Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY

COURSE PLAN

Academic Year 2019-20

Program:	B E – Mechanical Engineering
Semester :	4
Course Code:	18ME42
Course Title:	Applied Thermodynamics
Credit / L-T-P:	4 / 3-2-0
Total Contact Hours:	50
Course Plan Author:	B.M.Krishne Gowda

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18ME42: Applied Thermodynamics

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	ME
Year / Semester :	2020/IV	Academic Year:	2019-20
Course Title:	Applied Thermodynamics	Course Code:	18ME42
Credit / L-T-P:	4/3-2-0	SEE Duration:	180 Minutes
Total Contact Hours:	50	SEE Marks:	60 Marks
CIA Marks:	40	Assignment	1 / Module
Course Plan Author:	B.M.Krishne Gowda	Sign	Dt:
Checked By:		Sign	Dt:

2. Course Content

Module	Module Content	Teaching Hours	Module Concepts	Blooms Level
1	Gas Power Cycles: Air standard cycles; Carnot, Otto, Diesel, Dual and Stirling cycles, p-v and T -s diagrams, description, efficiencies and mean effective pressures. Comparis on of Otto and Diesel cycles. I.C.Engines: Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, heat balance, Morse test, IC Engine fuels, Ratings and Alternate Fuels.	10 Hours	Working principles. combustion Phenomenon	L3
2	Gas turbine (Brayton) cycle; description and analysis. Regenerative gas turbine cycle. Inter-cooling and reheating in gas turbine cycles. Jet propulsion: Introduction to the principles of jet propulsion. Turbojet, Ramjet, Turboprop and turbofan engines	10 Hours	Efficiency of gas turbines Principles of jet engines	L3
3	Vapour Power Cycles: Carnot vapour power cycle, drawbacks as a reference cycleSimple Rankine cycle; description, T-sdiagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles. Ideal and practical regenerative Rankine cycles, open and closed feed water heaters. Reheat Rankine cycle. Characteristics of an Ideal working fluid in Vapour power cycles, Binary Vapour cycles.	10 Hours	Efficiency of steam power plants Reheat and regenerative	L4
4	Refrigeration Cycles:	10 Hours	COP	L3

	Vapour compression refrigeration system; description, analysis,refrigerating effect. Capacity, power required, units ofrefrigeration, COP, Refrigerantsand their desirable properties, alternate Refrigerants. Any one case study on cold storage or industrial refrigerator. Air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle, Vapour absorption refrigeration system. Steam jet refrigeration. Pscychrometrics and Air-conditioning Systems: Properties of Atmospheric air, and Psychometric properties of Air, Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams. Cooling towers.		Cooling and heating loads	
5	Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, saving in work, Optimum intermediate pressure, Inter-cooling, Minimum work for compr ession. Steam nozzles: Flow of steam through nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Supersaturated flow	10 Hours	optimum intermediate pressure. Critical pressure ratio	L3

3. Course Material

#	Details	Available
1	Text books	
	1. Basic and Applied Thermodynamics” by P .K. Nag, Tata McGraw Hill, 2nd Edi. 2009	In Lib
	2.Fundamentals of Thermodynamics by G.J. Van Wylenand R.E. Sonntag, Wiley Eastern. Fourth edition 1993.	In Lib
2	Reference books	
	1.Thermodynamics for engineers, Kenneth A. Kroos and Merle C. Potter, Cengage Learning, 2016	In dept
	2.Principles of Engineering Thermodynamics, Michael J,Moran, Howard N. Shapiro, Wiley, 8 th Edition	In Lib
	3.An Introduction to Thermo Dynamics by Y.V.C.Rao, Wiley Eastern Ltd, 2003.	In Lib
	5.I.C Engines by Ganeshan.V. Tata McGraw Hill, 4rth Edi. 2012.	In Lib
	6.I.C.Engines by M.L.Mathur & Sharma. Dhanpat Rai&	
3	Others (Web, Video, Simulation, Notes etc.)	Not Available

4. Course Prerequisites

SNo	Course Code	Course Name	Module / Topic / Description	Sem	Remarks	Blooms Level
1	15ME33	Basics of	1. Knowledge on basic laws and	3		L3

		thermodynamics	thermodynamic process			
2	15ME34	Fluid mechanics	Working principles of turbines , and compressors.	4		L3

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

B. OBE PARAMETERS

1. Course Outcomes

#	COs	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
17ME43.1	Apply thermodynamic concepts to analyze the performance of gas power cycles.	10Hrs	Working principles	Chalk and Board	Assignment and viva	L3
17ME43.2	Apply thermodynamic concepts to analyze the performance of vapour power cycles	10 Hrs	Efficiency of gas turbines.	Chalk and Board	Assignment and viva	L3
17ME43.3	Understand combustion of fuels and performance of I C engines.	10 Hrs	combustion Phenomenon	Chalk and Board	Assignment and Test	L2
17ME43.4	Understand the principles and applications of refrigeration systems	10 Hrs	Energy Dissipation	Chalk and Board	Assignment and Test	L3
17ME43.5	Apply Thermodynamic concepts to determine performance parameters of refrigeration and airconditioning systems.	5Hrs	Efficiency of steam power plants	Chalk and Board	Assignment and Test	L3
17ME43.6	Understand the working principle of Air compressors and Steam nozzles, applications, relevance of air and identify methods for performance improvement.	5Hrs	Reheat and regenerative	Chalk and Board	Assignment and Test	L3

Note: Identify a max of 2 Concepts per Module. Write 1 CO per concept.

2. Course Applications

SNo	Application Area	CO	Level
1	Applications In Internal combustion engines	CO1	L3
2	In research and development organizations (G.T.R.E) gas turbine engine.	CO2	L3
3	Application can be seen in heating devices, I.c engines, Rocket propulsion system.	CO3	L3

4	Road vehicles , Air craft, Motorboats and small machines.	CO4	L3
5	In steam power plants for electricity generation	CO5	L3
6	Application in Nuclear power plants.	CO6	L3
7	Applications In Domestic , commercial and marine Refrigeration system.	CO7	L3
8	Application in heating, ventilating, and cooling	CO8	L3
9	In industry, including natural gas processing and delivery, chemical plants, and oil refineries.	CO9	L2
10	In Steam turbine plants.	CO10	L3

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO – PO MAPPING)

-	Course Outcomes	Program Outcomes												
#	COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Level
18ME43.1	Apply thermodynamic concepts to analyze the performance of gas power cycles.	√	√	√	-	-	-	-	-	-	-	-	-	L2
18ME43.2	Apply thermodynamic concepts to analyze the performance of vapour power cycles.	√	√	√	-	-	-	-	-	-	-	-	-	L2
18ME43.3	Understand combustion of fuels and performance of I C engines.	√	√	√	-	-	-	-	-	-	-	-	-	L3
18ME43.4	Understand the principles and applications of refrigeration systems	√	√	√	-	-	-	-	-	-	-	-	-	L3
18ME43.5	Apply Thermodynamic concepts to determine performance parameters of refrigeration and airconditioning systems	√	√	√	-	-	-	-	-	-	-	-	-	L3
18ME43.5	Understand the working principle of Air compressors and Steam nozzles, applications, relevance of air and identify methods for performance improvement.	√	√	√	-	-	-	-	-	-	-	-	-	L3

Note: Mention the mapping strength as 1, 2, or 3

4. Mapping Justification

Mapping		Justification	Mapping Level
CO	**PO**		Level
CO1	PO1	The knowledge of air standard cycles is required for the solution of problems.	L2
CO1	PO2	Anlysing problems of actual I.C Engines using gas power cycles	L2
CO2	PO1	The knowledge of principles of Gas turbines is required for the solution of problems.	L3
CO2	PO2	Anlysing problems of Gas turbine for different process.	L3
CO3	PO1	The knowledge of different prtocess is required for the solution of problems.	L2
CO3	PO2	Anlysing the phenomena of combustion using bacis process	L2
CO4	PO1	The knowledge of basic concepts is required for solution ptoblems	L3
CO4	PO2	Anlysing problems of I.c engines efficiency using performance parameters..	L3
CO5	PO1	The knowledge of working principle of vapour cycles is needed for solution problems of steam power plants	L3
CO5	PO2	Anlysing the efficiency of steam power plants using parameters	L3
CO6	PO1	The knowledge of work done and efficiency of modified Rankine cycle required for the solution of problems.	L3
CO6	PO2	Analysis of problems of steam power plants using modified Rankine cycle	L3

Note: Write justification for each CO-PO mapping.

