SAMANTA CHANDRASEKHAR INSTITUTE OF TECHNOLOGY AND MANAGEMENT

DEPT. OF MECHANICAL ENGINEERING

ATTENDANCE REGISTER

SESSION 2020-21 (odd Sem)

Name: [illegible]

Designation: Lecturer.

Dept.: Mechanical (Diploma) [illegible]

Signature

COURSES ALLOTED

[illegible]

Semester	[illegible]	Course Title	[illegible]
8th		Refrigeration & Airconditioning	[illegible]
2nd		Thermal Engineering-I	[illegible]

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[illegible] KORAPUT (ODISHA)

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ATTENDANCE REGISTER

Sl. No.	Regd. No.	Name	Attendance
1	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]

SAMANTA CHANDRASEKHAR INSTITUTE OF TECHNOLOGY AND MANAGEMENT

SEMILIGUDA - 764 036

DEPT. OF MECHANICAL ENGINEERING

ATTENDANCE REGISTER

SESSION 2023-2024 (Even)

Name : Er. [illegible]

Designation : Lecturer

Dept : Mechanical (Diploma) 4th & 6th Sem

[illegible]

Signature

COURSES ALLOTED

FOR DIFFERENT BRANCHES & SEMESTERS

Semester	Course No.	Course Title	Period
[illegible]		Industrial Engineering & Management	[illegible]
[illegible]		Thermal Engineering-II	[illegible]

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ATTENDANCE REGISTER

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1

SAMANTA CHANDRASEKHAR INSTITUTE OF TECHNOLOGY & MANAGEMENT

SEMILIGUDA-764 036, KORAPUT

DEPT. OF Mechanical Engineering

LESSON PLAN AND PROGRESS REGISTER

(To be maintained by all members of the teaching staff)

SESSION: 2023-24 (Even)

NAME: Mr. Jitendra Kumar Mallik

DESIGNATION: Lecturer

DEPT: Mechanical (Diploma - 4th & 6th)

SIGNATURE

This Lesson Plan and Progress Register is to be submitted to the Director for verification and counter signature at end of every semester. The H.O.D. must verify and sign the Register before submission.

COURSES ALLOTED

FOR DIFFERENT BRANCHES & SEMESTERS (Degree/Diploma/ITI/School)

Semester	Course No.	Course Title
6th		Thermal Engg-II
8th		Industrial Engineering & Management

N.B. Maintenance of Annual Lesson Plan cum Progress Register and performance Reports is/are an responsibility of each faculty member.

LESSON PLAN

Degree/Diploma/I.T.I./[illegible]

Semester: 5th Branch: Mechanical

Month & Date	Course No. & Title	Brief note of the topics to be covered	No. of Classes Required
01/11/24 to	Performance of IC Engine	1. Define mechanical efficiency, indicated thermal efficiency, relative efficiency, brake thermal efficiency, overall	2
09/11/24		efficiency, Mean effective pressure & specific fuel consumption	1
		2. Define air fuel ratio & calorific value of fuel	2
		3. Work out problems to determine efficiency & specific fuel consumption	1
11/11/24 to	Air compressors	1. Explain function of compressor & industrial use of compressed air	1
21/11/24		2. Classify air compressors & principle of operation	1
		3. Describe the parts & working principle of reciprocating air compressor	2
		4. Explain the terminology of reciprocating compressor such as	1
		bore, stroke, pressure ratio, free air delivered & volumetric efficiency	
		5. Specify the advantages of single stage & two stage compressor with [illegible]	2
		6. Solve simple problems	2
22/11/24 to	Properties of Steam	1. Difference between gas & vapour	1
14/12/24		2. Formation of steam	
		3. Representation on P-V, T-S, H-S, T-H diagram	2

LESSON PLAN

Degree/Diploma/+2 Science
(Theory/Practical/Lab/Workshop)

Semester: 4th Branch: Mechanical

Month & Date	Chapter No. & Title	Brief note of the topics to be covered	No. of Classes Required
		1. Explanation & properties of steam	1
		2. Use of steam table & mollier chart for finding unknown properties	3
		3. Non flow & flow process of vapour	1
		3. P-V, T-S, & H-S diagram	2
		5. Determine the change in properties & solve simple numericals	2
26/3/24 to	Steam Generator	1. Classification & types of boilers. 2. Important terms for boilers	3
9/3/24		3. Comparison between fire tube & water tube boilers	4
		4. Description & working of common boilers (Cochran, Lancashire,	4
		Babcock & Wilcox boiler)	
		5. Boiler draught (forced, induced & balanced)	2
9/3/24		6. Boiler mounting & accessories	2
9/3/24 to [illegible]	Steam power cycle	1. Carnot cycle with vapour 2. Derive work & efficiency	3
30/3/24		of the cycle	

LESSON PLAN

Degree/Diploma/+2 Science
(Theory/Practical/Lab/Workshop)

Semester: 4th Branch: Mechanical

Tentative Date	Chapter No. & Title	Brief notes of the topics to be covered	No. of Classes Required
		• Rankine cycle, P-V, T-S, H-S diagram, Rankine work & efficiency	4
		Effect of operating [illegible] conditions, Reheat cycle & regenerative cycle.	
		• Solve simple numerical on Carnot vapour cycle & Rankine cycle.	2
4/4/24	Heat Transfer	• Modes of heat transfer (Conduction, Convection, Radiation)	1
to 15/4/24		• Fourier's law of heat conduction & thermal conductivity (K)	2
		• Newton's law of cooling	1
		• Radiation heat transfer (Stefan Boltzmann & Kirchhoff's law) only statement	2
		• Black body radiation, definition of emissivity, absorptivity, transmissibility	2

LESSON PLAN

Degree/Diploma/+2 Science
(Theory/Practical/Lab/Workshop)

Semester: 6th Branch: Mechanical

Month & Year	Chapter No. & Title	Brief account of the topics to be covered	No of Classes Required
10/1/19 to	PLANT ENGINEERING	1. Selection of site of industry 2. Define plant layout 3. Describe objectives & principles of	2
11/1/19		plant layout	
		= Explain process layout, product layout and combination layout	1
		3. Techniques to improve layout	1
		4. Principles of material handling equipments	2
		5. Plant maintenance 1. Importance of plant maintenance	2
		= Break down maintenance = Preventive maintenance	1
		= Scheduled maintenance	
11/1/19 to	OPERATIONS & RESEARCH	- Introduction to operations research and its applications	2
18/1/19		1. Define linear programming problem	} 3
		3. Solution of LPP by graphical method [illegible] (problems)	
		= Explanation of project completion time by critical path method	} 3
		and PERT simple problems	
		= Explain distinct features of PERT with respect to CPM	2

LESSON PLAN

Semester: 4th   Branch: Mechanical

Expected Date	Chapter No. & Title	Brief idea of the topics to be covered	No. of Classes Required
[illegible]	Inventory control.	1. Classification of inventory 2. Functions of inventory control	2
[illegible]		3. Describe the functions of inventory	1
		4. Benefits of inventory control 5. Costs associated with inventory	2
		6. Terminology in inventory control 7. Explain & derive economic order quantity for basic model (Numericals)	4
		8. Define & explain ABC Analysis	2
[illegible]	Inspection & Quality control.	1. Define inspection & quality control 2. Describe planning & inspection.	1
[illegible]		3. Describe types of inspection 4. Advantages and disadvantages of quality control	2
		5. Study of factors influencing the quality of manufacture	1
		6. Explain the concept of statistical quality control, control chart (S.Q.C.)	2
		7. Methods of attributes 8. Concept of ISO 9001-2008	2
		9. Quality management system, Registration or certification procedure 10. Benefits of ISO to the organisation	2

LESSON PLAN [illegible]

Semester: 5th Branch: Mechanical

Month & Date	Chapter No. & Title	Brief note of the topics to be covered	No. of Classes Required
		iii. T.Y.P., Bio-gas, H_2 gas manufacturing	2
		iv. Solve related problems	1
[illegible]	Production Planning & Control	i. Introduction ii. Major functions of production & control	3
[illegible]		iii. Methods of forecasting iv. Routing	1
		v. Scheduling vi. Dispatching vii. Follow-up	2
		viii. Types of Production ix. Mass production x. Batch Production xi. Job order production	2
		xii. Principle of product and process planning	1

SAMANTA CHANDRASEKHAR INSTITUTE OF TECHNOLOGY & MANAGEMENT

SEMILIGUDA-764 036, KORAPUT

DEPT. OF MECHANICAL ENGINEERING

LESSON PLAN AND PROGRESS REGISTER

(To be maintained by all members of the teaching staff)

SESSION: [illegible] (odd)

NAME: [illegible]

DESIGNATION: Lecturer

DEPT: Mechanical (Diploma [illegible] sem)

SIGNATURE

This Lesson Plan and Progress Register is to be submitted to the Director for verification and periodic signature twice in every semester. The H.O.D. must verify and sign this Register before submission.

