Kadi Sarva Vishwavidyalaya

B.E. Sem III (Mechanical Engineering/Automobile Engineering) Examination December 2016

Subject: Engineering Thermodynamics (ME306 & AE-306)

Date: 30th December, 2016 Max. Marks: 70 Time: 3 Hrs.

Instruction: (1) Use of Scientific calculator is permitted.

(2) Assume suitable data if necessary.

(3) Use of Steam Table and Mollier Diagram is permitted.

Section – I

Q.1 Each carries equal marks

[A] Differentiate between the following: [5]
(i) Reversible Vs irreversible process
(ii) State function Vs path function

[B] Mention Various statements of Zeroth, first, second, and third law of thermodynamics. Also, explain limitations of each. [5]

[C] Prove that violation of Kelvin-Plank statement leads to violation of Clausius statement. [5]

OR

[C] Explain PVT behaviour of a pure substance with the help of PT and PV diagrams. [5]

Q.2

[A] Derive the general energy equation for steady flow process and show how this equation can be applied to Boiler. [5]

[B] Show different states of a pure substance (Water) on a neatly drawn P-v diagram and explain the following terms in perspective: [5]
(i) Critical temperature (ii) Triple point
(iii) Wet vapours (iv) Superheated vapours.
Using Steam Tables determine the following:
(i) Enthalpy at State of water at 120 ^{0}C and 2.25 bar.
(ii) Enthalpy at Saturation pressure of water at 180 ^{0}C.
(iii) h_g at 125 ^{0}C and 1 bar.
(iv) s_g at 140 ^{0}C.
(v) Saturation temperature at 1 MPa.
(vi) h_{fg} at critical temperature.

OR

Q.2

[A] Air flows at the rate 5 kg/s in a 25 cm diameter pipe. initial pressure is 8 bar and temperature 100 ^{0}C .It is throttled by a valve to 4 bar pressure. Find the final velocity of air. [5]

[B] Show that work is a path function, and not a property. [5]

Q.3

[A] 0.75 m^3 of hydrogen gas is initially at a pressure of 1 bar and temperature 290 K. It is compressed isentropically to 15 bar. Next is it is expanded at constant temperature to original volume. Finally heat rejection takes place at constant volume and the gas pressure is restored to the original condition of pressure. [5]
Calculate: 1) pressure,volume and temperature at the end of each operation 2) Heat added during isothermalexpansion and 3) Change of internal energy during each process.
R= 4126 J/kg K C_p= 14.26 kJ/ kg K.

[B] Prove that all reversible engines working between two constant temperature reservoirs have the same efficiency. [5]

OR

Q.3

[A] With special reference to mathematical statement of the second law of thermodynamics, justify that "All isentropic processes are adiabatic, but all adiabatic processes are not isentropic." [5]

[B] Define Clausius inequality and prove it. [5]

Section – II

Q.4 **Each carries equal marks**

[A] Derive the following thermodynamic relationship: [5]

$$\left(\frac{\partial P}{\partial V}\right)_T \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V = -1$$

[B] Sketch the Rankine cycle on (P-V) (T-S) (h-S) diagram and derive the expression for its thermal efficiency with & without pump work. [5]

[C] Prove that for an infinitesimally reversible process, we must have $(\partial T/\partial V)_S = -(\partial P/\partial S)_V$ & $(\partial T/\partial P)_S = (\partial V/\partial S)_P$ [5]

OR

[C] Write down the van der Waals equation of state. How does it differ from the ideal gas equation of state. What is force of cohesion? What is co-volume. [5]

Q.5

[A] Find the availability(exergy) of 100 kW delivered at 500 K when the ambient temperature is 300 K. [5]

[B] A steam boiler uses pulverised coal in the furnace. The ultimate analysis of coal (by mass) as received is: C 78 %, H_2 3 %, O_2 3 %, S 1 %, ash 10 % and moisture 5 %. Excess air supplied is 30 %. Calculate the mass of air to be supplied and mass of gaseous product formed per kg of coal burnt. [5]

OR

Q.5

[A] Explain Carnot cycle & derive its expression for its efficiency. [5]

[B] A steam turbine operating on Rankine cycle receives steam from boiler at 3.5 MPa and 350 ^{0}C.It is exhausted to the condenser at 10 kPa.Calculate: (1) The energy supplied in the boiler per kg of steam generated (including the superheater), (2) Dryness fraction of steam entering the condenser, (3) Rankine efficiency including pump work. [5]