C. COURSE ASSESSMENT

1. Course Coverage

Module #	Title	Teaching Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Gas Power Cycles & Gas turbine (Brayton)	10	2	-	-	1	1	2	CO1, CO2	L2, L3
2	Combustion Thermodynamics & I.C.Engines:	10	2	-	-	1	1	2	CO3, CO4	L2, L3
3	Va pour Power Cycles	10	-	2	-	1	1	2	CO5, CO6	L2, L3
4	Refrigeration Cycles & Pscychrometrics and Air-conditioning Systems.	10	-	2	2	1	1	2	CO7, C08	L3, L3
5	Reciprocating Compressors & Steam nozzles	10	-	-	2	1	1	2	CO9, CO10	L3, L3
-	**Total**	**50**	**4**	**4**	**4**	**5**	**5**	**10**	**-**	**-**

Note: Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	30	CO1, CO2 CO3, CO4	L2, L4
CIA Exam – 2	30	CO5, CO6 CO7, CO8	L2, L3
CIA Exam – 3	30	CO9, CO10	L2, L3
Assignment - 1	10	CO1, CO2 CO3, CO4	L2, L3
Assignment - 2	10	CO5, CO6 CO7, CO8	L2, L3
Assignment - 3	10	CO9, CO10	L2, L3
Seminar - 1	-	-	-
Seminar - 2	-	-	-
Seminar - 3	-	-	-
	-	-	-
Other Activities – define – Slip test	-	-	-
Final CIA Marks	**40**	**-**	**-**

Note : Blooms Level in last column shall match with A.2 above.

D1. TEACHING PLAN - 1

Module - 1

Title:	Gas Power Cycles & I.C.Engines:	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms Level**
1	Apply thermodynamic concepts to analyze the performance of gas power cycles.	CO1	L3
2	Student should able to apply thermodynamic concepts to analyze the performance of gas turbine and propulsion systems.	CO2	L3
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Air standard cycles; Carnot, p-v and T -s diagrams	C01	L2
2	Otto, Diesel p-v and T -s diagrams	C01	L3
3	Dual and Stirling cycles, p-v and T -s diagrams	C01	L3
4	Efficiencies and mean effective pressures Comparis on of Otto and Diesel cycles.	C01	L3
5	problems	C01	L2
6	Gas turbine (Brayton)cycle	C02	L3
7	Regenerative gas turbine cycle	C02	L3
8	Inter-cooling and reheating in gas turbine cycles.	C02	L3
9	Jet propulsion: Introduction to the principles of jet propulsion	C02	L3
10	problems	C02	L3

c	**Application Areas**	**CO**	**Level**
1	Applications In Internal combustion engines.	CO1	L2
2	In research and development organizations (G.T.R.E) gas turbine engine.	CO2	L3
d	**Review Questions**	-	-
1	Define air standard cycles.	CO1	L2
2	Draw p-v and T -s diagrams for Carnot, otto and diesel	CO1	L2
3	Derive an expression of efficiency for carnot cycle	CO1	L2
4	Derive an expression of efficiency for Otto cycle	CO1	L2
5	Derive an expression of efficiency for Diesel cycle	CO1	L2
6	Derive an expression for mean effective pressure for Diesel cycle	CO1	L2
7	The stroke and cylinder diameters of a compression ignition engine are 250 mm and150 mm respectively. If the clearance volume is 0.0004 m3 and fuel injection takes place at constant pressure for 5 percent of the stroke determine the efficiency of the engine. Assume the engine working on the diesel cycle.	CO1	L3
8	Derive an expression for optimum pressure ratio which gives maximum specific work output in gas turbine considering machine efficiency.	CO2	L3
9	Explain the working of a ramjet engine with the help of a sketch. What are its advantages, disadvantages and applications?	CO2	L3
10	In ideal diesel cycle running at 2000rpm, has a compression ratio of 20 and uses air as theworking fluid. The state of air at the beginning of the compression process is 95kPa and20°C. If the maximum temperature in the cycle is not to exceed 2200K, Determine:i) Thermal efficiency; ii) Mean effective pressure; iii) Net work output per unit mass of air;iv) Specific air consumption in kg/s and Take density air = 1.225 kg/m3.	CO2	L3
11	A gas turbine plant works between the temperature limits of 300K and 1000K and a pressure of 1 bar and 16 bar. The compression is carried out in two stages with perfect intercooling in between. Calculate the net power of the plant, Cp = 1 kJ / kg.per kg of air circulation ; y = 1.4 for air.	CO2	L3
12	In a regenerative gas turbine cycle air enters the compressor at 1 bar, 15°C, pressure ratio 6.The isentropic efficiencies of compressor and turbine are 0.8 and 0.85 respectively. The maximumtemperature in the cycle is 800°C. The regenerator efficiency is 0.78. Assume Cp = 1.1 KJ/kgK, y = 1.32 for the combustion products find the cycle efficiency.	CO2	L3

Module – 2

Title:	Gas turbine (Brayton)& Jet proplusion	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms Level**
1	Understanding the components of energy transfer and find energy transfer and dor using velocity triangles.	CO3	L2
2	Perform the preliminary design of turbo machines (pumps, rotary compressors and turbines)	CO4	L3
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
17	Combustion Thermodynamics	CO3	L2

	Theoretical (Stoichiometric) air for combustion of fuels.Excess air, mass balance,		
18	Exhaust gas analysis, A/F ratio.Energy balance for a chemical reaction,	CO3	L3
19	Enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency.	CO3	L2
20	Dissociation and equilibrium, emissions.	CO3	L2
21	problems	CO3	L3
22	I.C.Engines: Classification of IC engines, Combustion of SI engine and CI engine	CO4	L3
23	Detonation and factors affecting detonation, Performance analysis of I.C Engines,, IC Engine fuels,	CO4	L3
24	Heat balance, Morse test	CO4	L3
25	Ratings and Alternate Fuels.	CO4	L3
26	problems	CO4	L3
c	**Application Areas**	**CO**	**Level**
1	In research and development organizations for predicting the parameters for analysis of actual turbines.	CO3	L2
2	In research and development organizations for predicting the parameters for analysis of actual fluid machines	CO4	L3
d	**Review Questions**	-	-
12	Explain i) Enthalpy of formation. ii)Enthalpy of combustion.	CO3	L2
13	Explain ii) Stoichiometric air. iv) Excess air and	CO4	L3
14	Explain Adiabatic flame temperature.	CO3	L2
15	The products of combustion of an unknown hydro carbon Cx1-ly have the following composition as measured by an orsat apparatus: CO2 = 8.0%, CO = 0.9%, 02 = 8.8%,N2 = 82.3%.Determine: The composition of the fuel. ii) The air/fuel ratio and iii) The percent excess air used	CO4	L3
16	Explain the with neat sketch orsat orsat operatus.	CO3	
17	Explain briefly Morse test.	CO4	L3
18	Explain the heat balance sheet.	CO4	L2
19	The following data were obtained on MORSE test of 4-cylinder four stroke SI enginecoupled to a hydraulic dynamometer operating at constant speed of 1500rpm, brake load with second cylinder not firing = 206N, brake load with third cylinder not firing =192N, brake load with fourth cylinder not firing = 200N. Brake power in kW is calculated using the equation BP = WN/42,300, where 'W' is brake load in Newton, N-speed of the engine in RPM. Calculate: i) Brake power; ii) Indicated power; iii) Mechanical efficiency.	CO4	L3
20	4 cylinder gasoline engine operates on a 4 stroke cycle. The base of each cylinder is 70mm and the stroke is 90mm. Clearance volume per cylinder is 70CC. At a speed of 3500 rpm, the fuel consumption is 20 kg/hr and torque developed is 150N-m. Calorific value of fuel is 42000 kJ/kg. IP of the engine is 72 kW. Calculate BP, BMEP, brake thermal efficiency, relative efficiency and ISFC.	CO4	L4

