

**Government College of Engineering, Amravati**  
**(An Autonomous Institute of Government of Maharashtra)**

**Forth Semester B. Tech. (Mechanical Engineering)**

**Summer – 2018**

**Course Code: MEU403**

**Course Name: Thermal Engineering and Energy Conversion**

**Time: 2 Hrs. 30 Min.**

**Max. Marks: 60**

**Instructions to Candidate**

- 1) All questions are compulsory & carry equal marks.
- 2) Assume suitable data wherever necessary and clearly state the assumptions made.
- 3) Diagrams/sketches should be given wherever necessary.
- 4) Use of Refrigerant property chart, Mollier chart, steam table, drawing instruments and calculators is permitted.
- 5) Figures to the right indicate full marks.

**1. *Solve any Two***

- a. Discuss with a neat sketch the methodology of 6 ‘Fluidized-bed-combustion’ in boiler. Also Compare Fluidized-bed-combustion with pulverized coal combustion in boilers.
- b. Discuss with neat sketch the following devices: 6  
(i) Green’s Economizer &  
(ii) Sudgen Superheater
- c. A Rankine cycle operates with steam as working 6 fluid. The saturated vapour enters the turbine at 8.0 MPa and saturated liquid leaves the condenser at a pressure of 0.008 MPa. The net power output of the cycle is 100 MW. Consider pump work for the

*Contd..*

cycle and determine- (i) Thermal efficiency,

- (ii) Mass flow rate of steam in kg/h,
- (iii) Rate of heat transfer to the working fluid in the boiler
- (iv) Rate of heat rejection in the condenser,
- (v) Mass flow rate of cooling water in kg/h, if cooling water enters the condenser at  $15^{\circ}\text{C}$  and leaves at  $35^{\circ}\text{C}$ .

2. ***Solve any Two***

- a. Why governing of steam turbine is necessary? 6  
Discuss the different techniques of governing of steam turbines.
- b. Enlist the sources of air-leakage in condenser. 6  
What are its effects? How is it remedified?
- c. In a convergent-divergent nozzle, the steam enters 6  
at 15 bar,  $300^{\circ}\text{C}$  and leaves at 2 bar. The inlet velocity to the nozzle is 150 m/s. find the required throat and exit areas for the mass flow ratw of 1 kg/s. Assume nozzle efficiency to be 90% and  $c_{ps}=2.4 \text{ kJ/kg-K}$ . Sketch the process on h-s plot.

3. ***Solve any Two***

- a. With a neat sketch discuss the working and 6  
construction of 'Root's blower'.
- b. Analyze an ideal thermodynamic cycle referred for 6  
gas-turbine power plant.
- c. A single stage, double-acting reciprocating air 6  
compressor has a FAD of 14 CMM measured at 1.013 bar and 300 K. The pressure and temperature of the cylinder during suction are 0.95 bar and  $45^{\circ}\text{C}$ . The delivery pressure is 7 bar. The index of

compression and expansion is 1.3. Calculate the indicated power and volumetric efficiency if the clearance volume is 5% of the swept volume.

4. a. Describe the various psychometric terms giving 6 their units.
- b. 4-cylinder, 4-stroke petrol engine develops 6 indicated power of 14.7 kW at 1000 rpm. The mean-effective pressure is 5.5 bar. Calculate the dimensions of the engine cylinder if the stroke is 1.5 times the bore.
5. a. Classify Air-conditioning systems. Discuss their 6 applications.
- b. Write precise notes precise notes in the context of 6 present scenario on:
- (i) Solar energy &
  - (ii) Wind Energy

**Summer - 2017**

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**Max. Marks: 60**

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- 1) All questions are compulsory & carry equal marks.
- 2) Assume suitable data wherever necessary and clearly state the assumptions made.
- 3) Diagrams/sketches should be given wherever necessary.
- 4) Use of Refrigerant property chart, Mollier chart, steam table, drawing instruments and calculators is permitted.
- 5) Figures to the right indicate full marks.