Q.6

[A] In an air standard Diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15 ^{0}C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480 ^{0}C. Calculate (1) the cut-off ratio (2) the heat supplied per kg of air (3) the cycle efficiency (4) the m.e.p. [5]

[B] State and prove Carnot theorem for heat engines. [5]

OR

Q.6

[A] With neat sketch explain the construction and working of Bomb calorimeter [5]

[B] What is compressibility factor? What is the generalised compressibility chart? [5]

*******END OF PAPER*******

KADI SARVA VISHWAVIDHYALAYA
B.E MECHANICAL/AUTOMOBILE Semester–III

Subject: Engineering Thermodynamics **Date: 09/12/2015**
Subject Code: ME-306/AE 306 **Time: 10:30 am to 1:30 pm**
Total Marks: 70

Instructions:
1. Answer each section in separate Answer sheet.
2. Use of Scientific calculator is permitted.
3. All questions are **Compulsory**.
4. Indicate **clearly**, the options you attempt along with its respective question number.
5. Use the last page of main supplementary of **rough work**.

SECTION-I

Que:1 (A) Explain with diagram following term [5]
(1) Critical point
(2) Triple point
(3) cycle

(B) Using Maxwell relation derive the Causius clapeyron equation. [5]

(C) Derive expression of S.F.E.E & write down its application. [5]

OR

(C) Air flows at the rate 5kg/s in a 25 cm diameter pipe, initial pressure is 8 bar and temperature 1000C .It is throttled by a valve to 4 bar pressure. Find the final velocity of air. [5]

Que:2 (A) Prove that the cyclic integration of $\delta Q/T = 0$. [5]

(B) Prove that Energy is a point function of a system undergoing change of state. [5]

OR

(A) Show that the COP of heat pump is greater than the COP of refrigerator by unity. [5]

(B) Steam at 20 bar, 350°C is expanded in a steam turbine to 0.075 bar. It then enters a condenser, where it is condensed to liquid water. The pump feeds back the water into boiler.
i) Assuming ideal processes, find per kg of steam the net work and [5]
ii) The cycle efficiency.
The above data for super heated and wet steams can be made use of if desired.

Que:3 (A) To prove that $W_{max} = C_p[(T-T_o) - T_o \ln T/T_o]$. [5]

(B) Explain following terms. [5]
1) joule Thomson coefficient
2) Exothermic reaction
3) Endothermic reaction

OR

(A) Explain maximum Work Obtainable from Two Finite bodies at Temperatures T_1 and T_2. [5]

(B) A reversible heat engine absorbs heat from three thermal reservoirs at 1200K, 1000K and 800K. The heat engine rejects 5.5 kJ/s heat to sink at 300K and produces 12kW work output. The heat supplied by reservoir at 1200K IS 60% of heat supplied by reservoir at 800K. Calculate heat supplied by each reservoir to engine. **[5]**

SECTION-II

Que:4 (A) Explain entropy generation in a open system. **[5]**

(B) Explain availability of open system. **[5]**

(C) To derive first and second Tds equation. **[5]**

OR

(C) Derive vander waal's equation in reduced form of properties. **[5]**

Que:5 (A) Write down the statement **[5]**

1) Dalton's law of partial pressure.
2) Gibb's Dalton's law

(B) Derive the expression for Atkinson cycle efficiency with help of (P-V) and (T-S) Diagram. **[5]**

OR

(A) Derive the expression for Rankine cycle efficiency with help of(P-V) & (T-S) Diagram. **[5]**

(B) In an ideal Brayton cycle, the ambient air at 1 bar -298K is compressed to 6 bar and the maximum cycle temperature is limited to 1000 K. if the heat supply is110 MW, find (i) The thermal efficiency of the cycle (ii) work ratio (iii) power output and (iv) mass flow rate of air. **[5]**

Que:6 (A) Define the following term **[5]**

1) Non Dispersive Infra-Red analyzer
2) Flame Ionization Detector.