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	18ME42	Sem: IV	I	Marks:	30	Time:	75 minutes
Course:	APPLIED THERMODYNAMICS						

-	-	**Note: Answer any 2 full questions.**	**Marks**	**CO**	**Level**
1	a	Define air standard cycles.	2	CO1	L1
	b	Derive an expression of efficiency for carnot cycle	4	CO1	L2
	c	Derive an expression of efficiency for Otto cycle	4	CO1	L3
	d	The stroke and cylinder diameters of a compression ignition engine are 250 mm and150 mm respectively. If the clearance volume is 0.0004 m3 and fuel injection takes place at constant pressure for 5 percent of the stroke determine the efficiency of the engine. Assume the engine working on the diesel cycle.	5	CO1	L3
		OR			
2	a	Derive an expression for optimum pressure ratio which gives maximum specific work output in gas turbine considering machine efficiency.	5	CO2	L3
	b	A gas turbine plant works between the temperature limits of 300K and 1000K and a pressure of 1 bar and 16 bar. The compression is carried out in two stages with perfect intercooling in between. Calculate the net power of the plant, Cp = 1 kJ / kg.per kg of air circulation ; y = 1.4 for air.	5	CO2	L3
	c	In a regenerative gas turbine cycle air enters the compressor at 1 bar, 15°C, pressure ratio 6.The isentropic efficiencies of compressor and turbine are 0.8 and 0.85 respectively. The maximum temperature in the cycle is 800°C. The regenerator efficiency is 0.78. Assume Cp = 1.1 KJ/kgK, y = 1.32 for the combustion products find the cycle efficiency.	5	CO2	L3
					L2
3	a	Explain i) Enthalpy of formation.ii)Enthalpy of combustion ii) Stoichiometric air. iv) Excess air and	7	CO3	L3
	d	The products of combustion of an unknown hydro carbon Cx1-ly have the following composition as measured by an orsat apparatus: CO2 = 8.0%, CO = 0.9%, 02 = 8.8%,N2 = 82.3%.Determine: The composition of the fuel. ii) The air/fuel ratio and iii) The percent excess air used	8	CO3	L3
4	a	Explain briefly Morse test. Explain the heat balance sheet.	7	CO4	L2
	b	The following data were obtained on MORSE test of 4-cylinder four stroke SI engine coupled to a hydraulic dynamo meter operating at constant speed of 1500rpm, brake load with second cylinder not firing = 206N, brake load with third cylinder not firing =192N, brake load with fourth cylinder not firing = 200N. Brake power in kW is calculated using the equation BP = WN/42,300, where 'W' is brake load in Newton, N-speed of the engine in RPM. Calculate:	8	CO4	L3

		i) Brake power; ii) Indicated power; iii) Mechanical efficiency.			

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

model Assignment Questions							
Crs Code:	18ME42	Sem: IV	I	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	APPLIED THERMODYNAMICS						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Define air standard cycles.	5	CO1	L2
2		Draw p-v and T -s diagrams for Carnot, otto and diesel	5	CO2	L3
3		Derive an expression of efficiency for carnot cycle		CO2	L4
4		Derive an expression of efficiency for Otto cycle	5	CO1	L3
5		Derive an expression of efficiency for Diesel cycle	5	CO1	L2
6		Derive an expression for mean effective pressure for Diesel cycle	5	CO2	L3
7		The stroke and cylinder diameters of a compression ignition engine are 250 mm and150 mm respectively. If the clearance volume is 0.0004 m3 and fuel injection takes place at constant pressure for 5 percent of the stroke determine the efficiency of the engine. Assume the engine working on the diesel cycle.		CO2	L3
8		Derive an expression for optimum pressure ratio which gives maximum specific work output in gas turbine considering machine efficiency.	5	CO1	L3
9		Explain the working of a ramjet engine with the help of a sketch. What are its advantages, disadvantages and applications?	5	CO1	L2
10		In ideal diesel cycle running at 2000rpm, has a compression ratio of 20 and uses air as theworking fluid. The state of air at the beginning of the compression process is 95kPa and20°C. If the maximum temperature in the cycle is not to exceed 2200K, Determine:i) Thermal efficiency; ii) Mean effective pressure; iii) Net work output per unit mass of air;iv) Specific air consumption in kg/s and Take density air = 1.225 kg/m3.	5	CO2	L3
11		A gas turbine plant works between the temperature limits of 300K and 1000K and a pressure of 1 bar and 16 bar. The compression is carried out in two stages with perfect intercooling in between. Calculate the net power of the plant, Cp = 1 kJ / kg.per kg of air circulation ; y = 1.4 for air.		CO2	L3
12		In a regenerative gas turbine cycle air enters the compressor at 1 bar, 15°C, pressure ratio 6.The isentropic efficiencies of compressor and turbine are 0.8 and 0.85 respectively. The maximumtemperature in the cycle is 800°C. The regenerator efficiency is 0.78. Assume Cp = 1.1 KJ/kgK, y = 1.32 for the combustion products find the cycle efficiency.	5	CO3	L2
13		Define air standard cycles.	5	CO1	L3
14		Draw p-v and T -s diagrams for Carnot, otto and diesel	5	CO2	L3
15		Derive an expression of efficiency for carnot cycle		CO2	L3
16		Derive an expression of efficiency for Otto cycle	5	CO1	L2
17		Derive an expression of efficiency for Diesel cycle			L3
18		Derive an expression for mean effective pressure for Diesel	5	CO1	L2

		cycle			
19		The stroke and cylinder diameters of a compression ignition engine are 250 mm and150 mm respectively. If the clearance volume is 0.0004 m3 and fuel injection takes place at constant pressure for 5 percent of the stroke determine the efficiency of the engine. Assume the engine working on the diesel cycle.	5	CO2	L3
20		Derive an expression for optimum pressure ratio which gives maximum specific work output in gas turbine considering machine efficiency.		CO2	L2
21		Explain the working of a ramjet engine with the help of a sketch. What are its advantages, disadvantages and applications?	5	CO1	L3
22		In ideal diesel cycle running at 2000rpm, has a compression ratio of 20 and uses air as theworking fluid. The state of air at the beginning of the compression process is 95kPa and20°C. If the maximum temperature in the cycle is not to exceed 2200K, Determine:i) Thermal efficiency; ii) Mean effective pressure; iii) Net work output per unit mass of air;iv) Specific air consumption in kg/s and Take density air = 1.225 kg/m3.	5	CO1	L2
23		A gas turbine plant works between the temperature limits of 300K and 1000K and a pressure of 1 bar and 16 bar. The compression is carried out in two stages with perfect intercooling in between. Calculate the net power of the plant, Cp = 1 kJ / kg.per kg of air circulation ; y = 1.4 for air.	5	CO2	L3
24		In a regenerative gas turbine cycle air enters the compressor at 1 bar, 15°C, pressure ratio 6.The isentropic efficiencies of compressor and turbine are 0.8 and 0.85 respectively. The maximumtemperature in the cycle is 800°C. The regenerator efficiency is 0.78. Assume Cp = 1.1 KJ/kgK, y = 1.32 for the combustion products find the cycle efficiency.		CO2	L3
25		Define air standard cycles.	5	CO1	L3
26		Draw p-v and T -s diagrams for Carnot, otto and diesel	5	CO1	L2
27		Derive an expression of efficiency for carnot cycle	5	CO2	L3
28		Derive an expression of efficiency for Otto cycle		CO2	L2
29		Derive an expression of efficiency for Diesel cycle	5	CO1	L3
30		Derive an expression for mean effective pressure for Diesel cycle	5	CO1	L2
31		The stroke and cylinder diameters of a compression ignition engine are 250 mm and150 mm respectively. If the clearance volume is 0.0004 m3 and fuel injection takes place at constant pressure for 5 percent of the stroke determine the efficiency of the engine. Assume the engine working on the diesel cycle.	5	CO2	L3
32		Derive an expression for optimum pressure ratio which gives maximum specific work output in gas turbine considering machine efficiency.		CO2	L4
33		Explain the working of a ramjet engine with the help of a sketch. What are its advantages, disadvantages and applications?	5	CO1	L3
34		In ideal diesel cycle running at 2000rpm, has a compression ratio of 20 and uses air as theworking fluid. The state of air at the beginning of the compression process is 95kPa and20°C. If the maximum temperature in the cycle is not to exceed 2200K, Determine:i) Thermal efficiency; ii) Mean effective pressure; iii)	5	CO1	L2

