Minoufiya University
Faculty of Engineering
Mechanical Eng. Dept.

Post Graduate, Doctorate
MPE713 Gas Turbines
Date: 03-01-2018
Time allowed: 3 hrs

Solve all questions

1. (a) Explain what is meant by rothalpy. Using the definition of the rothalpy show why the static enthalpy rise in a centrifugal compressor is so large compared with a single stage axial compressor.

   (b) Describe in details why vaneless diffusers are suitable for only low pressure rise.

   (c) Write down the Euler equation for radial flow compressor and show what is meant by coefficient of work (head coefficient) and how it can be maximized.

   (d) What is meant by stonewall and a surge in radial flow compressor and how do they affect the operation of the compressor.

   (e) Write down the advantages and disadvantages of using free vortex guide vanes upstream of the impeller of a high pressure ratio centrifugal compressor. What other sorts of guide vanes can be used and how do they compare with free vortex vanes?

2. (a) Explain why *slip* occurs in centrifugal compressors, and discuss what causes the greatest influence on the case.

   (b) Air with k=1.4, c_p=1005 $Jkg^{-1}K^{-1}$ and R=287 $Jkg^{-1}K^{-1}$ enters a centrifugal compressor at a mass flow rate of 1.0 kgs^{-1}. The entry stagnation temperature is 300 K and the stagnation pressure is 105 kPa. The rotational speed is 120,000 rpm. At impeller exit, the vanes are radial and the radius is 50 mm. The slip factor is 0.92. There is no swirl at the inlet to the compressor. Determine the stagnation temperature at the exit of the impeller.

   (c) At impeller exit the radial velocity is 0.3 times the tip speed. Determine the absolute flow angle, the absolute Mach number and the relative Mach number of the flow leaving the impeller. Sketch the velocity triangle at this location.

   (d) The total-to-total efficiency of the impeller is 91%. Determine the stagnation pressure at impeller exit and hence the axial width of the impeller. You may ignore the thickness of the blades.

3. Discuss in details the possible use of radial flow compressors in gas turbines rather than axial flow ones.