COURSES ALLOTED

FOR DIFFERENT BRANCHES & SEMESTER (Degree/Diploma/+2 Science)

Semester	Course No.	Course Title
3rd		THERMAL ENGINEERING-I
5th		REFRIGERATION & AIR CONDITIONING

LESSON PLAN

Semester: 3rd

Branch: Mechanical

Week & Date	Chapter No. & Title	Brief mention of the topics to be covered	No. of Classes Required
[illegible]	Thermodynamic concept & laws of thermodynamics	- Thermodynamic systems (closed, open, isolated) - Thermodynamic properties of a system	2
[illegible]		(pressure, volume, temperature, entropy, enthalpy, internal energy	
		and units of measurement) - Intensive & extensive properties	3
		- Define thermodynamic process, path, cycle, state, path function, point	2
		function - Thermodynamic equilibrium	1
		- Quasi-static process - Conceptual explanation of energy & its sources	
		- Work, heat & comparison between the two - Mechanical equivalent of heat - Work transfer, displacement work	1
[illegible]	Laws of thermodynamics	- State & explain Zeroth law of thermodynamics - State & explain First law of thermodynamics	2
[illegible]		- Limitations of first law of thermodynamics - Application of first law of TD (steady	2
		flow energy equation & its application to turbine & compressor)	
		- Second law of TD (Clausius, Kelvin-Planck statements)	2
		- Application of second law in heat engine, heat pump, refrigerator	2
		Determination of efficiency & COP (numerical)	2

LESSON PLAN

[illegible]

Semester: 4th   Branch: Mechanical

Month & Date	Chapter No. & Title	Sub-topics to be covered	No. of Classes Required
[illegible]	[illegible]	[illegible]	1
[illegible]	[illegible]	[illegible]	
		Explain ideal gas [illegible]; Relation between Cp & Cv	1
		[illegible]	2
		[illegible]	2
		[illegible]	1
[illegible]	Internal Combustion Engine	Explain & classify I.C. engines; [illegible]	1
[illegible]		[illegible]	
		Explain the working principle of 2-stroke & 4-stroke engine (C.I. & S.I.)	1
		Differentiate [illegible] 2-stroke & 4-stroke engine, C.I. & S.I. engine	1
[illegible]	Gas Power Cycle	Carnot cycle; Otto cycle; Diesel cycle	1
[illegible]		Dual cycle; Solve simple numericals	1

LESSON PLAN

Degree/Diploma/[illegible]
(Theory/Tract/Lab/Practical)

Semester: 3rd   Branch: Mechanical

Month & Date	Chapter No. & Title	Brief note of the topics to be covered	No. of Classes Required
[illegible]	Fuels & Combustion	- Define fuel - Types of fuel	[illegible]
[illegible]		- Application of different types of fuel - Heating values of fuel	
		- Quantity of air required for complete combustion / [illegible]	4

LESSON PLAN

Degree/Diploma [illegible]
(Theory/Practical/Lab/Workshop)

Semester: 5th   Branch: Mechanical

Week & Date	Chapter No. & Title	Brief details of the topics to be covered	No. of Classes Required
[illegible]/8/23	Air Refrigeration	• Definition of refrigeration and unit of refrigeration	2
"	Cycle	• Definition of refrigerating effect (R.E.)	
[illegible]/8/23		• Principle of working of open and closed air system of refrigeration	2
		• Calculation of C.O.P. of Bell-Coleman cycle and numerical on it	
[illegible]/8/23	Simple vapour compression refrigeration system	• Schematic diagram of simple vapour compression refrigeration system & cycle	2
"		• Cycle with dry saturated vapour after compression	
[illegible]/8/23		• Cycle with wet vapour after compression • Cycle with superheated vapour after compression	2
		• Cycle with superheated vapour before compression	
		• Cycle with sub cooling of refrigerant • Representation of above cycle on	
		temperature entropy and pressure enthalpy diagram	
		• Numerical on above (determination of COP and R.E.)	
[illegible]/8/23	Vapour absorption refrigeration system	• Simple vapour absorption refrigeration system	2
[illegible]/8/23		• Practical vapour absorption refrigeration system	

LESSON PLAN

[illegible]

Semester: 5th Branch: Mechanical

[illegible]	[illegible]	[illegible]	[illegible]
		• COP of practical vapour absorption refrigeration system	1
		• Numerical on COP	
[illegible] to [illegible]	Refrigeration Equipment	• Refrigeration Equipment: • Principle of working and constructional details of reciprocating and rotary compressors.	2
		• Centrifugal compressor only theory • Important terms	1
		• Hermetically and semi hermetically sealed compressor	
[illegible] to [illegible]	Condensers	• Principle of working and constructional details of air cooled & water cooled condenser. • Heat rejection ratio. • Cooling tower and spray pond.	2
[illegible] to [illegible]	Evaporators	• Principle of working and constructional details of an evaporator.	1
		• Types of evaporator. • Bare tube and [illegible] evaporator, [illegible] and [illegible] evaporator	1

LESSON PLAN

[illegible]

Semester: 6th   Branch: Mechanical

Month & Year	Chapter No & Title	Brief note of the topics to be covered	No. of Classes Required
		EQUIPMENT AND CONTROLS, REFRIGERANTS & APPLICATIONS OF REFRIGERANTS :-	
[illegible]	Expansion valves	• Capillary tube • Automatic expansion valve • Thermostatic expansion valve	2
do	Refrigerants	• Classification of refrigerants • Desirable properties of an ideal refrigerant	2
[illegible]		• Designation of refrigerants • Thermodynamic properties of refrigerants	
		• Chemical properties of refrigerants • Commonly used refrigerants	
		R-12, R-22, R-134a, R-717 • Substitutes for CFC	
[illegible]	Applications of Refrigeration	• Cold storage • Dairy refrigeration	
[illegible]		• Ice plant • Water cooler • Frost free refrigerator	
[illegible]	Psychrometrics	• Psychrometric terms • Adiabatic saturation of air by evaporation of water	1
do	Comfort air conditioning	• Psychrometric chart and uses • Psychrometric processes	
[illegible]	Systems	• Sensible heating & cooling • Cooling & dehumidification	
		• Heating & humidification • Adiabatic cooling with humidification	
		• Total heating of a cooling process • SHF, BPF	

LESSON PLAN

Degree/Diploma: [illegible]
(Theory/Practical/Lab/Workshop)

Semester: [illegible] Branch: Mechanical

Month & Date	Completion & Sign	Brief note of the topic(s) to be covered	No. of Classes Required
		• Adiabatic mixing • Heating on coil	
		• Effective temperature and comfort chart	4
7/4/13	Air conditioning System	• Factors affecting comfort air conditioning	
		• Equipment used in an air-conditioning plant	2
18/4/13		• Classification of air conditioning system	
		• Window air conditioning system. • Summer air-conditioning system.	2
		• Numerical on above	2

LESSON PLAN Degree/Diploma [illegible]

Semester: 8th Branch: Mechanical

Week & Date	Chapter No. & Title	Brief note of the topics to be covered	No. of Classes Required
4/9/10	Practicals	i. Study the construction features of domestic refrigerator	1
do		ii. Study the construction features of water cooler	1
11/9/10		iii. Study the construction features of window air conditioner	1
		iv. Study the construction features of split air conditioner	1
		v. Determine the capacity and cost of various components of refrigerator [illegible]	1
		vi. Determine the capacity and cost of water cooler	
		vii. Determine the capacity and cost of window air conditioner	
		viii. Determine the capacity and cost of split air conditioner	
		ix. Determine the capacity and cost of vapour absorption refrigerator [illegible]	
		x. Complete charging of domestic refrigerator and its leak test	

DEPARTMENT OF MECHANICAL ENGINEERING

INTERNAL NOTICE

SCITM, SEMLIGUDA

[illegible] Mechanical [illegible] Mechanical [illegible]

[illegible]

Name of the Proctor: Er. Jitendra Kumar Madul (Lecturer)

2nd Year Mechanical Dept. (2023-24) ([illegible])

Sl. No.	ROLL NO	NAME OF THE STUDENT
1.	F2203[illegible]	Rajesh Kumar Gosal
2.	F2203[illegible]	Rajesh Kumar Pangi
3.	F2203[illegible]4062	Ramesh Chapadi
4.	F2203[illegible]	Ramesh Jani
5.	F2203[illegible]	Ranjan Handika
6.	F2203[illegible]	Ranjit Nayak
7.	F2203[illegible]	Roshan Gumtha
8.	F2203[illegible]	Rani Pangi
9.	F2203[illegible]	Sanjay Kulde
10.	F2203[illegible]	Sanjaya Khilla
11.	F2203[illegible]	Sanjaya Pangi
12.	F2203[illegible]4063	Santosh Pujari
13.	F2203[illegible]	Saroj Jani
14.	F2203[illegible]	Shankar Kuli
15.	F2203[illegible]4067	Shiba Nayak

Sl. No.	REGD. NO.	NAME OF THE STUDENT
16.	[illegible]	Subash Mandal
17.	[illegible]	Sangeeta Ranjit
18.	[illegible]	Sunil Champi
19.	[illegible]	Sunil Kumar Jani
20.	[illegible]	Sunil Majhi
21.	[illegible]	Sunil Majhi
22.	[illegible]	Suresh Khara
23.	[illegible]	Susanta Digal
24.	[illegible]	Sushanta Guntha
25.	[illegible]	Trinatha Khabara
26.	[illegible]	Brahman Pulaka
27.	[illegible]	Bikram Jani
28.	[illegible]	Chandramadhab Tripathy
29.	[illegible]	Deepak Sahu
30.	[illegible]	Dipu Chapadi
31.	[illegible]	Kaushtya Sisa
32.	[illegible]	Prasanta Kumar Lenka
33.	[illegible]	Rama Anjana
34.	[illegible]	Sanjaya Kumar Mandal
35.	[illegible]	Subrat Kumar Jani
36.	[illegible]	Sunil Chapadi
37.	[illegible]	Sunil Nayak

S. No.	REGD NO	NAME OF THE STUDENT
38.	[illegible]	Surya [illegible]
39.	[illegible]	Vicky [illegible]

LECTURE NOTES ON

THERMAL ENGINEERING -II

SAMANTA CHANDRASHEKHAR INSTITUTE OF TECHNOLOGY AND MANAGEMENT,

SEMILIGUDA,764 036

(LECTURER IN MECHANICAL ENGG. DEPT.)