		Net work output per unit mass of air;iv) Specific air consumption in kg/s and Take density air = 1.225 kg/m3.			
35		A gas turbine plant works between the temperature limits of 300K and 1000K and a pressure of 1 bar and 16 bar. The compression is carried out in two stages with perfect intercooling in between. Calculate the net power of the plant, Cp = 1 kJ / kg.per kg of air circulation ; y = 1.4 for air.	5	CO2	L3
36		In a regenerative gas turbine cycle air enters the compressor at 1 bar, 15°C, pressure ratio 6.The isentropic efficiencies of compressor and turbine are 0.8 and 0.85 respectively. The maximumtemperature in the cycle is 800°C. The regenerator efficiency is 0.78. Assume Cp = 1.1 KJ/kgK, y = 1.32 for the combustion products find the cycle efficiency.		CO2	L3
37		Define air standard cycles.	5	CO1	L3
38		Draw p-v and T -s diagrams for Carnot, otto and diesel	5	CO1	L2
39		Derive an expression of efficiency for carnot cycle	5	CO2	L3
40		Derive an expression of efficiency for Otto cycle		CO2	

D2. TEACHING PLAN - 2

Module – 3

Title:	Vapour Power Cycles:	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms Level**
1	Evaluate the performance of steam turbine components.	CO5	L3
2	Student should Understand the working principle of practical regenerative Rankine cycles, open and closed feed water heaters. Reheat Rankine cycle. , Binary Vapour cycles.	CO6	L3
b	***Course Schedule***		
Class No	**Module Content Covered**		**Level**
1	Vapour Power Cycles: Carnot vapour power cycle,	CO5	L3
2	Drawbacks as a reference cycleSimple Rankine cycle,T-sdiagram, analysis for performance.	CO5	L3
3	Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance.	CO5	L3
4	Actual vapour power cycles.	CO5	L3
5	problems	CO5	L3
6	open and closed feed water heaters.	CO6	L3
7	Ideal and practical regenerative Rankine cycles,	CO6	L3
8	Reheat Rankine cycle. Characteristics of an Ideal working fluid in Vapour power cycles,	CO6	L3
9	Binary Vapour cycles.	CO6	L3
10	Problems.	CO6	L3
c	**Application Areas**	**CO**	**Level**
1	Power generation in steam power plant	CO5	L3

2	Power generation in steam power plant	CO6	L3
d	**Review Questions**	-	-
1	Explain the Carnot vapour power cycle,	CO5	L3
2	Explain the Simple Rankine cycle,T-sdiagram, analysis for performance.	CO6	L3
	Explain the drawbacks also Effects of pressure and temperature on Rankine cycle performance.		
3	Explain the Comparison of Carnot and Rankine cycles.	CO5	L3
4	Explain the Actual vapour power cycles.	CO6	L3
5	Explain the Ideal regenerative Rankine cycles,	CO5	L3
	Explain the practical regenerative Rankine cycles,		
6	What is Reheat Rankine cycle explain	CO6	L3
7	What is Binary Vapour cycles.	CO5	L3
8	What are the Characteristics of an Ideal working fluid in Vapour power cycles,	CO6	L3
9	Sketch the flow diagram and the corresponding temperature-entropy diagram of a reheat vapour cycle and derive an expression for the reheat cycle efficiency. What are theadvantages gained by reheating the steam between stages	CO5	L3
10	steam power plant incorporates an ideal reheat cycle to improve the existing efficiency.Steam at 30 bar and 250 °C is supplied at high pressure turbine inlet and expands till it is dry saturated at 3 bar. Now the steam is taken to a reheater and its temperature is again increased to 250°C by constant pressure reheating process. The reheated steam expands in the low pressure turbine to a condenser pressure of 0.04 bar. Determine the cycle efficiency.	CO6	L3
11	40MW steam power plant working on Rankine cycle operates between boiler pressure of 4MPa and condenser pressure of 10KPa. The steam leaves the boiler and enters the turbine at 400°C. the isentropic efficiency of the steam turbine is 85% determine: i) The cycle efficiency ii) The quality of exhaust steam from turbine iii) Steam flow rate in kg/hr. consider pump work.		

Module – 4

Title:	Refrigeration Cycles & Pscychrometrics and Air-conditioning Systems:	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-		-	**Level**
1	Understand the principles and applications of refrigeration systems.	CO7	L2
2	performance improvement of air-conditioning processes using the principles of psychrometry. Evaluate cooling and heating loads in an air-conditioning system.	CO8	L3
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Refrigeration Cycles:Vapour compression refrigeration system;	CO7	
2	analysis,refrigerating effect. Capacity, power required, units of refrigeration, COP	CO7	

3	Refrigerantsand their desirable properties, alternate Refrigerants. Any one case study on cold storage or industrial refrigerator. Air cycle refrigeration;	CO7	
4	Reversed Carnot cycle, reversed Brayton cycle, Vapour absorption refrigeration system. Steam jet refrigeration.	CO8	
5	Problems.	CO8	
6	Pscychrometrics and Air-conditioning Systems: Properties of Atmospheric air,	CO8	
7	Psychometric properties of Air, Psychometric Chart, Analyzing Air-conditioning Processes;	CO8	
8	Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling	CO8	
9	Adiabatic mixing of two moist air streams. Cooling towers.	CO8	
10	Problems.	CO8	
c	**Application Areas**	**CO**	**Level**
1	Applications In Domestic , commercial and marine Refrigeration system.	CO7	L3
2	Application in heating, ventilating, and cooling	CO8	L3
d	**Review Questions**	-	-
1	With Neat sketch Explain the Vapour compression refrigeration system;	CO7	L1
2	What is refrigerating effect. Capacity, power required, units of refrigeration, COP	CO7	L3
3	What are their desirable properties Refrigerant explain,	CO8	L2
4	Draw the P-V and T-S diagram for reversed Brayton cycle,	CO7	L4
5	Derive COP for reversed Brayton cycle,		
6	With neat explain Steam jet refrigeration.	CO8	L2
7	A refrigeration system of 10.5 Tonnes capacity at a evaporator temperature of -12°C and acondenser temperature of 27°C is needed in a food storage locker. The refrigerant Ammoniais sub cooled by 6°C before entering the expansion valve. The vapour is 0.95 dry as it leavesthe evaporator coil. The compression in the compressor is of adiabatic type. Using P-H chart find i) Condition of vapour at the outlet of the compressor ii) Condition of vapour atentrance to evaporator iii) COP iv) Power required in kW Neglecting valve Throttling and clearance effect	CO8	L3
8	Define the following: i) DBT ii) Specific humidity iii) Relative humidity	CO8	L5
9	Show the following processes on Psychrometric chart. i) Sensible heating and cooling ii) Cooling and dehumidification iii) Adiabatic mixing of two streams iv) Heating and humidification.	CO8	L2
10	With a neat sketch, briefly describe a summer air conditioning system.	CO8	L3
11	Adiabatic mixing of two moist air streams. Cooling towers.	CO8	L3
12	It is required to design an air conditioning plant for a small office room for following winterconditions: Outdoor conditions: 14°C DBT and 10°C WBT, Required conditions = 20°CDBT and 60% RH, Amount of air circulation = 0.30 m3/min/person, Seating capacity of office = 60.The required condition is achieved first by heating and then by adiabatic humidifying.Determine the following:	CO8	L3

	i)Heatcapacity of the coil in kW and the surface temperature required if the by-pass factor of coil is 0.4 ii) The capacity of the humidifier using psychrometric chart.		