(B) Define and Explain the following **[5]**

1) Enthalpy of formation
2) Enthalpy of reaction

OR

(A) Explain Construction and Working the Bomb calorimeter with neat sketch. **[5]**

(B) The ultimate analysis of coal burnt in a boiler gave 85% C, 10% H_2 and 5% incombustible. Calculate the mass of dry flue gases if the volumetric analysis of products are 9% CO_2, 8% O_2 ,2% CO and 81% N_2. **[5]**

Best of luck

KADI SARVA VISHWAVIDHYALAYA

B.E.Semester III

Subject code: ME-305 **Subject Name: Engineering Thermodynamics**

Date: 29|11|13 **Time:** 10 to 1 **Total Marks: 70**

Instructions:

1. Answer each section in separate Answer sheet.
2. Make suitable assumptions wherever necessary.
3. Use of Scientific calculator,. Steam table and mollier chart is permitted.
4. All questions are **Compulsory.**
5. Indicate Clearly, the options you attempt along with its respective question number.
6. Use the last page of main answer sheet for **rough work.**

SECTION-I

Q.1 (A) (i) Explain the concept of macroscopic and microscopic point of view as applied to the study of thermodynamics. **[03]**

(ii) Specify giving reasons whether the following systems are open, closed or isolated when in operation. **[02]**

(a) Scooter Engine (b) Universe

(B) Write the general steady flow energy equation and make the energy analysis of combustion chamber and centrifugal pump. **[05]**

(C) State and prove the Carnot theorem. **[05]**

OR

(C) Set up a Tds relation in the following form: **[05]**

$$Tds = C_v dT + \left(\frac{\beta T}{\alpha}\right) dv$$

where β is co-efficient of volume expansion, α is isothermal compressibility and the other symbols have their usual meanings.

Q.2 (A) Write and explain first law of thermodynamics for a closed system undergoing a cycle and change of state. **[05]**

(B) An inventor claims that his engine absorbs 300 kJ of energy from a thermal reservoir at 325 K and delivers 75 kJ of work. The inventor also states that his engine has two heat rejections : 125 kJ to a reservoir at 300 K and 100 kJ to a reservoir at 275 K. Check the validity of his claim. **[05]**

OR

Q.2 (A) Define entropy and show that for an irreversible process; $\int ds > \int \frac{dQ}{T}$ **[05]**

(B) A perfect gas has a molar mass of 26 kg/kmol and a value of γ=1.25. Make calculation for the heat rejected when 1 kg/s mass of the gas enters a pipeline at 300°C, and flows steadily to the end of the pipe where the temperature is 25 °C. The changes in velocity of gas in the pipeline are negligible. **[05]**

Q.3 (A) Explain the establishment of a thermodynamic temperature scale. **[05]**

(B) An inventor claims that he has developed a heat engine which absorbs 1200 kJ and 800 kJ of heat from reservoirs at 800 K and 600 K respectively, and rejects 600 kJ and 200 kJ of heat to reservoirs at 400 K and 300 K. The engine is further stated to give an output equivalent to 1200 kJ. Determine whether the engine suggested by the inventor is theoretically possible. **[05]**

OR

Q.3 (A) Set up an expression for availabilities of a steady flow system. **[05]**

(B) Derive the following relation for the difference in heat capacities: **[05]**

$$Cp - Cv = \frac{Tv\beta^2}{\alpha}$$

SECTION-II

Q.4 (A) How does Rankine cycle differ from the Carnot cycle for a vapor? Sketch Rankine cycle on p-v and T-s plots. **[05]**

(B) Describe briefly the construction and operational aspects of a system used to experimentally determine the calorific value of a sample coal. **[05]**

(C) Set up an expression for the Vander Waal's equation of state in terms of the compressibility factor, reduced temperature and reduced pressure. **[05]**

OR

(C) Write down the Vander Waal's equation of state. How does it differ from the ideal gas equation? What are the units of constant a and b appearing in Vander Waal's equation? **[05]**

Q.5 (A) With the help of p-v and T-s diagrams, show that for the same maximum pressure and heat input; $\eta_{Diesel} > \eta_{Dual} > \eta_{Otto}$. **[05]**

(B) A cylinder of volume capacity 0.1 m^3 is filled with 1.35 kg of ammonia at 2 MPa pressure. Using Vander Waal's equation of state, determine the temperature at which ammonia exists in the cylinder. The Vander Waal's constant for ammonia are: $a = 422.55 \times 10^{-3}$ $Pa(m^3/mol)^2$ and $b = 37 \times 10^{-6}$ m^3/mol. Compare the result obtained if ammonia is treated as ideal gas. **[05]**