JITENDRA KUMAR MUDULI

CONTENTS

THERMAL ENGINEERING - II

CH 1 (PERFORMANCE OF IC ENGINE)

Engine:

- [illegible]
- [illegible]
- [illegible]

Heat Engine:

- [illegible]
- [illegible]
- [illegible]

    i. [illegible]
    ii. [illegible]

Basics of IC Engine:

- [illegible]

[illegible]

Compression Ratio: [illegible]

[illegible]

Engine Performance Parameter:

- [illegible]

    i. [illegible]
    ii. [illegible]

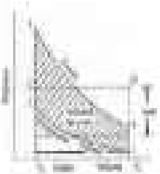
- Mechanical efficiency
- Relative efficiency or efficiency ratio
- Volumetric efficiency
- Mean effective pressure
- Mean piston speed
- Specific power output
- Specific fuel consumption
- Inlet-valve Mach index
- Fuel-air or air-fuel ratio
- Calorific value of the fuel

Indicated Mean Effective Pressure (P_{mi}):

- Mean effective pressure is the average pressure inside the engine cylinders of an internal combustion engine based on the calculated or measured power output.

$$P_{mi} = \frac{\text{Net work of cycle}}{\text{Swept volume}}$$

$$= \frac{\text{Area of the indicator diagram}}{\text{Length of the indicator diagram}}$$



Indicated Power (ip)

(Power is defined as rate of doing work)

- Indicated power is the power developed in the engine cylinder.

$$ip = \frac{P_{mi} L A n}{60} W$$

$$ip = \frac{P_{mi} L A n}{60000} kW$$

OR

$$ip = \frac{P_{mi} L A n k}{60} W$$

$$ip = \frac{P_{mi} L A n k}{60000} kW$$

Where,

ip = indicated power (W or kW)

P_{mi} = indicated mean effective pressure (N/m²)

L = length of the stroke (m)

[illegible]

Brake Power (bp):

- [illegible]
- [illegible]

[illegible]

Frictional Power (fp):

- [illegible]
- [illegible]
- [illegible]
- [illegible]

$$ip = bp + fp$$

$$fp = ip - bp$$

Specific Fuel Consumption (s.f.c):

- [illegible]

$$sfc = \frac{\text{fuel consumption per unit time}}{\text{power}} \left[\frac{kg/s}{kW}\right]$$

Indicated Specific Fuel Consumption (isfc)

$$isfc = \frac{\text{mass of fuel consumption per unit time}}{\text{indicated power}} \left[\frac{kg/s}{kW}\right] = \left[\frac{kg}{kWh}\right]$$

Brake Specific Fuel Consumption (bsfc)

$$bsfc = \frac{\text{mass of fuel consumption per unit time}}{\text{brake power}} \left[\frac{kg}{kWh}\right]$$

Air-Fuel Ratio or Fuel-Air Ratio (A/F OR F/A)

- The relative proportions of the fuel and air in the engine are very important from the standpoint of combustion and the efficiency of the engine.
- This is expressed either as a ratio of the mass of the fuel to that of air or vice versa.

Mathematically,

$$\frac{F}{A} = \frac{\text{mass of fuel}}{\text{mass of air}}$$

Or

$$\frac{A}{F} = \frac{\text{mass of air}}{\text{mass of fuel}}$$

Calorific Value (CV)

- Calorific value of a fuel is the thermal energy released per unit quantity of the fuel when the fuel is burnt completely and the products of combustion are cooled back to initial temperature of the combustible mixture.

Mechanical Efficiency (η_m)

- Mechanical efficiency is defined as the ratio of brake power (delivered power) to the indicated power (power provided to the piston).
- It can also be defined as the ratio of the brake thermal efficiency to the indicated thermal efficiency.

$$\eta_m = \frac{bp}{ip} = \frac{bp}{bp + fp}$$

Indicated Thermal Efficiency (η_{ith})

- [illegible]

$$\eta_{ith} = \frac{ip\ (kJ/s)}{\text{energy in fuel per second}\ (kJ/s)}$$

$$\eta_{ith} = \frac{ip}{\frac{\text{mass of fuel}}{s} \times \text{calorific value of fuel}}$$

[illegible]

Brake Thermal Efficiency:

- [illegible]

[illegible]

Relative Efficiency:

- [illegible]
- [illegible]

[illegible]

Overall Efficiency:

- [illegible]
- [illegible]

[illegible]

- [illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

Uses of compressed air:

[illegible]

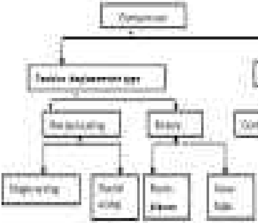
i. [illegible]
ii. [illegible]
iii. [illegible]
[illegible]
iv. Cleaning purposes
v. [illegible]
vi. [illegible]
vii. [illegible]
viii. [illegible]
ix. [illegible]
x. [illegible]

Classification:

The compressors are broadly classified as

i. Reciprocating compressor
ii. Rotary compressor

[illegible]



- [illegible]
- [illegible]
- [illegible]

Reciprocating compressor terminology

i. **Single acting compressor**

- [illegible]

ii. **Double acting compressor**

- [illegible]

ii. Single stage compressor:

- [illegible]

iii. Multi stage compressor:

- [illegible]

iv. Pressure ratio:

- [illegible]

v. Compressor displacement volume:

- [illegible]

[illegible]

vi. Compressor capacity:

- [illegible]

vii. Free air delivered (FAD):

- [illegible]

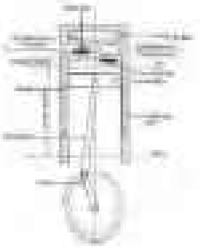
ix. Piston speed:

- [illegible]

x. Volumetric efficiency:

- [illegible]

Reciprocating air compressor:



- [illegible]

Construction:

- [illegible]
- [illegible]
- [illegible]

Working:

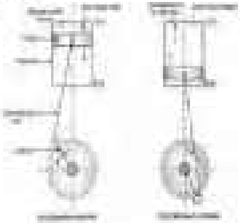
[illegible]

c) Suction stroke

- [illegible]
- [illegible]

ii) Compression stroke

- [illegible]
- [illegible]
- [illegible]
- [illegible]



- [illegible]

Stage [illegible]

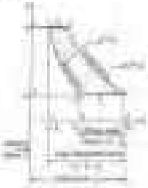
Stage [illegible]

Stage [illegible]

[illegible]

W = [illegible]

[illegible]



[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

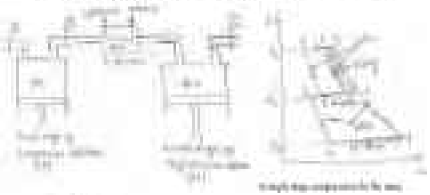
$$\boxed{[illegible]}$$

Multistage compression:

[illegible]

Advantages:

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]



[illegible]

[illegible]

Condition for perfect intercooling:

[illegible]

[illegible]

- [illegible]

Process A-B:

- [illegible]

Process B-C:

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

Process C-D:

- [illegible]
- [illegible]

Process D-E:

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

- [illegible]

Process (ef):

- [illegible]

Note:

- [illegible]
- [illegible]
- [illegible]
- [illegible]

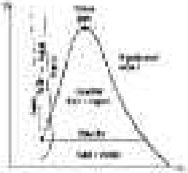
Relation between pressure and temperature for same substance (H_2O):

- [illegible]
- [illegible]
- [illegible]

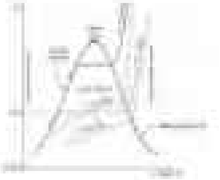
Note:

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

T-s Diagram:



T-s diagram:



- [illegible]
- [illegible]
- [illegible]
- [illegible]

Critical point:

- [illegible]

Critical point data for water:

[illegible]

Subcooling: [illegible]

Degree of subcooling: [illegible]

Superheating: [illegible]

Degree of superheating: [illegible]

Sensible heat: [illegible]

Latent heat:

[illegible]

Latent heat of vaporization:

Latent heat of condensation:

Note:

- [illegible]
- [illegible]
- [illegible]

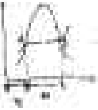
Dryness fraction or Quality of steam (x):

- [illegible]

[illegible]

Specific volume of wet steam:

[illegible]



[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

1. **Boiler shell:** [illegible]
2. **Combustion chamber:** [illegible]
3. **Grate:** [illegible]
4. **Furnace:** [illegible]
5. **Heating surface:** [illegible]
6. **Mounting:** [illegible]
7. **Accessories:** [illegible]
   i. [illegible]
   ii. [illegible]

[illegible]

[illegible]

1. [illegible]

a) **Water tube boiler:** [illegible]

b) **Fire tube boiler:** [illegible]

Ex: Locomotive, Cochran, Lancashire boiler etc.

2. **According to the water circulation arrangement:**

a) **Natural circulation:** [illegible]

Babcock and Wilcox boiler, [illegible]

b) **Forced circulation:** [illegible]

[illegible]

Ex: [illegible]

3. **According to the use:**

a) **Stationary boiler:** [illegible]

plants.

b) **Portable boiler:** [illegible]

c) **Locomotive:** [illegible]

d) **Marine boiler:** [illegible]

4. **According to the position of the boiler:**

a) Horizontal

b) Vertical

c) Inclined

5. **According to the position of furnace:**

a) **Internally fired:** [illegible]

Cochran, Locomotive boiler etc.

b) **Externally fired:** [illegible]

Babcock and Wilcox, [illegible]

6. **According to pressure of steam generated:**

a) **Low pressure boiler:** [illegible]

[illegible]

b) **Medium pressure boiler:** [illegible]

[illegible]

c) **High pressure boiler:** [illegible]

d) **Sub critical boiler:** [illegible]

called subcritical boiler.

e) **Supercritical boiler:** [illegible]

[illegible]

[illegible]

7. **According to the charge in the boiler:**

a) [illegible]

b) [illegible]

c) [illegible]

8. **According to number of tubes:**

a) [illegible]

b) [illegible]

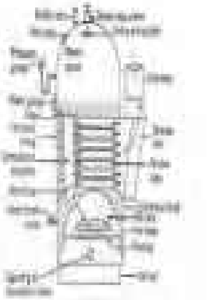
	Fire tube boiler		Water tube boiler
i.	[illegible]	i.	[illegible]
ii.	[illegible]	ii.	[illegible]
iii.	[illegible]	iii.	[illegible]
iv.	[illegible]	iv.	[illegible]
v.	[illegible]	v.	[illegible]
vi.	[illegible]	vi.	[illegible]