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	18ME42	Sem: IV	3	Marks:	30	Time:	75 minutes
Course:	APPLIED THERMODYNAMICS						

			Marks	CO	Level
		Note: Answer any 2 full questions.	**Marks**	**CO**	**Level**
1	a	Explain the practical regenerative Rankine cycles	7	CO7	L2
	b	steam power plant incorporates an ideal reheat cycle to improve the existing efficiency.Steam at 30 bar and 250 °C is supplied at high pressure turbine inlet and expands till it is dry saturated at 3 bar. Now the steam is taken to a reheater and its temperature is again increased to 250°C by constant pressure reheating process. The reheated steam expands in the low pressure turbine to a condenser pressure of 0.04 bar. Determine the cycle efficiency.	8	CO7	L3
		OR			
2	a	What is Reheat Rankine cycle explain	7	CO7	L3
	b	40MW steam power plant working on Rankine cycle operates between boiler pressure of 4MPa and condenser pressure of 10KPa. The steam leaves the boiler and enters the turbine at 400°C. the isentropic efficiency of the steam turbine is 85% determine: i) The cycle efficiency ii) The quality of exhaust steam from turbine iii) Steam flow rate in kg/hr. consider pump work.	8	CO7	L3
3	a	Derive COP for reversed Brayton cycle,	7	CO8	L3
	d	A refrigeration system of 10.5 Tonnes capacity at a evaporator temperature of -12°C and acondenser temperature of 27°C is needed in a food storage locker. The refrigerant Ammoniais sub cooled by 6°C before entering the expansion valve. The vapour is 0.95 dry as it leavesthe evaporator coil. The compression in the compressor is of adiabatic type. Using P-H chart find i) Condition of vapour at the outlet of the compressor ii) Condition of vapour atentrance to evaporator iii) COP iv) Power required in kW Neglecting valve Throttling and clearance effect	8	CO8	L3
		OR			
4	a	Show the following processes on Psychrometric chart. i) Sensible heating and cooling ii) Cooling and dehumidification iii) Adiabatic mixing of two streams iv) Heating and humidification.	7	CO8	L3
	b	With a neat sketch, briefly describe a summer air conditioning system. Explain Adiabatic mixing of two moist air streams. Cooling towers.	8	CO8	L3

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	18ME42	Sem: IV	3	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	APPLIED THERMODYNAMICS						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Explain the Carnot vapour power cycle,	5	CO5	L3
2		Explain the Simple Rankine cycle,T-sdiagram, analysis for performance.	5	CO5	L3
3		Explain the drawbacks also Effects of pressure and temperature on Rankine cycle performance.	5	CO5	L3
4		Explain the Comparison of Carnot and Rankine cycles.	5	CO5	L3
5		Explain the Actual vapour power cycles.	5	CO6	L3
6		Explain the Ideal regenerative Rankine cycles,	5	CO6	L3
7		Explain the practical regenerative Rankine cycles,	5	CO5	L3
8		What is Reheat Rankine cycle explain	5	CO6	L3
9		What is Binary Vapour cycles.	5	CO5	L3
10		What are the Characteristics of an Ideal working fluid in Vapour power cycles,	5	CO6	L3
11		Sketch the flow diagram and the corresponding temperature-entropy diagram of a reheat vapour cycle and derive an expression for the reheat cycle efficiency. What are theadvantages gained by reheating the steam between stages	5	CO7	L3
12		steam power plant incorporates an ideal reheat cycle to improve the existing efficiency.Steam at 30 bar and 250 °C is supplied at high pressure turbine inlet and expands till it is dry saturated at 3 bar. Now the steam is taken to a reheater and its temperature is again increased to 250°C by constant pressure reheating process. The reheated steam expands in the low pressure turbine to a condenser pressure of 0.04 bar. Determine the cycle efficiency.	5	CO7	L3
13		40MW steam power plant working on Rankine cycle operates between boiler pressure of 4MPa and condenser pressure of 10KPa. The steam leaves the boiler and enters the turbine at 400°C. the isentropic efficiency of the steam turbine is 85% determine: i) The cycle efficiency ii) The quality of exhaust steam from turbine iii) Steam flow rate in kg/hr. consider pump work.	5	CO8	L3
14		With Neat sketch Explain the Vapour compression refrigeration system;	5	CO7	L3
15		What is refrigerating effect. Capacity, power required, units of refrigeration, COP	5	CO8	L2
16		What are their desirable properties Refrigerant explain,	5	CO8	L5
17		Draw the P-V and T-S diagram for reversed Brayton cycle,	5	CO8	L2
18		Derive COP for reversed Brayton cycle,		CO8	L3
19		With neat explain Steam jet refrigeration.	5	CO8	L3
20		A refrigeration system of 10.5 Tonnes capacity at a	5	CO8	L3

		evaporator temperature of -12°C and acondenser temperature of 27°C is needed in a food storage locker. The refrigerant Ammoniais sub cooled by 6°C before entering the expansion valve. The vapour is 0.95 dry as it leavesthe evaporator coil. The compression in the compressor is of adiabatic type. Using P-H chart find i) Condition of vapour at the outlet of the compressor ii) Condition of vapour atentrance to evaporator iii) COP iv) Power required in kW Neglecting valve Throttling and clearance effect			
21		Define the following: i) DBT ii) Specific humidity iii) Relative humidity	5	CO5	L3
22		Show the following processes on Psychrometric chart. i) Sensible heating and cooling ii) Cooling and dehumidification iii) Adiabatic mixing of two streams iv) Heating and humidification.	5	CO6	L3
23		With a neat sketch, briefly describe a summer air conditioning system.	5	CO5	L3
24		Adiabatic mixing of two moist air streams. Cooling towers.	5	CO6	L3
25		It is required to design an air conditioning plant for a small office room for following winterconditions: Outdoor conditions: 14°C DBT and 10°C WBT, Required conditions = 20°CDBT and 60% RH, Amount of air circulation = 0.30 m3/min/person, Seating capacity of office = 60.The required condition is achieved first by heating and then by adiabatic humidifying.Determine the following: i)Heatcapacity of the coil in kW and the surface temperature required if the by-pass factor of coil is 0.4 ii) The capacity of the humidifier using psychrometric chart.	5	CO5	L3
26		What is Binary Vapour cycles.		CO6	L3
27		What are the Characteristics of an Ideal working fluid in Vapour power cycles,	5	CO5	L3
28		Sketch the flow diagram and the corresponding temperature-entropy diagram of a reheat vapour cycle and derive an expression for the reheat cycle efficiency. What are theadvantages gained by reheating the steam between stages	5	CO6	L3
29		steam power plant incorporates an ideal reheat cycle to improve the existing efficiency.Steam at 30 bar and 250 °C is supplied at high pressure turbine inlet and expands till it is dry saturated at 3 bar. Now the steam is taken to a reheater and its temperature is again increased to 250°C by constant pressure reheating process. The reheated steam expands in the low pressure turbine to a condenser pressure of 0.04 bar. Determine the cycle efficiency.	5	CO5	L3
30		40MW steam power plant working on Rankine cycle operates between boiler pressure of 4MPa and condenser pressure of 10KPa. The steam leaves the boiler and enters the turbine at	5	CO5	L3

