc =4%, stroke to bore ratio L/D=1.2,Mechanical efficiency =82%, value of index n= 1.32	**10 M**
CO3	**L3**	3	A reaction turbine runs at 3000 rpm and the steam consumption is 20000 kg/hr. The pressure of steam at a certain pair is 2 bar, its dryness fraction is 0.93 and the power developed by the pair is 50 kW. The discharge blade angle is 20° for both the fixed and moving blades and the axial velocity of flow is 0.72 times the blade velocity. Find the drum diameter and the blade height. Take the tip leakage steam as 8%. Neglect blade thickness.	**10 M**

VISAKHA INSTITUTE OF ENGINEERING & TECHNOLOGY

Name of the Examination : III B.Tech. I Semester MID II Examination Date of Exam : 28-11-2022

Name of the Subject : Thermal engineering - II Sub.Code : R2031031

Name of the Faculty : D. Demudu Naidu Dept. : Mech Contact No. 6304496152

Q. No.	Scheme of Valuation	Marks Allotted
1.	Derivation of Critical pressure Ratio in Nozzles. Termanolozy of Terms. Steps with minimum fifteen. Answer.	 2 5 3.
2.	Given data of double acting Cylinder Compressor. Procedure of problem. Answer.	2 6 2
3	i, Reaction Turbine Given data. ii, Procedure of problem & answer	2 8

Signature of the Faculty

VISAKHA INSTITUTE OF ENGINEERING & TECHNOLOGY

Name of the Examination : III B.Tech. I Semester MID I Examination Date of Exam : 26-09-2022

Name of the Subject : Thermal engineering -II Sub.Code : R2031031

Name of the Faculty : D. Demudu Naidu. Dept. : Mech Contact No. 6304496152

Q. No.	Scheme of Valuation	Marks Allotted
1	1(a) Boiler Mountings Types minimum five type 1(b) Boiler accessories Types with minimum 10 points	5 5
2	(a) i, Functions of nozzles ii, Applications of Nozzles (b) Given data. procedure of problem & Result.	2 2 2 4
3	(a) Difference Between impluse & Reaction turbins with – minimum 10 points. (b) Given data. of problem. Procedure & Result	5 2 3.

Signature of the Faculty