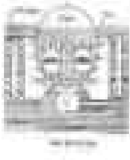
5. **Cochran boiler**

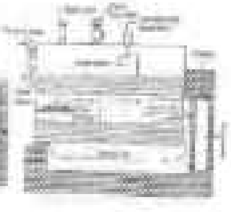
i) **Construction and operation:**

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

ii) **Sketches:**







- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

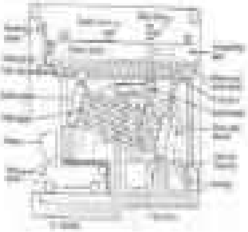
- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

Babcock and Wilcox Boiler

- [illegible]



ii. Construction:

[illegible]

iii. Operation:

[illegible]

- [illegible]

ii. [illegible]

- [illegible]
- [illegible]
- [illegible]

Boiler Mountings:

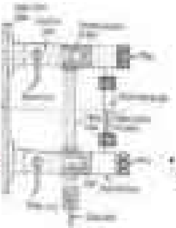
- [illegible]
- [illegible]
- [illegible]
  1. Safety Valve 2 numbers
  2. Water level indicator 2 numbers
  3. Fusible plug
  4. Pressure gauge
  5. Steam stop valve
  6. Feed check valve
  7. Blow off cock
  8. Man hole and mud hole

1. **Safety Valve**

- [illegible]
- [illegible]
- [illegible]
- [illegible]
  a. Dead weight safety valve
  b. Spring loaded safety valve
  c. Lever loaded safety valve
  d. High steam and low water safety valve

2. **Water Level Indicator**

- [illegible]

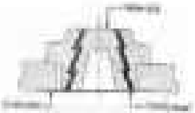


- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

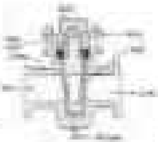
Pressure Gauge

- [illegible]
- [illegible]
- [illegible]

4. Fusible Plug



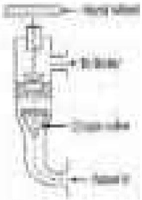
5. Blow Off Cock



[illegible]

- [illegible]

6. Feed check valve



- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

7. Steam stop valve

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

- [illegible]

2. [illegible]

- [illegible]
- [illegible]

Boiler accessories:

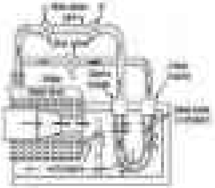
- [illegible]
- [illegible]
- [illegible]

1. Superheater
2. Economiser
3. Air preheater
4. Feed pump
5. [illegible]

1. **Superheater:**

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

- [illegible]
- [illegible]

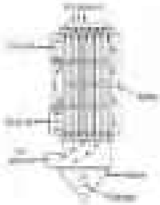


2. ECONOMISER

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

3. **Air preheater:**

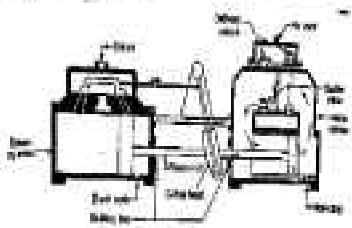
- [illegible]
- [illegible]
- [illegible]
- [illegible]



4. **Feed pump:**

- [illegible]
- [illegible]
- [illegible]
- [illegible]

- [illegible]
- [illegible]



Steam separator

- [illegible]
- [illegible]
- [illegible]

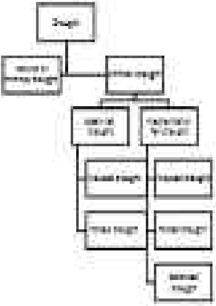
Boiler draught (draft)

- [illegible]
- [illegible]

Function of draught

- [illegible]
- [illegible]
- [illegible]
- [illegible]

Classification of Boiler draught



Natural or chimney draught:

- [illegible]

Artificial draught:

- [illegible]

Mechanical draught:

- [illegible]
- [illegible]

Induced draught:

- [illegible]
- [illegible]
- [illegible]

Forced draught

- [illegible]
- [illegible]

Balanced draught

- [illegible]
- [illegible]

[illegible]

Thermodynamic cycle

- [illegible]
- [illegible]

[illegible]

[illegible]

Carnot Vapour Power Cycle

[illegible]

Rankine Cycle: The Ideal Cycle for Vapour Power Cycles

[illegible]

- The above figure shows the Rankine cycle on T-s coordinates, P-v coordinates and h-s coordinates.
- In all three diagrams, the cycle 1-2-3-4-1 represents an ideal Rankine cycle using saturated steam and the cycle 1'-2'-3'-4'-1 represents an ideal Rankine cycle with superheated steam at the turbine inlet.
- The ideal Rankine cycle does not involve any internal irreversibilities and consists of the following four processes:

  1-2 Isentropic expansion in a turbine

  2-3 Constant pressure heat rejection in a condenser

  3-4 Isentropic compression in a pump

  4-1 Constant pressure heat addition in a boiler

- **Thermal Efficiency of Ideal Rankine Cycle:**

  Assumptions:

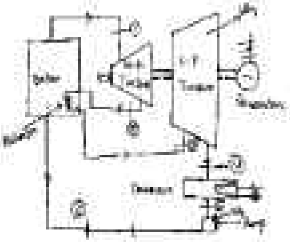
  1. Each device is steady flow device.
  2. All the processes are internally reversible.
  3. Changes in K.E. and P.E. are negligible.
  4. Complete cycle is a closed system.

  S.F.E.E for any device,

[illegible]

[illegible]

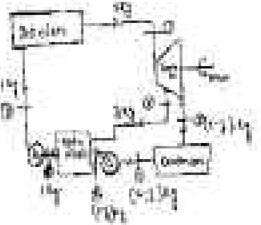
- [illegible]
- [illegible]

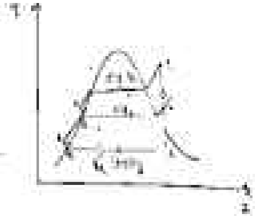


- [illegible]
- [illegible]
- [illegible]
- [illegible]
- Thermal efficiency

[illegible]

- [illegible]



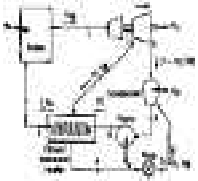


- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

- [illegible]
- [illegible]

Regenerative cycle with closed feedwater heater

- [illegible]
- [illegible]
- [illegible]



- [illegible]
- [illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

THERMAL ENGINEERING - II

CH-5 (HEAT TRANSFER)

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

- [illegible]

[illegible]

1. Conduction

- [illegible]
- [illegible]
  1. [illegible]
  2. [illegible]
- [illegible]
- [illegible]
- [illegible]

2. Convection

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

Where [illegible]

[illegible]

[illegible]

[illegible]

Radiation heat transfer

Thermal radiation

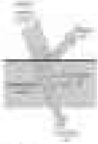
- [illegible]
- [illegible]
- [illegible]

[illegible]

[illegible]

Absorptivity, Reflectivity, and Transmissivity

- [illegible]
- [illegible]



- [illegible]

[illegible]

Note:

- [illegible]

[illegible]

- [illegible]
- [illegible]

[illegible]

Black body radiation

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

Emissive power

- [illegible]
- [illegible]
- [illegible]

[illegible]

[illegible]

[illegible]

Emissivity

- [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

Kirchoff's Law

- [illegible]

LECTURE NOTE

REFRIGERATION AND AIR CONDITIONING

SAMANTA CHANDRASHEKHAR INSTITUTE OF TECHNOLOGY AND MANAGEMENT, SEMILIGUDA,764 036

(LECTURER IN MECHANICAL ENGG. DEPT.)

JITENDRA KUMAR MUDULI

1.0 AIR REFRIGERATION CYCLE

1.1 Definition of Refrigeration:

[illegible]

Units of Refrigeration:

[illegible]

[illegible]

1.2 Definition of COP:

[illegible]

Refrigerating effect(R.E):

[illegible]

1.3 Principle of working of Open air system of refrigeration

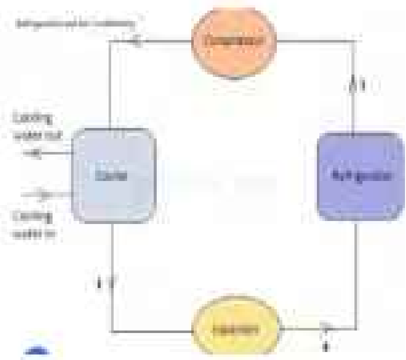
[illegible]

Principle of working of closed air system of refrigeration.