		400°C. the isentropic efficiency of the steam turbine is 85% determine: i) The cycle efficiency ii) The quality of exhaust steam from turbine iii) Steam flow rate in kg/hr. consider pump work.			
31		With Neat sketch Explain the Vapour compression refrigeration system;	5	CO6	L3
32		Explain the Carnot vapour power cycle,	5	CO5	L3
33		Explain the Simple Rankine cycle,T-sdiagram, analysis for performance.		CO6	L3
34		Explain the drawbacks also Effects of pressure and temperature on Rankine cycle performance.	5	CO5	L3
35		Explain the Comparison of Carnot and Rankine cycles.		CO6	L3
36		Explain the Actual vapour power cycles.	5	CO5	L3
37		Explain the Ideal regenerative Rankine cycles,	5	CO6	L3
38		Define the following: i) DBT ii) Specific humidity iii) Relative humidity	5	CO5	L3
39		Show the following processes on Psychrometric chart. i) Sensible heating and cooling ii) Cooling and dehumidification iii) Adiabatic mixing of two streams iv) Heating and humidification.	5	CO6	L3
40		With a neat sketch, briefly describe a summer air conditioning system.	5	CO5	L3

D3. TEACHING PLAN - 3

Module – 5

Title:	Reciprocating Compressors & Steam nozzles	Appr Time:	16 Hrs
a	***Course Outcomes***	-	**Blooms**
-		-	**Level**
1	Should able to find Volumetric efficiency, minimum work and Optimum intermediate pressure for reciprocating compressor.	CO9	L3
2	Should able to understand Critical pressure ratio, Supersaturated flow for flow of steam through nozzle.	CO10	L3
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Reciprocating Compressors: Operation of a single stage reciprocating compressors.	CO9	L3
2	Work input through p-v diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency.	CO9	L3
3	Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, saving in work, Optimum intermediate pressure,	CO9	L3
4	Inter-cooling, Minimum work for compRession.	CO9	L3
5	Problems.	CO9	L3
6	Steam nozzles: Flow of steam through nozzles,	CO10	L3
7	Shape of nozzles, Supersaturated flow	CO10	L3

8	effect of friction	CO10	L3
9	Critical pressure ratio	CO10	
10	Problems.	CO10	
c	**Application Areas**	**CO**	**Level**
1	In industry, including natural gas processing and delivery, chemical plants, and oil refineries.	CO9	L3
2	In Steam turbine plants.	CO10	L3
d	**Review Questions**	-	-
1	Derive expression for workdone of a single stage reciprocating compressors.	CO9	L3
2	Derive an expression for volumetric efficiency of a single stage reciprocating air compressor in terms of clearance factor (K), pressure ratio (P2/**P**1) and index of compression (n).	CO9	L3
3	Explain the Adiabatic, Isothermal and Mechanical efficiencies.	CO9	L3
4	Derive an expression for minimum work required by a two stage air compressor with perfect inter cooling between stages.	CO9	L3
5	Derive expression for the intermediate pressure which gives minimum power in a two stage compressor with perfect inter cooling.	CO9	L3
6	What are the different methods to increase isothermal efficiency of air compressor		
7	What are the advantages of multi-stage compression?	CO9	L3
8	A two stage single-acting reciprocating compressor takes in air at the rate of 0.2 m3/s. The intake pressure and temperature of air are 0.1 MPa and 16°C. The air is compressed to a finalpressure of 0.7 MPa. The intermediate pressure is ideal and inter cooling is perfect. The compression index in both stages is 1.25 and the compressor runs at 600 rpm. Neglectingclearance determine i) The intermediate pressure ii) The total volume of each cylinder iii) Power required to drive the compressor and iv) The rate of heat rejection in the intercooler take Cp = 1.005 kJ/kgK and R = 0.287 kJ/kgK.	CO9	L3
9	single cylinder, double acting air compressor is required to deliver 100m3/min of air at amean piston speed of 500m/min measured at lbar and 15°C. The air is delivered at 7 bar. Assume a clearance volume of swept volume per stroke. Find volumetric efficiency15speed, bore, stroke for the following two cases.i) If ambient and suction conditions are same ii) If ambient and suction conditions are different.Assume,Ambient pressure = 1.0bar,Ambient temperature = 15°C, Suction pressure = 0.98 bar. Suction temperature = 30°C L/D=1.25	CO9	L3
10	A single acting, two-stage air-compressor delivers air at 17 bar when the pressure andtemperature of air at the end of suction are 1 bar and 303 k. The interstage pressure is 4 barand there is perfect intercooling. If LP cylinder diameter is 23 cm and common stroke is15 cm and speed of the compressor is 350 rpm. Determine:i) Volumetric efficiency of LP stage compressor. ii) Heat transfer in the inert cooler in kJ/min and iii) Capacity of the motor required to drive the compressor if the mechanical efficiency is 85%.Assume the clearance volume of LP compressor = 5% of stroke volume. The compression and expansion in both cylinders follow the law PV' 25 = constant.	CO9	L3

10	Explain the Supersaturated flow	CO10	L3
11	What is the effect of friction	CO10	L3
12	Derive an expression for Critical pressure ratio	CO10	L3

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	18ME42	Sem: IV	3	Marks:	30	Time:	75 minutes
Course:	APPLIED THERMODYNAMICS						

-	-	**Note: Answer any 2 full questions.**	**Marks**	**CO**	**Level**
1	a	Derive an expression for minimum work required by a two stage air compressor with perfect inter cooling between stages.	7	CO9	L3
	b	A two stage single-acting reciprocating compressor takes in air at the rate of 0.2 m3/s. The intake pressure and temperature of air are 0.1 MPa and 16°C. The air is compressed to a finalpressure of 0.7 MPa. The intermediate pressure is ideal and inter cooling is perfect. The compression index in both stages is 1.25 and the compressor runs at 600 rpm. Neglectingclearance determine i) The intermediate pressure ii) The total volume of each cylinder iii) Power required to drive the compressor and iv) The rate of heat rejection in the intercooler take Cp = 1.005 kJ/kgK and R = 0.287 kJ/kgK.	8	CO9	L3
		OR		CO9	L3
2	a	Derive an expression for volumetric efficiency of a single stage reciprocating air compressor in terms of clearance factor (K), pressure ratio (P2/**P**1) and index of compression (n).	7	CO9	L3
	b	single cylinder, double acting air compressor is required to deliver 100m3/min of air at amean piston speed of 500m/min measured at lbar and 15°C. The air is delivered at 7 bar. Assume a clearance volume of swept volume per stroke. Find volumetric efficiency15speed, bore, stroke for the following two cases.i) If ambient and suction conditions are same ii) If ambient and suction conditions are different.Assume,Ambient pressure = 1.0bar,Ambient temperature = 15°C, Suction pressure = 0.98 bar. Suction temperature = 30°C L/D=1.25	8	CO9	L3
		OR			
3	a	Derive expression for workdone of a single stage reciprocating compressors.	7	CO10	L3
	b	A single acting, two-stage air-compressor delivers air at 17 bar when the pressure andtemperature of air at the end of suction are 1 bar and 303 k. The interstage pressure is 4 barand there is perfect intercooling. If LP cylinder diameter is 23 cm and common stroke is15 cm and speed of the compressor is 350 rpm. Determine:i) Volumetric efficiency of LP stage compressor. ii) Heat transfer in the inert cooler in kJ/min and iii) Capacity of the motor required to drive the compressor if the mechanical efficiency is 85%.Assume the clearance volume of LP compressor = 5% of stroke volume. The compression and expansion in both cylinders follow the law PV' 25 = constant.	8	CO10	L3

4	a	Explain the Supersaturated flow and What is the effect of friction	7	CO10	L3
	b	Derive an expression for Critical pressure ratio	8	CO10	L3