OR

Q.5 (A) Define co-volume and force of cohesion. Also define compressibility and explain its significance. **[05]**

(B) An engine working on Diesel cycle has a compression ratio of 15 and fuel supply is cut off at 8% of stroke. If the engine has a relative efficiency of 50%, determine the fuel consumption per kW-hr. Assume the fuel has a calorific value of 42000 kJ/kg. **[05]**

Q.6 (A) Define and explain Enthalpy of formation and adiabatic flame temperature. **[05]**

(B) A steam power plant is to operate with a boiler pressure of 50 bar and a condenser pressure of 0.07 bar. The steam leaving the boiler is at a temperature of 350 °C. Determine the cycle efficiency and specific steam consumption for Rankine cycle. **[05]**

OR

Q.6 (A) State and explain the Dalton's law of partial pressures. On what assumptions this law is based? **[05]**

(B) A vessel contains 10 kg of oxygen, 8 kg of nitrogen and 25 kg of carbon dioxide at 375 K temperature and 250 kPa pressure. Make calculations for the capacity of the vessel, the partial pressure of each gas present in the vessel, and the total pressure in the vessel when the temperature is raised to 450 K. **[05]**

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KADI SARVA VISHWAVIDHYALAYA
B.E MECHANICAL Semester–III

Subject: Engineering Thermodynamics **Date: 02/05/2014**
Subject Code: ME-306 **Time: 10:30 am to 1:30 pm**
Total Marks: 70

Instructions:
1. Answer each section in separate Answer sheet.
2. Use of Scientific calculator is permitted.
3. All questions are **Compulsory**.
4. Indicate **clearly**, the options you attempt along with its respective question number.
5. Use the last page of main supplementary of **rough work.**

SECTION-I

Que:1 (A) Explain the following term [5]
1) Triple point with diagram.
2) Draw (T-h) diagram for steam.

(B) Explain the throttling process with help of diagram. [5]

(C) Derive expression of S.F.E.E & write down its application. [5]

OR

(C) The mass flow rate of steam into a steam turbine is 1.5Kg/s and heat transfer from the turbine is 8.5KW. The steam is entering in the turbine at the pressure of 2 MPa, temperature 350 °C, velocity 50m/s, elevation 6m and is leaving the turbine at a pressure of 0.1 MPa, quality of 100% velocity of 200m/s, elevation of 3m. Determine the power output of turbine. [5]

Que:2 (A) Explain the clausius inequality. [5]

(B) Prove that entropy as a property. [5]

OR

(A) Explain the following term [5]
1) Nernest law
2) Entropy and disorder

(B) Steam at 20 bar, 350°C is expanded in a steam turbine to 0.075 bar. It then enters a condenser, where it is condensed to liquid water. The pump feeds back
the water into boiler.
i) Assuming ideal processes, find per kg of steam the net work and [5]
ii) The cycle efficiency.
The above data for super heated and wet steams can be made use of if desired.

Que:3 (A) Explain Absolute thermodynamic scale [5]

(B) Explain the Carnot's therom. [5]

OR

(A) Explain equivalency of clausius and Kelvin plank statement [5]

(B) A reversible heat engine operates within the higher and lower temperature limits of 1400K and 400K respectively. The entire output from this engine is utilized to operate a heat pump. The pump works on reversed Carnot cycle, extracts heat from a reservoir at 300K and delivers it to the reservoir at 400K. If 100 KJ/s of net heat is supplied to the reservoir at 400K, calculate the heat supplied by the reservoir at 1400K. [5]

SECTION-II

Que:4 (A) Explain second law efficiency. [5]

(B) Explain availability of closed system. [5]

(C) To derive Tds equation. [5]

OR

(C) Derive vander waal's equation in reduced form of properties. [5]

Que:5 (A) Write down the statement [5]

1) Dalton's law of partial pressure.
2) Gibb's Dalton's law

(B) Derive the expression for Rankine cycle efficiency with help of (T-S) Diagram. [5]

OR

(A) Derive the expression for Diesel cycle efficiency with help of(P-V) & (T-S) Diagram. [5]