[illegible]

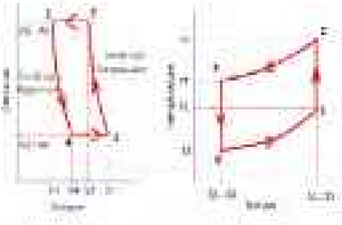
[illegible]

1.3.1 COP of Bell-Coleman cycle



[illegible]

Different process in Bell-Coleman refrigeration:



(a) P-V diagram (b) T-S diagram

[illegible]

1-2: [illegible]

[illegible]

2-3: Constant pressure cooling process

[illegible]

3-4: [illegible]

[illegible]

4-1: Constant pressure expansion

[illegible]

Equation of Coefficient of performance (COP) of Bell Coleman cycle:

[illegible]

[illegible]

[illegible]

[illegible]

$$C.O.P. = \frac{[illegible]}{[illegible]} = \frac{[illegible]}{[illegible]}$$

$$= \frac{[illegible]}{[illegible]}$$

$$C.O.P. = \frac{[illegible]}{[illegible]} \quad [illegible]$$

[illegible]

$$[illegible] \quad [illegible]$$

[illegible]

$$[illegible] \quad [illegible]$$

[illegible]

$$[illegible] = [illegible] \quad [illegible]$$

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Questions for exercise/assignment

Short questions

1. Define Tonne Of Refrigeration
2. Define Refrigerating effect
3. [illegible]

Long questions

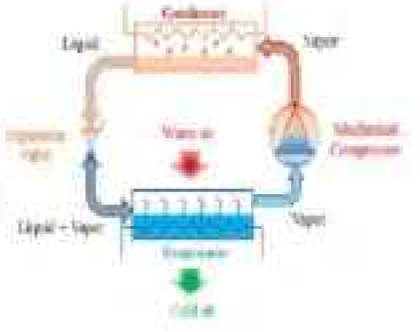
1. Derive the COP of [illegible] Cycle
2. [illegible]

References:

- [illegible]
- [illegible]

7.0 SIMPLE VAPOUR COMPRESSION REFRIGERATION SYSTEM

1.1 Schematic Diagram of simple vapour compression refrigeration system



2.2 Types of vapour compression refrigeration system are

7.2.1 Cycle with dry saturated vapour after compression

1. Compression process: [illegible]

[illegible]

[illegible]

2. Condensing process: [illegible]

3. Expansion process: [illegible]

Note:

[illegible]

[illegible]

[illegible]

4. Vaporising process: [illegible]

[illegible]

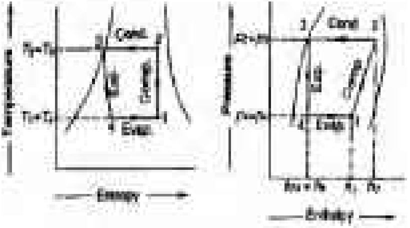
$$R_E = h_1 - h_4 = h_1 - h_{f3}$$

[illegible]

$COP = \text{Refrigerating effect} / \text{Work done} = (h_1 - h_4) / (h_2 - h_1)$

1.1.2 Cycle with wet vapour after compression.

[illegible]



(a) T-s diagram.

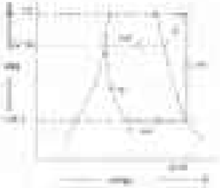
(b) p-h diagram.

[illegible]

[illegible]

$$COP = \frac{\text{refrigerating effect}}{\text{work done}} = \frac{h_1 - h_{f3}}{h_2 - h_1}$$

2.2.3 Cycle with superheated vapors after compression.



[illegible]

[illegible]

[illegible]

$$C.O.P = \frac{\text{refrigerating effect}}{\text{work done}} = \frac{h_1 - h_4}{h_2 - h_1}$$

2.2.4 Cycle with superheated vapour before compression.

Fig. 2.7 T-S diagram for Vapour Compression cycle with superheated vapour before compression

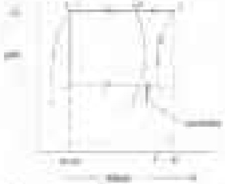


Fig. 2.8 P-h diagram for Vapour Compression cycle with superheated vapour before compression
In this cycle, the evaporation starts at state 4 and continues up to the point 1

$$C.O.P. = \frac{\text{Refrigerating effect}}{\text{work done}} = \frac{h_1 - h_4}{h_2 - h_1}$$

Cycle with sub-cooling of refrigerant.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Questions for exercise/assignment

Short questions

1. [illegible]
2. Draw T-s and P-h diagram of Cycle [illegible] of refrigerant.
3. Draw T-s and P-h diagram of Cycle [illegible] vapour after compression.

Long questions

1. [illegible] vapour after compression.
2. [illegible] COP [illegible] vapour [illegible]

REFERENCES

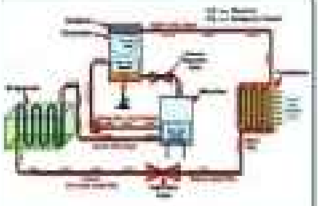
1. [illegible]
2. [illegible]

3.0 VAPOUR ABSORPTION REFRIGERATION SYSTEM

3.1 Simple vapour absorption refrigeration system

[illegible]

Working of Vapour Absorption Refrigeration System:



Working of Vapour Absorption Refrigeration System

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Components in Vapour Absorption Refrigeration System:

1. Evaporator

[illegible]

2. Absorbers

[illegible]

3. Pump

[illegible]

4. Generator

[illegible]

[illegible]

5. Analyser

[illegible]

6. Pressure Reducing Valve

[illegible]

7. Condenser

[illegible]

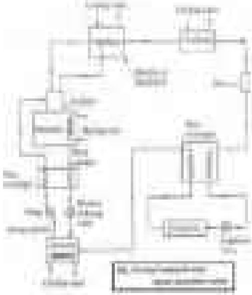
8. Expansion Valve

[illegible]

1.3 Practical vapour absorption refrigeration system

Construction :

- The vapour absorption system consists of a condenser, an expansion valve and an evaporator.
- They perform the same as they do in vapour compression method.
- In addition to these, this system has an absorber, a heat exchanger, an analyser and a rectifier.



[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

6.6 COP of ideal vapour absorption refrigeration system

If

The heat supplied to the generator = Q_G

The heat rejected by the condenser to the atmosphere = Q_C

The heat absorbed by the cold system in the evaporator = Q_E

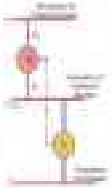
Then, from energy balance we have

$Q_C = Q_G + Q_E$

Where T_G = Temperature at which heat is given to the generator

T_C = Temperature at which heat is discharged to the atmosphere (by condenser)

T_E = Temperature at which heat is absorbed in the evaporator



[illegible]

[illegible]

Maximum COP of this system is expressed by

$(COP)_{max} = \frac{Q_E}{Q_G}$

[illegible]

The expression [illegible]

The expression [illegible]

So, the maximum COP [illegible]

$(COP)_{max} = (COP)_{[illegible]} \times$ [illegible]

Questions for practical assignment

Short questions

1. [illegible]
2. [illegible]

Long questions

1. [illegible]
2. [illegible]

REFERENCES

- [illegible]
- [illegible]

4. REFRIGERATION EQUIPMENTS

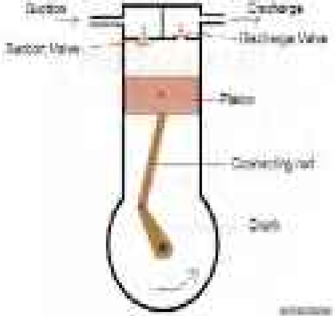
4.1 REFRIGERANT COMPRESSORS:

4.1.1 Principle of working and constructional details of reciprocating compressor:

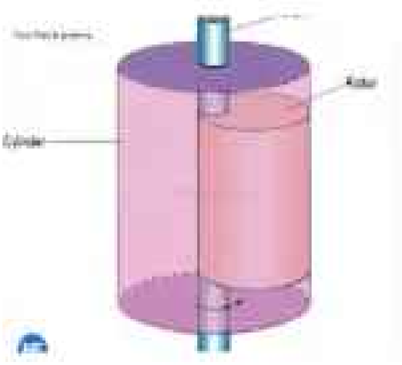
[illegible]

[illegible]

construction and working of reciprocating compressor



Principle of working and constructional details of Rotary compressor:


Rotor
Cylinder

[illegible]

[illegible]

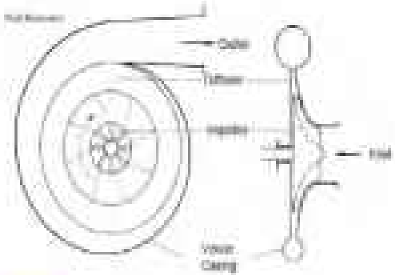
[illegible]

4.1.2 Centrifugal compressor

[illegible]

[illegible]

[illegible]



Centrifugal compressor schematic diagram

4.1 Important terms:

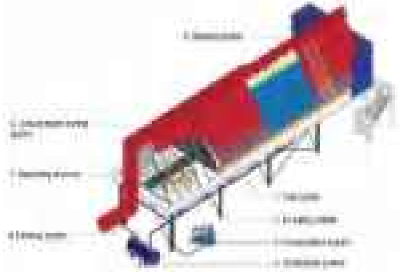
The following important terms are frequently used in air compressors.

- **Inlet Pressure:** [illegible]
- **Discharge Pressure:** [illegible]
- **Compression Ratio or Pressure Ratio:** [illegible]
- **Compressor capacity:** [illegible]
- **Free air delivery:** [illegible]
- **Swept volume:** [illegible]
- **Mean effective pressure:** [illegible]

4.2 CONDENSERS

4.2.1 Working principle and constructional details of air cooled condenser:

[illegible]

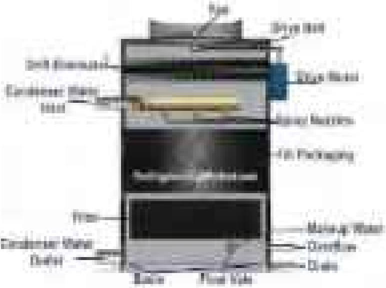


4.2.2 Heat rejection ratio(HRR)

4.2.3 Cooling tower and Spray ponds:

Cooling water:

[illegible]


Fan
Drive Belt
Drift Eliminators
Drive Motor
Condenser Water Inlet
Spray Nozzles
Fill Packaging
Frame
Make-up Water
Condenser Water Outlet
Overflow
Drain
Basin
Float Valve

Spray pond

[illegible]

[illegible]

4.3 EVAPORATORS

4.3.1 Principle of working and constructional details of an evaporator

[illegible]

Construction

[illegible]

Fig [illegible] Evaporator

Working of Evaporator

[illegible]

[illegible]

4.1.2 Type of evaporator based on construction

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]

1. Bare tube evaporator

[illegible]