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17ME43	Sem: IV	3	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	APPLIED THERMODYNAMICS						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Derive expression for workdone of a single stage reciprocating compressors.	5	CO9	L3
2		Derive an expression for volumetric efficiency of a single stage reciprocating air compressor in terms of clearance factor (K), pressure ratio (P2/**P**1) and index of compression (n).	5	CO9	L3
3		Explain the Adiabatic, Isothermal and Mechanical efficiencies.	5	CO9	L3
4		Derive an expression for minimum work required by a two stage air compressor with perfect inter cooling between stages.	5	CO9	L3
5		Derive expression for the intermediate pressure which gives minimum power in a two stage compressor with perfect inter cooling.	5	CO10	L3
6		What are the different methods to increase isothermal efficiency of air compressor	5	CO10	L3
7		What are the advantages of multi-stage compression?	5	CO10	L3
8		A two stage single-acting reciprocating compressor takes in air at the rate of 0.2 m3/s. The intake pressure and temperature of air are 0.1 MPa and 16°C. The air is compressed to a finalpressure of 0.7 MPa. The intermediate pressure is ideal and inter cooling is perfect. The compression index in both stages is 1.25 and the compressor runs at 600 rpm. Neglectingclearance determine i) The intermediate pressure ii) The total volume of each cylinder iii) Power required to drive the compressor and iv) The rate of heat rejection in the intercooler take Cp = 1.005 kJ/kgK and R = 0.287 kJ/kgK.	5	CO10	L3
9		single cylinder, double acting air compressor is required to deliver 100m3/min of air at amean piston speed of 500m/min measured at lbar and 15°C. The air is delivered at 7 bar. Assume a clearance volume of swept volume per stroke. Find volumetric efficiency15speed, bore, stroke for the following two cases.i) If ambient and suction conditions are same ii) If ambient and suction conditions are different.Assume,Ambient pressure = 1.0bar,Ambient temperature = 15°C, Suction pressure = 0.98 bar. Suction temperature = 30°C L/D=1.25	5	CO10	
10		A single acting, two-stage air-compressor delivers air at 17 bar when the pressure andtemperature of air at the end of suction are	5	CO9	L3

		1 bar and 303 k. The interstage pressure is 4 barand there is perfect intercooling. If LP cylinder diameter is 23 cm and common stroke is15 cm and speed of the compressor is 350 rpm. Determine:i) Volumetric efficiency of LP stage compressor. ii) Heat transfer in the inert cooler in kJ/min and iii) Capacity of the motor required to drive the compressor if the mechanical efficiency is 85%.Assume the clearance volume of LP compressor = 5% of stroke volume. The compression and expansion in both cylinders follow the law PV' 25 = constant.			
11		Explain the Supersaturated flow	5	CO10	L3
12		What is the effect of friction	5	CO10	L3
13		Derive an expression for Critical pressure ratio	5	CO10	L3
14		Derive an expression for minimum work required by a two stage air compressor with perfect inter cooling between stages.	5	CO9	L3
15		Derive expression for the intermediate pressure which gives minimum power in a two stage compressor with perfect inter cooling.	5	CO9	L3
16		What are the different methods to increase isothermal efficiency of air compressor	5		L3
17		What are the advantages of multi-stage compression?	5	CO9	L3
18		A two stage single-acting reciprocating compressor takes in air at the rate of 0.2 m3/s. The intake pressure and temperature of air are 0.1 MPa and 16°C. The air is compressed to a finalpressure of 0.7 MPa. The intermediate pressure is ideal and inter cooling is perfect. The compression index in both stages is 1.25 and the compressor runs at 600 rpm. Neglectingclearance determine i) The intermediate pressure ii) The total volume of each cylinder iii) Power required to drive the compressor and iv) The rate of heat rejection in the intercooler take Cp = 1.005 kJ/kgK and R = 0.287 kJ/kgK.	5	CO9	L3
19		Derive expression for workdone of a single stage reciprocating compressors.	5	CO9	L3
20		Derive an expression for Critical pressure ratio	5	CO10	L3
21		Explain the Supersaturated flow	5	CO10	L3
22		What is the effect of friction	5	CO10	L3
23		Derive an expression for Critical pressure ratio	5	CO10	L3
24		Derive an expression for minimum work required by a two stage air compressor with perfect inter cooling between stages.	5	CO9	L3
25		Derive expression for the intermediate pressure which gives minimum power in a two stage compressor with perfect inter cooling.	5	CO9	L3
26		What are the different methods to increase isothermal efficiency of air compressor	5	CO9	L3
27		What are the advantages of multi-stage compression?	5	CO9	L3
28		A two stage single-acting reciprocating compressor takes in air at the rate of 0.2 m3/s. The intake pressure and temperature of air are 0.1 MPa and 16°C. The air is	5	CO9	

		compressed to a finalpressure of 0.7 MPa. The intermediate pressure is ideal and inter cooling is perfect. The compression index in both stages is 1.25 and the compressor runs at 600 rpm. Neglectingclearance determine i) The intermediate pressure ii) The total volume of each cylinder iii) Power required to drive the compressor and iv) The rate of heat rejection in the intercooler take Cp = 1.005 kJ/kgK and R = 0.287 kJ/kgK.			
29		Derive an expression for minimum work required by a two stage air compressor with perfect inter cooling between stages.	5	CO9	L3
30		Derive expression for the intermediate pressure which gives minimum power in a two stage compressor with perfect inter cooling.	5	CO9	L3
31		What are the different methods to increase isothermal efficiency of air compressor	5		L3
32		What are the advantages of multi-stage compression?	5	CO9	L3
33		A two stage single-acting reciprocating compressor takes in air at the rate of 0.2 m3/s. The intake pressure and temperature of air are 0.1 MPa and 16°C. The air is compressed to a finalpressure of 0.7 MPa. The intermediate pressure is ideal and inter cooling is perfect. The compression index in both stages is 1.25 and the compressor runs at 600 rpm. Neglectingclearance determine i) The intermediate pressure ii) The total volume of each cylinder iii) Power required to drive the compressor and iv) The rate of heat rejection in the intercooler take Cp = 1.005 kJ/kgK and R = 0.287 kJ/kgK.	5	CO9	L3
34		Explain the Supersaturated flow		CO10	L3
35		What is the effect of friction		CO10	L3
36		Derive an expression for Critical pressure ratio		CO10	L3
37		Explain the Supersaturated flow		CO10	L3
38		What is the effect of friction		CO10	L3
39		Derive an expression for Critical pressure ratio		CO10	L3
40		Derive expression for workdone of a single stage reciprocating compressors.		CO9	L3

F. EXAM PREPARATION

1. University Model Question Paper

Course:	APPLIED THERMODYNAMICS					Month / Year	JAN /2019
Crs Code:	18ME42	Sem:IV	I	Marks:	100	Time:	180 minutes

-	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	CO	Level
1	a	Derive an expression of efficiency for Otto cycle	8	CO1	L2
	b	The stroke and cylinder diameters of a compression ignition engine are 250 mm and150 mm respectively. If the clearance volume is 0.0004 m3 and fuel injection takes place at constant pressure for 5 percent of the stroke determine the efficiency of the engine. Assume the engine working on the diesel cycle.	12	CO1	L3