***Solve any Two***

- a. Elaborate the functions of following device with typical layout of steam power plant: 6
- i) Economizer
  - ii) Super heater &
  - iii) Air-preheater
- b. Why the Carnot cycle can't be considered as an ideal 6 cycle for a steam power plant? Explain the facts.
- c. In a Rankine cycle with superheat and reheat, steam 6 enters the first stage turbine at 8.0 MPa, 480°C and expands to 0.7 MPa. It is then reheated to 440°C before entering the second stage turbine, where it

*Contd.*

expands to the condenser pressure of 0.008 MPa. The net power output of the cycle is 100 MW. Determine

- (i) Thermal efficiency of cycle,
- (ii) Mass flow rate of steam in kg/h,
- (iii) Specific-steam-consumption (kg/kW-h)

**2.** *Solve any Two*

- a. Enlist the points of difference between impulse and reaction turbine. 6
- b. What are the sources of air leakage and its effects on the performance of condenser? How is it remedied? 6
- c. Steam at a pressure of 10 bar & 0.98 dry is passed through a convergent-divergent nozzle to a back pressure of 0.1 bar. The mass flow rate is 0.55 kg/s. Determine (i) pressure at throat; (ii) Velocity at throat; (iii) Area at throat and (iv) Number of nozzles used if each nozzle has a throat area of  $0.5 \text{ cm}^2$ . The enthalpy drop used for reheating the steam by friction in the divergent part is 10% of overall isentropic drop. Take index of expansion for steam = 1.13. 6

**3.** *Solve any Two*

- a. Explain with neat sketch one of the positive displacement rotary compressor. Also state the equation for its efficiency. 6
- b. What are the effects of 'Clearance Volume' on work done and volumetric efficiency of a reciprocating air compressor? Also derive condition for minimum work required in two stage compression. 6
- c. A single stage, double-acting reciprocating air compressor has a FAD of 14 CMM measured at 1.013 bar and 300 K. The pressure and temperature of the cylinder during suction are 0.95 bar and 45°C. The 6

delivery pressure is 7 bar. The index of compression and expansion is 1.3. Calculate the indicated power and volumetric efficiency if the clearance volume is 5% of the swept volume.

4. a. How air-conditioning systems are classified? Enlist 6 the important applications of air-conditioning.
- b. 4-cylinder, 4-stroke petrol engine develops indicated 6 power of 14.7 kW at 1000 rpm. The mean-effective pressure is 5.5 bar. Calculate the dimensions of the engine cylinder if the stroke is 1.5 times the bore.
5. a. 30 CMM of moist air at 15 DBT & 13 WBT is mixed 6 with 12 CMM of moist air at 25 DBT & 18 WBT. Determine DBT, WBT and Enthalpy of the resulting mixture assuming the barometric pressure is 76 cm of Hg.
- b. Elaborate the present scenario of Solar energy in India 6 and abroad.

**Government College of Engineering, Amravati**  
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**Fourth Semester B. Tech. (Mechanical Engineering)**

**Summer – 2016**

**Course Code: MEU403**

**Course Name: Thermal Engineering and Energy Conversion**

**Time: 2 hrs. 30 min.**

**Max. Marks: 60**

**Instructions to Candidate**

- 1) All questions are compulsory.
- 2) Use of steam table, psychometric chart, refrigerant property chart is permitted. Assume suitable data if necessary and clearly state the assumptions made.
- 3) Diagrams/sketches should be given wherever necessary.
- 4) Use of logarithmic table, drawing instruments and non-programmable calculators is permitted.
- 5) Figures to the right indicate full marks.

1. a) Discuss the role of following devices in steam power plant: 6

- (i) Economizer      (ii) Superheater  
(iii) reheat & (iv) air-preheater

Also show these devices on the Block diagram of steam power plant

**OR**

b) Explain with neat sketch the methodology of 'Fluidized Bed Combustion' in Boiler also discusses the pros and cons with reference to pulverized coal combustion boilers. 6

Cont.

c)

In a thermal power plant operating on an ideal Rankine cycle, superheated steam produced at 5 MPa, 500°C is fed to turbine where it expands to the condenser pressure of 10 kPa. If the net power output of the plant is to be 20 MW, determine: 6

- (i) Heat added in boiler per kg of water
- (ii) Thermal efficiency of cycle
- (iii) steam flow rate in kg/sec &
- (iv) Mass flow rate of cooling water in condenser if the cooling water enters into the condenser at 25°C and leaves at 35°C.