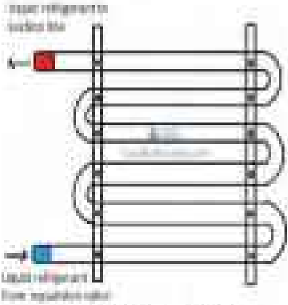


Fig. Bare tube evaporator

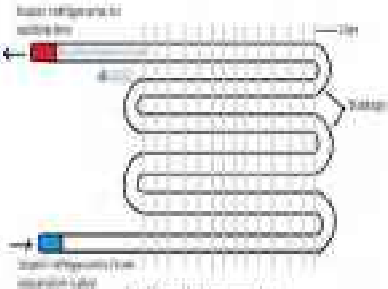
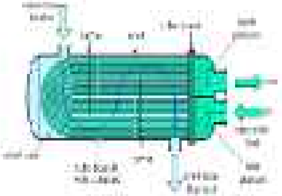


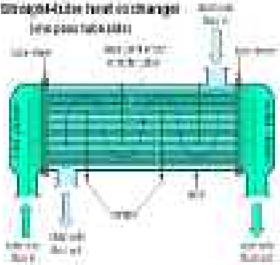
Fig. Finned tube evaporator

U-tube heat exchanger

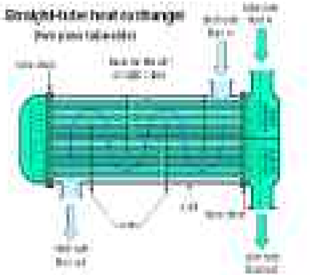


[illegible]

Straight-tube heat exchanger (one pass tube-side)



[illegible]


Straight-tube heat exchanger

Questions for external/assignment

Short questions

1. What is function of compressor
2. [illegible]
3. What is function of condenser
4. What is function of evaporator
5. What is function of [illegible]

Long questions

1. Briefly explain working of reciprocating air compressor
2. Briefly explain working of [illegible] compressor

REFERENCES

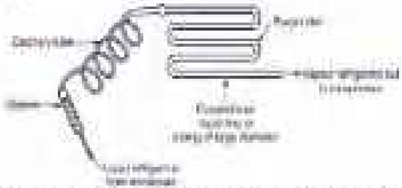
- [illegible]
- [illegible]
- [illegible]

5.0 REFRIGERANT FLOW CONTROLS, REFRIGERANTS & APPLICATION OF REFRIGERANTS

5.1 EXPANSION VALVES

5.1.1 Capillary Tube

[illegible]



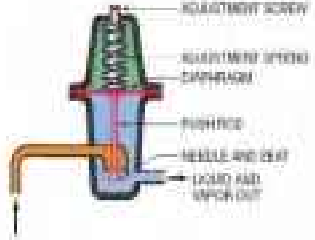
[illegible]

[illegible]

5.1.2 Automatic expansion valve

[illegible]

[illegible]

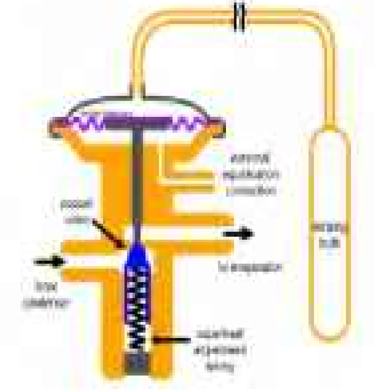


[illegible]

5.1.3 Thermostatic expansion valve

[illegible]

[illegible]



[illegible]

5.2 REFRIGERANTS

5.2.1 Classification of refrigerants

[illegible]

- Primary refrigerants
- Secondary refrigerants

- **Primary refrigerants**

  [illegible]

  e.g. Ammonia, [illegible]

[illegible]

(i) Halo-carbon compounds

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

(ii) Azeotropes

[illegible]

[illegible]

(iii) Hydrocarbons

[illegible]

- R50 – Methane (CH4)
- R170 – Ethane (C2H6)
- R290 – Propane (C3H8)

- [illegible]
- [illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

- **Secondary refrigerants**

[illegible]

5.2.2 Desirable properties :

[illegible]

5.2.3 Designation of refrigerant :

[illegible]

[illegible]

5.2.4 Thermodynamic Properties

(i) Low boiling point
(ii) Low freezing point
(iii) [illegible]
(iv) High critical temperature
(v) High latent heat of vaporization

5.2.5 Chemical Properties

(i) [illegible]
(ii) Non-flammable and non-explosive
(iii) [illegible]
(iv) Chemical stability in reacting
(v) [illegible]

(c) Physical properties

(i) [illegible]
(ii) [illegible]
(iii) High thermal conductivity
(iv) [illegible]
(v) High electrical insulation

5.2.6 Commonly used refrigerants

R-11, Trichloro-monofluoro methane(CCl3F): [illegible]

R-12, Dichloro-difluoro-methane(CCl2F2): [illegible]

R-22, Monochloro-difluoro-methane(CHClF2): [illegible]

R-134a, Tetrafluoro ethane(CF3CH2F): [illegible]

5.2.7 (Ammonia): [illegible]

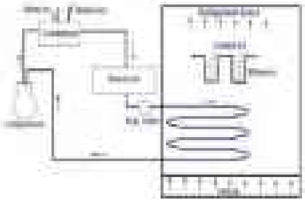
5.2.7 Substitute for CFC

- Substitutes for CFCs in aerosols: carbon dioxide
- Substitutes for CFCs in foam-blowing: water, carbon dioxide, hydrocarbons, HCFCs
- Substitutes for CFCs in refrigeration and air-conditioning: HCFCs, mainly hydrofluorocarbons (HFCs), hydrocarbons, and ammonia

5.3 Applications of refrigeration

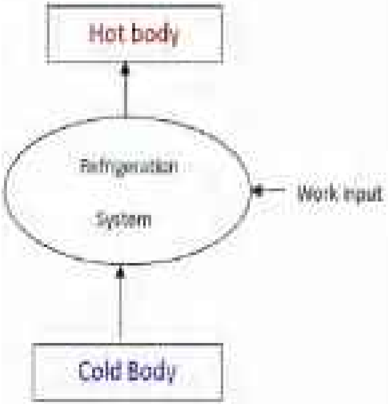
5.3.1 Cold storage:

Cold storage is a facility that primarily stores food items [illegible]



5.3.2 Dairy refrigeration:

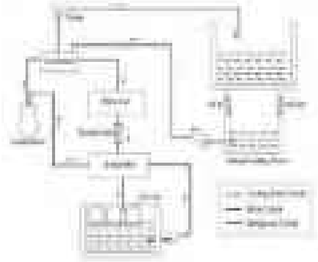
Storage of milk and milk products requires maintaining low temperatures in the cold storage [illegible]



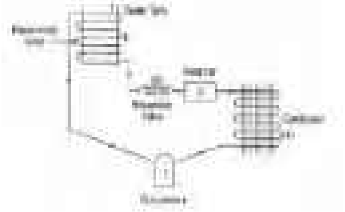
5.3.3 Ice plant:

[illegible]

- [illegible]
- [illegible]



5.1.4 Water cooler:



5.3.5 Frost free refrigerator:

[illegible]

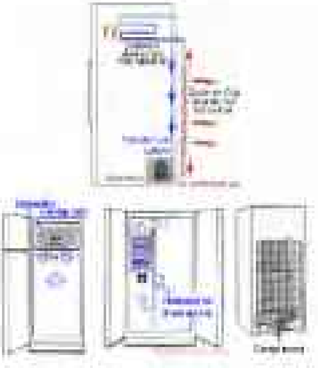
[illegible]

[illegible]

- [illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]



Questions for exercise/ assignment

Short questions

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]

Long questions

1. [illegible]
2. [illegible]

REFERENCES:

- https://www.linquip.com/blog/types-of-expansion-valve-guide/
- https://mech4engineering[illegible].blogspot.com/2015/02/classifications-of-refrigerant.html
- https://www.indiastudychannel.com/resources/14551-Construction-and-working-of-an-Ice-Plant
- https://www.engineeringenotes.com/electrical-engineering/electrical-appliances/water-cooler-parts-and-working-appliances-electrical-engineering/38526
- https://www.[illegible]/discover/journals/blogs/ecom/what-are-frost-free-refrigerators-and-how-do-they-work/

6.1 Psychrometrics terms

[illegible]

[illegible]

- dry bulb temperature
- wet bulb temperature
- relative humidity (rh)
- humidity ratio
- specific volume
- dew point temperature
- enthalpy

[illegible]

[illegible]

[illegible]

Wet Bulb Temperature - T_{wb}

[illegible]

[illegible]

[illegible]

[illegible]

Relative Humidity - RH

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Dew Point temperature - t_{dp}

[illegible]

[illegible]

Specific volume of moist air - v

[illegible]

Enthalpy - h

[illegible]

[illegible]

[illegible]

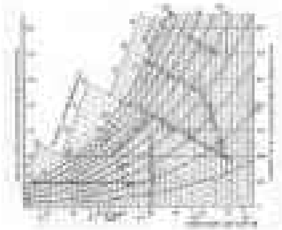
[illegible]

6.2 Adiabatic saturation of air by evaporation of water

[illegible]

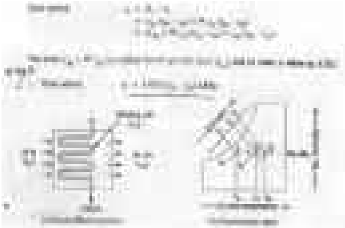
[illegible]

5.3 Psychrometric chart and uses



5.4 Psychrometric processes

5.4.1 Sensible cooling and heating



6.4.2 Cooling and Dehumidification

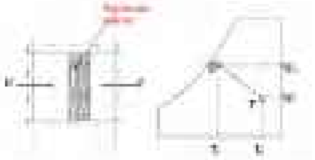
6.4.3 Heating and Humidification

6.4.4 Adiabatic cooling with humidification:

[illegible]

6.4.5 Total heating of a cooling process:

[illegible]



6.4.6 SHF(Sensible Heat Factor)

[illegible]

BPF(Bypass Factor)

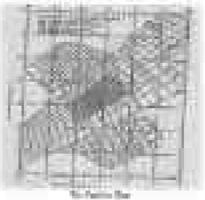
[illegible]

6.4.7 Adiabatic mixing

[illegible]

6.8 Effective temperature and comfort chart:

[illegible]



Effective temperature chart

Questions for exercise/assignment

Short questions

1. [illegible]
2. Define bypass factor
3. [illegible]
4. [illegible]
5. [illegible]

Long questions

1. [illegible]
2. [illegible]

REFERENCES:

- https://www.engineeringtoolbox.com/psychrometric-terms-d_230.html
- https://www.ques10.com/p/35752/what-is-an-effective-temperature-explain-briefly-1/#:~:text=Effective%20temperature%20that%14,velocity%20of%2021%20m%2Fmin.