		OR			
	a	Derive an expression for optimum pressure ratio which gives maximum specific work output in gas turbine considering machine efficiency.	10	CO2	L3
	b	A gas turbine plant works between the temperature limits of 300K and 1000K and a pressure of 1 bar and 16 bar. The compression is carried out in two stages with perfect intercooling in between. Calculate the net power of the plant, Cp = 1 kJ / kg.per kg of air circulation ; y = 1.4 for air.	10	CO2	L3
2	a	Explain i) Enthalpy of formation.ii)Enthalpy of combustion ii) Stoichiometric air. iv) Excess air and	8	CO3	L2
	b	The products of combustion of an unknown hydro carbon Cx1-ly have the following composition as measured by an orsat apparatus: CO2 = 8.0%, CO = 0.9%, 02 = 8.8%,N2 = 82.3%.Determine: The composition of the fuel. ii) The air/fuel ratio and iii) The percent excess air used	12	CO3	L3
	a	Explain briefly Morse test. Explain the heat balance sheet.	8	CO4	
	b	The following data were obtained on MORSE test of 4-cylinder four stroke SI engine coupled to a hydraulic dynamo meter operating at constant speed of 1500rpm, brake load with second cylinder not firing = 206N, brake load with third cylinder not firing =192N, brake load with fourth cylinder not firing = 200N. Brake power in kW is calculated using the equation BP = WN/42,300, where 'W' is brake load in Newton, N-speed of the engine in RPM. Calculate: i) Brake power; ii) Indicated power; iii) Mechanical efficiency.	12	CO4	L2
3	a	Explain the practical regenerative Rankine cycles	8	CO5	L3
	b	steam power plant incorporates an ideal reheat cycle to improve the existing efficiency.Steam at 30 bar and 250 °C is supplied at high pressure turbine inlet and expands till it is dry saturated at 3 bar. Now the steam is taken to a reheater and its temperature is again increased to 250°C by constant pressure reheating process. The reheated steam expands in the low pressure turbine to a condenser pressure of 0.04 bar. Determine the cycle efficiency.	12	CO5	L3
		OR			
	a	What is Reheat Rankine cycle explain	8	CO6	
	b	40MW steam power plant working on Rankine cycle operates between boiler pressure of 4MPa and condenser pressure of 10KPa. The steam leaves the boiler and enters the turbine at 400°C. the isentropic efficiency of the steam turbine is 85% determine: i) The cycle efficiency ii) The quality of exhaust steam from turbine iii) Steam flow rate in kg/hr. consider pump work.	12	CO6	L3
4	a	Derive COP for reversed Brayton cycle,	8	CO7	L3
	b	A refrigeration system of 10.5 Tonnes capacity at a evaporator temperature of -12°C and acondenser temperature of 27°C is needed in a food storage locker. The refrigerant Ammoniais sub cooled by 6°C before entering the expansion valve. The vapour is 0.95 dry as it leavesthe evaporator coil. The compression in the compressor is of adiabatic type. Using P-H chart find i) Condition of vapour at the	12	CO7	L3

		outlet of the compressor ii) Condition of vapour atentrance to evaporator iii) COP iv) Power required in kW Neglecting valve Throttling and clearance effect			
		OR			
	a	Show the following processes on Psychrometric chart. i) Sensible heating and cooling ii) Cooling and dehumidification iii) Adiabatic mixing of two streams iv) Heating and humidification.	8	CO8	L3
	b	The dry and wet bulb temperatures of atmospheric air at 1 atm pressure are measured with a sling psychrometer and found to be 25°C and 15°C respectively. Determine i) Specific humidity ii) Relative humidity iii) Enthalpy of air. Use the table to find property values. Do not use psychrometric chart	12	CO8	L3
		OR			
5	a	Derive an expression for minimum work required by a two stage air compressor with perfect inter cooling between stages.	8	CO9	L3
	b	A two stage single-acting reciprocating compressor takes in air at the rate of 0.2 m3/s. The intake pressure and temperature of air are 0.1 MPa and 16°C. The air is compressed to a finalpressure of 0.7 MPa. The intermediate pressure is ideal and inter cooling is perfect. The compression index in both stages is 1.25 and the compressor runs at 600 rpm. Neglectingclearance determine i) The intermediate pressure ii) The total volume of each cylinder iii) Power required to drive the compressor and iv) The rate of heat rejection in the intercooler take Cp = 1.005 kJ/kgK and R = 0.287 kJ/kgK.	12	CO9	L3
		OR			
	a	Explain the Supersaturated flow and What is the effect of friction	10	CO10	L3
	b	Derive an expression for Critical pressure ratio	10	CO10	L3

2. SEE Important Questions

Course:	APPLIED THERMODYNAMICS					Month / Year	Jan/2019
Crs Code:	18ME42	Sem: IV	3	Marks:	100	Time:	180 minutes

	Note	Answer all FIVE full questions.	-	-	
Module	Qno.	Important Question	**Marks**	**CO**	**Year**
1	1	Derive an expression for mep for otto cycle	8	CO1	2014
	2	An air-standard diesel cycle has an compression ratio of 14. The pressure at the beginning ofcompression stroke is 98.1 kPa and temperature is 27°C. The maximum temperature of thecycle is 2500°C. Determine: i) Temperature at all salient points; ii) Thermal efficiency;iii) Mean effective pressure.	12	CO2	2014
2	1	Define 1) Stoichiometric air ii) Enthalpy of formation iii) Enthalpy of reaction iv) Adiabatic flame temperature	8	CO3	2015

	2	The following data were obtained on MORSE test of 4-cylinder four stroke SI enginecoupled to a hydraulic dynamometer operating at constant speed of 1500rpm, brake loadwith all four cylinders firing = 296N, brake load with first cylinder not firing = 201 N. brakeload with second cylinder not firing = 206N, brake load with third cylinder not firing =192N, brake load with fourth cylinder not firing = 200N. Brake power in kW is calculatedusing the equation BP = WN/42,300, where 'W' is brake load in Newton, N-speed of theengine in RPM. Calculate: i) Brake power; ii) Indicated power; iii) Mechanical efficiency	8	CO4	2014
3	1	With a superimposed T — S diagram, compare Carnot and Rankine vapour cycles operating between the same boiler and condenser temperatures	8	CO5	2015
	2	In a Rankine cycle, the steam inlet to turbine is saturated at a pressure of 35 bar and theexhaust pressure is 0.2bar. Calculate i) Turbine work ii) Pump work iii) Rankineefficiency iv) Condenser heat flow v) Dryness fraction at the end of expansion.Assume the mass flow rate of steam as 9.5kg/sec	12	CO6	2015
4	1	Derive an Expression for COP for refrigeration system working on Bell Colemann cycle.	8	CO7	2014
	2	A refrigeration system of 10.5 Tonnes capacity at a evaporator temperature of -12°C and acondenser temperature of 27°C is needed in a food storage locker. The refrigerant Ammoniais sub cooled by 6°C before entering the expansion valve. The vapour is 0.95 dry as it leavesthe evaporator coil. The compression in the compressor is of adiabatic type. Using P-H chart find i) Condition of vapour at the outlet of the compressor ii) Condition of vapour atentrance to evaporator iii) COP iv) Power required in kW Neglecting valve Throttling and clearance effect	12	CO8	2016
5	1	A single acting, two-stage air-compressor delivers air at 17 bar when the pressure andtemperature of air at the end of suction are 1 bar and 303 k. The interstage pressure is 4 barand there is perfect intercooling. If LP cylinder diameter is 23 cm and common stroke is15 cm and speed of the compressor is 350 rpm. Determine:i) Volumetric efficiency of LP stage compressor. ii) Heat transfer in the inert cooler in kJ/min and iii) Capacity of the motor required to drive the compressor if the mechanical efficiency is 85%.Assume the clearance volume of LP compressor = 5% of stroke volume. The compression and expansion in both cylinders follow the law PV' 25 = constant.	10	CO9	2012
	2	A two stage single-acting reciprocating compressor takes in air at the rate of 0.2 m3/s. The intake pressure and temperature of air are 0.1 MPa and 16°C. The air is compressed to a finalpressure of 0.7 MPa. The intermediate pressure is ideal and inter cooling is perfect. The compression index in both stages is 1.25 and the compressor runs at 600 rpm. Neglectingclearance determine i) The intermediate pressure ii) The total volume of each cylinder iii) Power required to drive the compressor and iv) The rate of heat rejection in the intercooler take Cp = 1.005 kJ/kgK and R = 0.287 kJ/kgK.	10	CO10	2016