Department	Mechanical		Program	B.Tech	
Subject Name	Engineering Thermodynamics		Subject Code	MEC 304	
Semester	3rd	Credits	3	Teacher Incharge/Mentor	Prof. Adnan Qayoum
TA	Masrat Bashir (Research scholar)	Mobile No.	9797707178	email	masrat_13phd16@nitsri.net

Unit I

Text book to be consulted:

1. "**Fundamentals of Engineering Thermodynamics**" by Moran and Shapiro, 4th Edition, John Wiley.

Links to the resources:

1. https://www.youtube.com/watch?v=9GMBpZZtjXM
2. https://www.youtube.com/watch?v=xQwi9fveGTQ
3. https://www.youtube.com/watch?v=0jXeNaSM5Xc&index=3&list=PLD8E646BAB3366BC8
4. https://www.youtube.com/watch?v=sUDfpFD0xX4&index=4&list=PLD8E646BAB3366BC8
5. https://www.youtube.com/watch?v=bCToK4_dmbU&index=5&list=PLD8E646BAB3366BC8

Lecture 1:

Lecture 2:

Lecture 3:

Lecture 4:

Lecture 5:

Numerical Problems

1. A system consisting of 1 lb of a gas undergoes a process during which the relation between pressure and volume is pV = constant. The process begins with p_1 =100 lbf/in^2 , V_1 = 1.5ft^3 and ends with p_2 = 40 lbf/in^2. Determine the final volume, V_2 , in ft^3 and plot the processon a graph of pressure versus volume.

2. Determine the gage pressure , in lbf/in^2 , equivalent to a manometer reading of 1in. of
   (a) Water (density = 62.4 lb/ft^3)
   (b) mercury (the density of mercury is 13.59 times that of water)

3. A gas expands from an initial state where pressure is 340 kPa and volume is 0.0425 m^3 to a final state where *pressure* 136kPa. The relationship between pressure and volume during the process is pV ^{2} = constant. Sketch the process on a *p–V* diagram and determine the work, in kJ.

4. A gas undergoes two processes in series:
   Process 1–2: constant volume from p_1 = 50 lbf/in^2 to p_2 =10lbf/in^2
   Process 2–3: compression with pV$^{1..3}$ = constant from state 2 to p_3 = 50 lbf/in^2 and V_3 = 1 ft^3
   Sketch the processes on a *p*-V diagram and determine the work.

5. A gas in a piston–cylinder assembly is compressed from *p*1 = 3.4 bar, V_1 = 0.0283 m^3 to p_2 = 8.2 bar in a process for which the relation between pressure and volume is $pV^{1.2}$= *constant*. The mass of the gas is 0.183 kg. During the process, the heat transfer from the gas is 2.2 kJ. Determine the change in specific internal energy of the gas, in kJ/kg. Kinetic and potential energy effects are negligible.

6. A gas undergoes a thermodynamic cycle consisting of three processes beginning at an initial state where p_1 = 1bar, V_1 = 1.5 m^3, and U_1= 512kJ. The processes are as follows
   Process 1–2: compression with *pV* = *constant*, from p_2 = 2 bar, U_2 = 690kJ
   Process 2–3: W_{23} = 0, Q_{23} = -150 kJ
   Process 3–1: W_{31} = +50kJ
   There are no significant changes in kinetic or potential energy. Determine the heat transfer Q_{12} and Q_{31} each in kJ.

7. A gas undergoes a process from state 1, where p_1 = 20 lbf/in^2 to state 2, where p_2 = 60 lbf/in^2 and V_2 = 1.5 ft^3. The pressure volume relation during the process is pV = constant. The internal energy of the gas increases by 10,000 ft.lbf, and there are no changes in kinetic or potential energy during the process. Determine the heat transfer, in Btu.
8. Determine the phase or phases in a system consisting of H_2 O at the following conditions and sketch *p–v* and *T–v* diagrams showing the location of each state.
   (a) *p* = 5 lbf/in^2, *T* = 500 ^{0} F.
   (b) *p* = 50 lbf/in^2, *T* = 300 ^{0} F.

(c) p = 500 lbf/in^2, T = 600 ^{0} F.
(d) p = 20 lbf/in^2, T = 5 ^{0} F.
(e) p = 1000 lbf/in^2, T = 200 ^{0} F.

9. A two phase liquid vapor mixture of H_2 O at 200 lbf/in^2 has a specific volume of 1.5 ft^3 / lb. Determine the specific volume of a two phase liquid vapor mixture at 100 lbf/in^2 with the same quality.

10. A two phase liquid vapor mixture of H_2 O has a temperature of 300^0 C and a quality of 75%. The mixture occupies a volume of 0.05 m^3. Determine the masses of saturated liquid and vapor present each in kg.

11. Water vapor initially at 0.3 MPa and 160^0 C expands to 0.1 MPa in a piston cylinder assembly according to $pv^{1.2}$ = constant. Determine the specific volume at the final state, in m^3/kg, and sketch the process on a carefully labeled p-v diagram. For I kg of water vapor, calculate the work in kJ.

12. A rigid well insulated tank contains 3 kg of a two phase liquid vapor mixtutre of water, initially at 200 kPa with a quality of 84%. A paddle wheel stirs the mixture until only saturated vapor remains in the tank. Kinetic and potential energy effects are negligible. For the water, determine the amount of energy transferred by work in kJ.

13. Saturated water vapor initially at 40 lbf/in^2 is contained in a closed rigid tank with a volume of 1.5ft^3. Heat transfer from the water occurs and its pressure drops to 20 lbf/in^2. Calculate the amount of heat transfer, in Btu and the masses of saturated liquid and vapor present at the final state, in lb. Kinetic and potential energy effects are negligible.

14. A system consisting of 2 kg of H_2 O undergoes a cycle composed of the following processes:
Process 1–2: Expansion with pv = constant from saturated vapor at 100 bar to 10 bar
Process 2–3: constant pressure process to $v_3 = v_1$
Process 3–1: constant volume heating
Sketch the cycle on *p–v* and *T–v* diagrams. Neglecting kinetic and potential energy effects, determine the net work for the cycle and the heat transfer for each process, all in kJ.

15. Argon (Ar) gas initially at 500 kPa, 100 K undergoes a polytropic process with n = k to a final temperature of 300 K. determine the work and heat transfer for the process, each in kj per kg or argon. Assume ideal gas behavior and neglect kinetic and potential energy effects.

Reference books:

1. Cengal, Y., Boles, "Thermodynamics", *Mc-Graw Hill, 2001.*
2. Van-Wylen, G.J., "Fundamentals of Classical Thermodynamics", *John Wiley, 2001*.

Any other information:
In case of any difficulty, mail at: **masrat_13phd16@nitsri.net**