7.0 AIR CONDITIONING SYSTEM

7.1 Factors affecting air conditioning system

a) Temperature

b) Humidity

c) Purity/cleanliness and

d) Air motion

a) Temperature

[illegible]

b) Humidity

[illegible]

c) Purity/Cleanliness

[illegible]

d) Air Motion

[illegible]

7.2 Equipment used in an air-conditioning

Following are the main equipments or parts used in an air conditioning system:

1. Circulation fan: The main function of this fan is to move air to and from the room.
2. Air conditioning unit: It is a unit which consists of cooling and dehumidifying processes for summer air conditioning or heating and humidification processes for winter air conditioning.
3. Supply duct: It directs the conditioned air from the circulating fan to the space to be air conditioned at the proper point.
4. Supply outlets: These are the grills, which distribute the conditioned air evenly in the room.
5. Return outlets: these are the openings in a room surface which allow the room air to enter the return duct.
6. Filters: the main function of the filters is to remove dust, dirt and other harmful bacteria from the air.

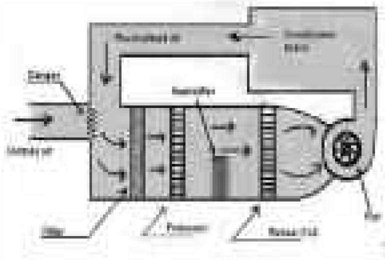
7.3 Classification of air-conditioning system

Following are the types of air conditioning system:

1. Winter air conditioning system.
2. Summer air conditioning system.

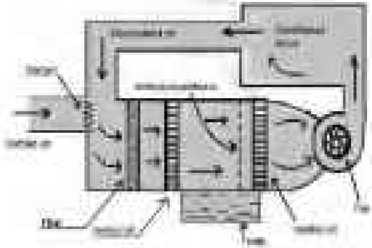
Winter Air Conditioning System

In winter air conditioning system, the air is heated, which is generally followed by humidification.
Schematic for the system is shown in [illegible]



WINTER AIR CONDITIONING SYSTEM

2.Summer Air Conditioning System



SUMMER AIR CONDITIONING SYSTEM

Questions for exercise/assignment

Short questions

1. What is function of humidifier
2. What is the function of dehumidifier

Long questions

1. Briefly explain working of Winter air conditioning with neat diagram.
2. Briefly explain working of Summer air conditioning with neat diagram.

REFERENCES:

- https://www.engineeringenotes.com/mechanical-engineering/air-conditioning/air-conditioning-definition-factors-and-types-mechanical-engineering/[illegible]
- https://www.theengineerspost.com/types-of-air-conditioning-system/

LECTURE NOTES ON

INDUSTRIAL ENGINEERING & MANAGEMENT

SAMANTA CHANDRASHEKHAR INSTITUTE OF TECHNOLOGY AND MANAGEMENT, SEMILIGUDA,764 036

(LECTURER IN MECHANICAL ENGG. DEPT)

JITENDRA KUMAR MUDULI

CONTENT

9. [illegible]
   - [illegible]
10. [illegible]
   - [illegible]
11. [illegible]
12. [illegible]
13. [illegible]
14. [illegible]
15. [illegible]
16. [illegible]

Plant layout

[illegible]

Objectives of plant layout

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

Principles of plant layout

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]

APPLICATIONS

[illegible]

1. [illegible]

i) [illegible]

ii) [illegible]

iii) [illegible]

2. Production and Facilities Planning

i) [illegible]

ii) [illegible]

iii) [illegible]

iv) [illegible]

v) [illegible]

vi) [illegible]

vii) [illegible]

3. [illegible]

i) [illegible]

ii) [illegible]

4. Marketing

i) [illegible]

ii) [illegible]

iii) [illegible]

iv) [illegible]

v) [illegible]

5. [illegible]

i) [illegible]

ii) [illegible]

iii) [illegible]

iv) [illegible]

6. Finance

i) [illegible]

ii) [illegible]

iii) [illegible]

iv) [illegible]

7. Research and Development

i) [illegible]

ii) [illegible]

iii) [illegible]

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[illegible]

[illegible] programming

[illegible]

[illegible] programming

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[illegible] LPP [illegible]

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Step 1 [illegible]

Step 2 [illegible]

Step 3 [illegible]

Step 4 [illegible]

Step 5 [illegible]

Step 6 [illegible]

[illegible]

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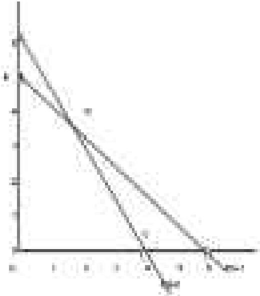

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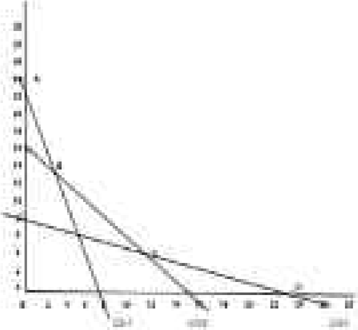

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1. [illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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ACTIVITY	PREDECESSOR	DURATION
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
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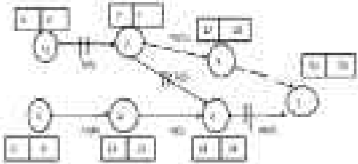

EVENT	ACTIVITY	DURATION	EST	LST	EFT	LFT	TOTAL FLOAT
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]

[illegible]

ACTIVITY	DURATION IN WEEKS	PREDECESSOR
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
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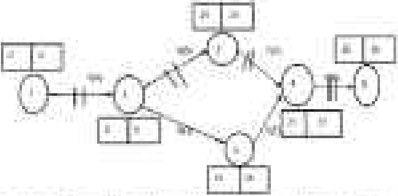

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

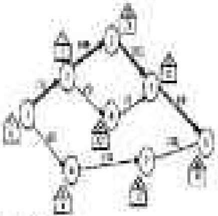
[illegible] [illegible]

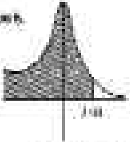
Job	1-2	1-6	2-3	2-4	3-5	4-5	6-7	5-8	7-8
t_0 (days)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
t_m (days)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
t_p (days)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Solution. [illegible]

Activity	$t_e = \frac{t_0 + 4t_m + t_p}{6}$	$\sigma^2 = \left(\frac{t_p - t_0}{6}\right)^2$
1-2	[illegible]	[illegible]
1-6	[illegible]	[illegible]
2-3	[illegible]	[illegible]
2-4	[illegible]	[illegible]
3-5	[illegible]	[illegible]
4-5	[illegible]	[illegible]
6-7	[illegible]	[illegible]
5-8	[illegible]	[illegible]
7-8	[illegible]	[illegible]





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[illegible]

a) [illegible]
b) [illegible]
c) [illegible]
d) [illegible]
e) [illegible]

[illegible]

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- [illegible]
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- [illegible]

EOQ

- [illegible]

Economic order quantity

- [illegible]
- [illegible]

Demand

[illegible]

- [illegible]

Lead time

[illegible]

Order cycle

[illegible]

[illegible]

[illegible]

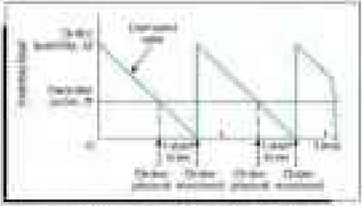
[illegible]

[illegible]

Buffer stock

[illegible]

[illegible]



[illegible]

Given that:

Annual usage [illegible] units

[illegible]

Ans: Given:

[illegible]

Average annual demand = [illegible] units

Inventory carrying cost = [illegible]

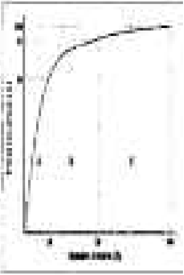
Cost of placing an order = [illegible]

[illegible]

Ans: Given:

[illegible]

[illegible]



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    (a) [illegible]
    (b) [illegible]
    (c) [illegible]

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[illegible] [illegible]

[illegible]

Statistical Quality Control

[illegible]

Control Charts

[illegible]

X-Chart

[illegible]

R-Chart

[illegible]

Advantages of control chart

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
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6. [illegible]
7. [illegible]
8. [illegible]

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Advantages Just in Time Systems

Disadvantages

- [illegible]

Myths about Six Sigma

There are several myths and misunderstandings surrounding Six Sigma. Some of them are given below:

- Six Sigma is only concerned with reducing defects.
- Six Sigma is a process for production or engineering.
- Six Sigma cannot be applied to engineering activities.
- Six Sigma uses difficult-to-understand statistics.
- Six Sigma is just training.

Benefits of Six Sigma

Six Sigma offers six major benefits that attract companies:

- Generates sustained success
- Sets a performance goal for everyone
- Enhances value to customers
- Accelerates the rate of improvement
- Promotes learning and cross-pollination
- Executes strategic change

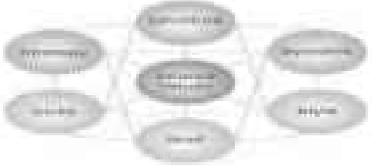
7-S

The 7-S model involves seven interdependent factors which are categorized as either "hard" or "soft" elements.