Also sketch the cycle on T-s plot.

2. a) Explain with a neat sketch the concept of Supersaturated flow in steam nozzles. 6

OR

b) Explain with the help of neat sketches the various methods of compounding of steam turbines. 6

c)

A single-cylinder single-acting reciprocating compressor sucks air at 1 bar, 30°C and delivers 0.6 kg of air per minute at 6 bar. The bore and stroke of compressor are 10 cm and 15 cm and clearance is 3% of stroke. The index of expansion and compression is 1.3. Determine: 6

- (i) volumetric efficiency of compressor
- (ii) driving power required if mechanical efficiency is 85%
- (iii) Speed of compressor in rpm.

3. a) What are the various sources of air-leakage in a condenser? How air-leakage affects the performance of condenser? 6

OR

b) Discuss the terminology of air-compressor. Also derive the volumetric efficiency of compressor referred to ambient conditions. 6

- c) In an ammonia vapour refrigeration plant, the pressure range is from 3.15 bar in the evaporator to 10.5 bar in condenser, the compression is isentropic and before leaving the throttle valve the refrigerant is sub-cooled. The temperature of refrigerant at entry and exit from the condenser is 50°C and 20°C respectively. The water circulated in the condenser at 10.5 kg/min has temperature rise of 10°C. The compressor unit is single cylinder-single acting with bore 10 cm, stroke 15 cm and while running at 200 rpm has 3.5 bar indicated mean effective pressure. If the plant produce 50 kg/hour of ice at 0°C from water at 15°C, determine:

- (i) COP of plant
- (ii) Mass flow rate of refrigerant
- (iii) Condition of vapor at entry to compressor

Take latent heat of ice as 335 kJ/kg & use tabulated values for relevant properties of NH<sub>3</sub>

Pressure (bar)	Sat. temp (K)	Enthalpy kJ/kg		Specific heat kJ/kg-K	
		Liquid	Vapour	Liquid	Vapour
3.5	264	-35.6	1264	-	-
10.5	304	134	1294	4.6	2.8

4. a) Explain with neat sketch one of the positive displacement rotary compressor. Also state the equation for its efficiency.

- b) 30 g of moist air at 15 DBT & 13 WBT is mixed with 12 CMM of moist air at 25 DBT & 18 WBT. Determine DBT, WBT and Enthalpy of the resulting mixture assuming the barometric pressure is 76 cm of Hg.

5. a) Enlist various non-conventional sources of energies. What is MHD? With a neat sketch explain their principle of operation

Cont.

- b) A gas engine working on the Otto cycle has a cylinder of diameter 200 mm & stroke 250 mm. The clearance volume is 1570 cc. Find stroke volume, compression ratio & air-standard efficiency. Take  $c_p=1.004 \text{ kJ/kg}$  &  $c_v=0.717 \text{ kJ/kg}$  6

$$\begin{aligned}V_{cu} &= 10^3 \\V_{cu} &= 10^3 \text{ cu} \\V_{cu} &= 10^3 \text{ m}^3 \\&\text{min}\end{aligned}$$

**Government College of Engineering, Amravati**  
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**Fourth Semester B.Tech. (Mechanical Engg)**  
**Summer - 2015**

**Course Code : MEU 403**

**Course Name: THERMAL ENGINEERING &  
ENERGY CONVERSION**

**Time : 2 hr.30min.**

**Max.Marks: 60**

**Instructions to Candidate**

- 1) All questions are compulsory.
- 2) Assume suitable data wherever necessary and clearly state the assumptions made.
- 3) Diagrams/sketches should be given wherever necessary.
- 4) Use of logarithmic table, drawing instruments and non-programmable calculators is permitted.
- 5) Figures to the right indicate full marks.
- 6) (Other special instruction, if any)



1. a) Describe the use of combined velocity triangle of an impulse turbine 05

**OR**

05

b) Compare the difference between impulse turbine and reaction turbine.

c) Derive an expression for volumetric efficiency of Reciprocating compressor 07

**Cont.**

2. a) Explain with the help of neat sketch/layout of steam power plant and 05 factor for site selection.