(B) In an ideal Brayton cycle, the ambient air at 1 bar - 300 K is compressed to 6 bar and the maximum cycle temperature is limited to 1200 K. if the heat supply is120 MW, find (i) The thermal efficiency of the cycle (ii) work ratio (iii) power output and (iv) mass flow rate of air. [5]

Que:6 (A) Define the following term [5]

1) Excess air
2) Equivalence ratio
3) Actual and Stoichiometric air fuel ratio

(B) Explain and Equation for adiabatic flame temperature. [5]

OR

(A) Explain the Bomb calorimeter with neat sketch. [5]

(B) Derive the Maxwell equation. [5]

Best of luck

KADI SARVA VISHWAVIDHYALAYA
B.E MECHANICAL Semester–III

Subject: Engineering Thermodynamics **Date: 21/11/2014**
Subject Code: ME-306/AE 306
Time: 10:30 am to 1:30 pm
Total Marks: 70

Instructions:
1. Answer each section in separate Answer sheet.
2. Use of Scientific calculator is permitted.
3. All questions are **Compulsory**.
4. Indicate **clearly**, the options you attempt along with its respective question number.
5. Use the last page of main supplementary of **rough work**.

	SECTION-I	
Que:1 (A)	Explain the following term 1) PMM-1 2) PMM-2	[5]
(B)	Explain the throttling process with help of diagram.	[5]
(C)	Derive expression of S.F.E.E & write down its application.	[5]
	OR	
(C)	The mass flow rate of steam into a steam turbine is 1.5Kg/s and heat transfer from the turbine is 8.5KW. The steam is entering in the turbine at the pressure of 2 MPa, temperature 350 °C, velocity 50m/s, elevation 6m and is leaving the turbine at a pressure of 0.1 MPa, quality of 100% velocity of 200m/s, elevation of 3m. Determine the power output of turbine.	[5]
Que:2 (A)	Explain the clausius Inequality.	[5]
(B)	Explain entropy principle.	[5]
	OR	
(A)	Explain the following term 1) Nernest law 2) Dead state.	[5]
(B)	Steam at 20 bar, 350°C is expanded in a steam turbine to 0.075 bar. It then enters a condenser, where it is condensed to liquid water. The pump feeds back the water into boiler. i) Assuming ideal processes, find per kg of steam the net work and ii) The cycle efficiency. The above data for super heated and wet steams can be made use of if desired.	[5]
Que:3 (A)	Explain Absolute thermodynamic scale	[5]
(B)	Explain the Carnot's therom.	[5]
	OR	
(A)	To prove that (C.O.P) refri +(C.O.P) heat pump= -1	[5]

(B)	A reversible heat engine operates within the higher and lower temperature limits of 1400K and 400K respectively. The entire output from this engine is utilized to operate a heat pump. The pump works on reversed Carnot cycle, extracts heat from a reservoir at 300K and delivers it to the reservoir at 400K. If 100 KJ/s of net heat is supplied to the reservoir at 400K, calculate the heat supplied by the reservoir at 1400K.	**[5]**
	SECTION-II	
Que:4 (A)	Explain second law efficiency.	**[5]**
(B)	Explain availability of open system.	**[5]**
(C)	To derive fundamental equation.	**[5]**
	OR	
(C)	Derive vander waal's equation in reduced form of properties.	**[5]**
Que:5 (A)	Write down the statement 1) Dalton's law of partial pressure. 2) Gibb's Dalton's law	**[5]**
(B)	Derive the expression for Brayton cycle efficiency with help of (T-S) Diagram.	**[5]**
	OR	
(A)	Derive the expression for Dual cycle efficiency with help of(P-V) & (T-S) Diagram.	**[5]**
(B)	In an ideal Brayton cycle, the ambient air at 1 bar - 300 K is compressed to 5 bar and the maximum cycle temperature is limited to 1200 K. if the heat supply is120 MW, find (i) The thermal efficiency of the cycle (ii) work ratio (iii) power output and (iv) mass flow rate of air.	**[5]**
Que:6 (A)	Define the following term 1) Excess air 2) Equivalence ratio 3) Actual and Stoichiometric air fuel ratio	**[5]**
(B)	Explain and Equation for adiabatic flame temperature.	**[5]**
	OR	
(A)	Explain the Orsat equipment with neat sketch.	**[5]**
(B)	Derive the Maxwell equation.	**[5]**

Best of luck