- "Hard" elements are easier to define or identify and management can directly influence them: These are strategy statements; organization charts and reporting lines; and formal processes and IT systems.
- "Soft" elements, on the other hand, can be more difficult to describe, and are less tangible and more influenced by culture. However, these soft elements are as important as the hard elements if the organization is going to be successful.

Hard Elements	Soft Elements
	Shared Values
Strategy	Skills
Structure	Style
Systems	Staff

The way the model is presented in Figure 1 below depicts the interdependency of the elements and indicates how a change in one affects all the others.



LECTURE NOTES ON

THERMAL ENGINEERING -I

SAMANTA CHANDRASHEKHAR INSTITUTE OF TECHNOLOGY AND MANAGEMENT,

SEMILIGUDA,764 036

(LECTURER IN MECHANICAL ENGG. DEPT)

JITENDRA KUMAR MUDULI

CONTENTS

THERMAL ENGINEERING

THERMODYNAMIC CONCEPT AND TERMINOLOGY

Thermodynamic Concepts

Thermal Engineering

- [illegible]
- [illegible]
- [illegible]

Thermodynamics

- [illegible]
- [illegible]
- [illegible]

Thermodynamic system

- [illegible]
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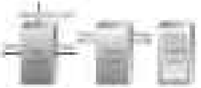
- [illegible]
- There are three classes of systems:
  1. Open system
  2. Closed system
  3. Isolated system



- **Open System**
  - [illegible]
  - [illegible]
- **Closed System**

i. [illegible]
ii. [illegible]

[illegible]

i. [illegible]
ii. [illegible]

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  - [illegible]
  - [illegible]
- [illegible]
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Unit

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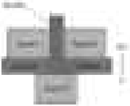

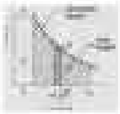

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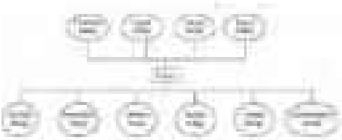


WORK AND HEAT

Work

[illegible]

Heat

[illegible]

Specific Heat and Heat Capacity

[illegible]

Displacement Work for Various Quasi-Static Processes

[illegible]

$$[illegible]$$

[illegible]

$$[illegible]$$

[illegible]

$$[illegible]$$

[illegible]

$$[illegible]$$

[illegible]

$$[illegible]$$

LAWS OF THERMODYNAMICS

Zeroth Law of Thermodynamics

First law of Thermodynamics

[illegible]

- [illegible]
  - [illegible]
  - [illegible]

[illegible]

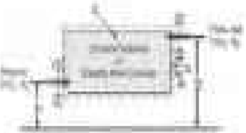
$$\Sigma W_{cycle} = \Sigma Q_{cycle}$$

$$\oint dW = \oint dQ$$

- [illegible]

Limitations of First law of Thermodynamics

Applications of First law of thermodynamics



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[illegible]

Second Law of Thermodynamics

Kelvin-Planck Statement

Clausius Statement

Application of Second Law

Heat engine

[illegible]

Thermal Efficiency [illegible]

[illegible]

Refrigerator

[illegible]

Coefficient of Performance of Refrigerator (COP)

[illegible]

Heat Pump

[illegible]

COP of Heat Pump

[illegible]

PROPERTIES, PROCESSES OF PERFECT GAS

Laws of Perfect Gas

Boyle's Law

Charle's Law

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[illegible]

[illegible]

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Specific Heats of Ideal Gas

Specific Heat at Constant Volume

- [illegible]
- [illegible]
- [illegible]

[illegible]

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3.2.1 Specific Heat at Constant Pressure

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Relation between specific heats

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Therefore [illegible]

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Enthalpy of a Gas

[illegible]

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[illegible]

Therefore [illegible]

[illegible]

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[illegible]

[illegible]

Application of 1st Law of Thermodynamics to Non Flow Process

[illegible]

1) [illegible]

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3. [illegible]
4. [illegible]
5. [illegible]

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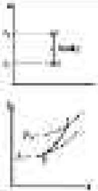
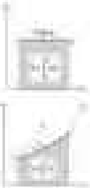
[illegible]		Property Relation	[illegible]
		Work done	[illegible]
		Heat Transferred	[illegible]
		Change in Enthalpy	[illegible]
		Change in Internal Energy	[illegible]
[illegible]		Property Relation	[illegible]
		Work done	[illegible]
		Heat Transferred	[illegible]
		Change in Enthalpy	[illegible]
		Change in Internal Energy	[illegible]
[illegible]		Property Relation	[illegible]
		Work done	[illegible]

Non Flow Process	p-V, T-s diagram	Relations	
		Heat Transferred	[illegible]
		Change in Enthalpy	[illegible]
		Change in Internal Energy	[illegible]
Isentropic Process		Property Relations	[illegible]
		Work done	[illegible]
		Heat Transferred	[illegible]
		Change in Enthalpy	[illegible]
		Change in Internal Energy	[illegible]
Polytropic Process		Property Relations	[illegible]
		Work done	[illegible]
		Heat Transferred	
		Change in Enthalpy	[illegible]
		Change in Internal Energy	[illegible]

INTERNAL COMBUSTION ENGINES

Explain and Classify IC Engines

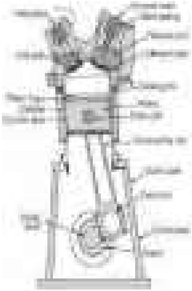
[illegible]

Classification

According to the number of strokes in the working cycle

1. Four stroke engine
2. Two stroke engine

According to the fuel used in the engine



1. Petrol engine
2. Diesel engine
3. Gas engine
4. Multi fuel engine

According to the method of ignition

1. Spark ignition
2. Compression ignition

According to the fuel feeding system

1. Carburetor engine
2. Engine with fuel injection

According to the arrangement of cylinders

1. [illegible]
2. [illegible]

According to the cooling system

1. Air cooled engine
2. Water cooled engine

According to the number of cylinders

1. Single cylinder engine
2. Multi cylinder engine

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

Terminology

[illegible]

- [illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

- [illegible]

[illegible]

- [illegible]
- [illegible]

[illegible]

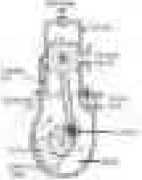
[illegible]

- [illegible]
- [illegible]

Crank Shaft

Working Principle of SI and CI Engines

Two Stroke Petrol Engine



- [illegible]
- [illegible]
- [illegible]
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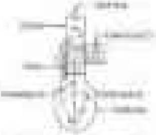
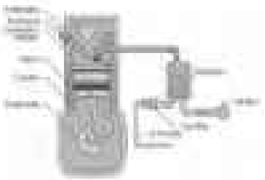
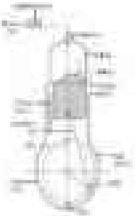


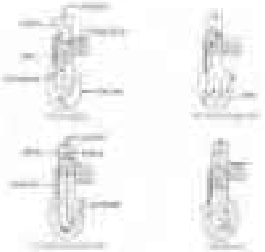
[illegible]

[illegible]

Four-Stroke Cycle Petrol Engine







[illegible]

FUEL AND COMBUSTION

Define Fuel

[illegible]

Types of Fuel

Coal

[illegible]

1. **Peat**

[illegible]

2. **Lignite**

[illegible]

3. **Bituminous Coal**

[illegible]

- [illegible]
- [illegible]

Liquid Fuels

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

Gaseous Fuel

1. LPG
   - [illegible]
   - [illegible]
   - [illegible]
   - [illegible]
2. **Natural Gas**
   - [illegible]
   - [illegible]
3. **Coal Gas**
   - [illegible]
   - [illegible]
   - [illegible]
   - [illegible]
4. **Producer Gas**

- [illegible]
- [illegible]
- [illegible]

ii. **Water Gas**

- [illegible]
- [illegible]
- [illegible]

iii. **Coke Oven Gas**

- [illegible]
- [illegible]
- [illegible]
- [illegible]

Heating Values of Fuel

- [illegible]
- [illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]
  i. [illegible]
  ii. [illegible]

Higher and Lower Calorific Value of Fuel

- [illegible]
- [illegible]
- [illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

Where,

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

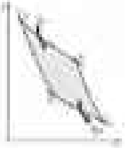
[illegible]

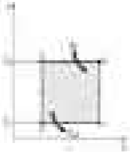
[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

GAS POWER CYCLES

Carnot Cycle

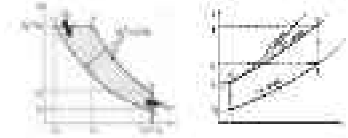




- Process 1-2 [illegible]
- Process 2-3 [illegible]
- Process 3-4 [illegible]
- Process 4-1 [illegible]

[illegible]

Diesel Cycle



- [illegible]
- [illegible]
- [illegible]
- [illegible]
    - i. **Process 1-2** Isentropic Compression
    - ii. **Process 2-3** Reversible constant pressure heat addition
    - iii. **Process 3-4** Isentropic Expansion
    - iv. **Process 4-1** Reversible constant volume heat rejection

Analysis

[illegible]

Heat supplied

$$q_{in} = h_3 - h_2 = c_p(T_3 - T_2)$$

Heat rejected

$$q_{out} = u_4 - u_1 = c_v(T_4 - T_1)$$

[illegible]

$$w_{net} = q_{in} - q_{out}$$
$$= c_p(T_3 - T_2) - c_v(T_4 - T_1)$$

[illegible]

$$\eta_{th} = \frac{w_{net}}{q_{in}}$$

Dual Cycle

Analysis

Heat supplied

$$q_s = c_v(T_3 - T_2) + c_p(T_4 - T_3)$$

Heat rejected

$$q_r = c_v(T_5 - T_1)$$

[illegible]

[illegible]

- [illegible]
- [illegible]

[illegible]