**OR**

b) Define the critical pressure ratio for the nozzle of the steam turbine. Obtain the analytically its value in terms of the index of expansion

07

c) Explain working of vane blower with neat sketch. Why this type of blower consumes less work as compared to root blower

05

3. a) Give the detail classification of I/c Engines

05

**OR**

b) With the aid of a neat diagram, explain the working principle of a ramjet engine

07

c) In De-lavel turbine steam enters the wheel through a nozzle with a velocity of 500m/s and at an angle of  $20^{\circ}$  to the direction of motion of blade. The blade speed is 200 m/s and the exit angle of the moving blade is  $25^{\circ}$ . Find the inlet angle of the moving blade, exit velocity of steam and its direction and work done per kg of steam.

14/3/21

14/3/21

4. a) With the aid of a neat diagram, explain the working principle of a ramjet engine 05

OR

- b) Compare the vapor compression with vapor absorption cycle 05

- c) The atmospheric air has a dry bulb temperature of  $21^{\circ}\text{C}$  and wet bulb temperature  $18^{\circ}\text{C}$ . If the barometer reads 750mm of Hg determine 1) Partial pressure of water vapour 2) Relative humidity and 3) Dew point temperature. 07

5. a) What is psychometric properties, define five of them. 05

OR 05

- b) State the essential features of a probable site for a wind farm

- c) A Gas turbine plant works between limits 300K and 900K. The pressure limits 1 bar & 4 bar. Estimate the thermal efficiency of plant and shaft power available for external load in KW. Assume mass flow rate of air to the compressor as 1600 Kg/min. 07

**Government College of Engineering, Amravati**  
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**Fourth Semester B. Tech. (Mechanical Engineering)**

**Summer – 2014**

**Course Code: MEU403**

**Course Name: Thermal Engineering and Energy Conversion**

**Time: 2 hr.30min.**

**Max.Marks: 60**

**Instructions to Candidate**

- 1) All questions are compulsory.
- 2) Assume suitable data wherever necessary and clearly state the assumptions made.
- 3) Diagrams/sketches should be given wherever necessary.
- 4) Use of logarithmic table, drawing instruments and non-programmable calculators is permitted.
- 5) Figures to the right indicate full marks.

**1 a) Explain the principle of fluidized bed boiler. 05**

**OR**

**b) Give the detail classification of I/C Engines 05**

**c) Derive an expression for volumetric efficiency of Reciprocating compressor 07**

**2 a) Explain the difference between impulse turbine and reaction turbine. 05**

**OR**

**b) What is the effect of friction on the flow through a steam nozzle? 05**

**c) Discuss limitations of single stage compression process. Explain how these limitations can be overcome by using multistage compression? 07**

**Cont.**

3 a) Compare the vapor compression with vapor absorption cycle 05

OR

b) Why testing of I/C engine is necessary? What is role of octane and cetene numbers 05

c) A rotary vane Compressor compresses  $4.5 \text{ m}^3$  of air 07 per min from 1 bar to 2 bar when running at 450 r.p.m. Find the power required to drive the compressor when 1) the ports are so placed that there is no internal compression, 2) the ports are so placed that there is 50% increase in pressure due to compression before the back flow occurs.

4 a) Derive equation for Specific work output and 05 efficiency of a simple gas turbine

b) Explain working of vane blower with neat sketch. 07 Why this type of blower consumes less work as compared to root blower

5 a) A two- stroke, four cylinder petrol engine develops 05 23.5KW brake power at 2500rpm. The mean effective pressure on each piston is 8.5 bar and mechanical efficiency=85% calculate the diameter and stroke of each cylinder, assuming the length of stroke equal to 1.5 times the diameter of cylinder.

b) A gas turbine operates on a ratio 6. The inlet air temperature to the compressor is  $300 \text{ }^\circ\text{K}$  and the air entering the turbine is at a temperature of  $577 \text{ }^\circ\text{C}$ . If the volume rate of air entering the compressor is  $240 \text{ m}^3/\text{s}$ . calculate the net power output of the cycle in MW. Also compute its efficiency. 07

