Benha University | **Faculty of Engineering-Shoubra**
Mechanical Engineering Department | **3rd year (Mechanical Power)**
First term (2014-2015) (Time Hr) | **Answer To Final Exam** | **Fluid Mechanics (gas dynamic)**

Answer The Following Questions:

1- a- Define **(5 Degree)**

a-Stagnation state: it the state at which the fluid flow brought to be at rest

b- Stagnation enthalpy: it the total enthalpy of the flow (total energy) and could be achieved when the flow brought to be at rest

c- Stagnation pressure: the total pressure of the flow (maximum pressure) and could be attained when the flow brought to be at rest

d-Enthalpy : total energy contained in fluid flow

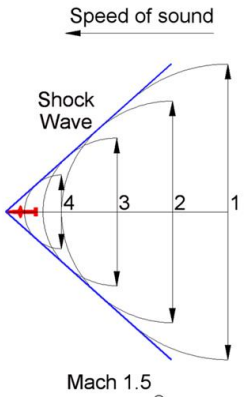
e- Adiabatic flow : the flow which it's properties could be estimated according to adiabatic process rules (no heat add or removed)

f- Isentropic flow: the flow which it's properties could be estimated according to isentropic process rules (no friction (frictionless))

g-Sound : it is a pressure wave (or small pressure disturbance in matter moved in form of wave)

b- Explain and describe How Mach cone formed for supersonic moving object in a compressible media (5-Degree)

When the object move with speed higher than the speed of sound
It generate sound waves in each location and move before it completely grow
The generated sound wave have different starting point and different time of creation
With grown up this waves looks like spheres have different diameter at different centers of creations but in the same line that object move on it
If the object move in straight line it created a cone the object the tip of it is the moving object
The cone boundary is a shock wave



C- Nitrogen flows in a duct. Conditions at section 1 are as follows: P1 = 200 kPa T_1 = 90°C and V_1 = 10 m/sec. At section 2, we find that p2 = 45 kPa and T2 = 90°C.
Determine the velocity at section 2. **(5-degree)**

d- An airplane files at an altitude of 10,000m where T=223 K and P=0.264 bar with a velocity of 800 Km/hr. Calculate:

a- The maximum possible temperature on the airplane skin.
b- The maximum possible pressure on the airplane body.
c- The critical and maximum. Velocities of air relative to airplane **(5-degree)**

2- a- 1- Prove the following relations for isentropic flow:

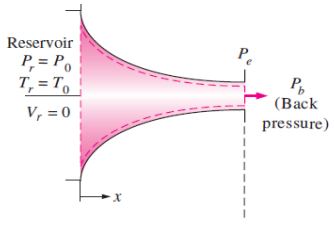
$$\frac{T_o}{T} = 1 + \frac{\gamma - 1}{2} M^2 \qquad \frac{p_o}{p} = \left(1 + \frac{\gamma - 1}{2} M^2\right)^{\gamma/(\gamma-1)}$$

(5 Degree)

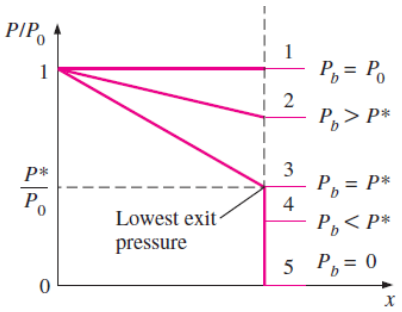
b- Air enters a converging–diverging nozzle at a pressure of 1.2 MPa with negligible velocity. What is the lowest pressure that can be obtained at the throat of the nozzle? **(5 Degree)**

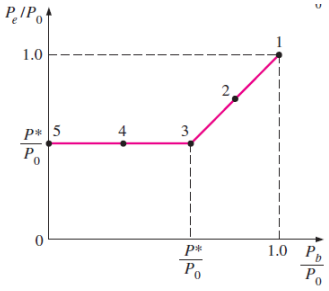
3- a- Consider the subsonic flow through a converging nozzle as shown Draw a chart to explain.

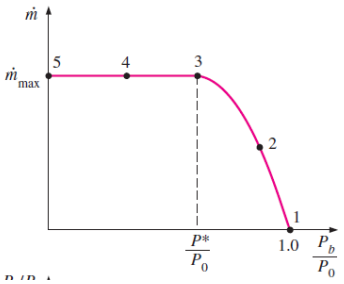
1-The effect of back pressure on the pressure distribution along a converging nozzle.
2-The effect of back pressure P_b on the mass flow rate
3- The effect of back pressure variation on the exit pressure ***Pe*** of a converging nozzle.



(15 Degree)







b- Is it possible to accelerate a gas to a supersonic velocity in a converging nozzle? and why (5 Degree)

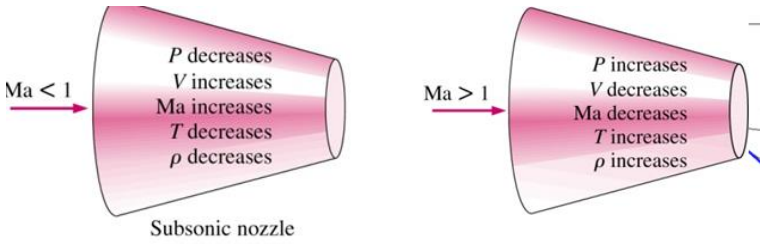
Answer

No it is impossible

due to that equation of

The speed of flow could reach to be sonic velocity through convergent section because it is a nozzle in case subsonic flow

But after that the flow couldn't increase the velocity due to that the convergent section work as diffuser for supersonic velocity



4- a- Can a shock wave develop in the converging section of a converging–diverging nozzle? Explain. (5 Degree)

No due to that the main condition of shock wave that the flow must be supersonic and in convergent divergent nozzle it is impossible for the flow to supersonic at convergent section

b- Air enters a converging–diverging nozzle of a supersonic wind tunnel at 1.5 MPa and 350 K with a low velocity. If a normal shock wave occurs at the exit plane of nozzle at Ma = 2, determine the pressure, temperature, Mach number, velocity, and stagnation pressure after the shock wave**.** **(10 Degree)**

5- a- A convergent – divergent nozzle is designed to produce air at Mach number of **2.8** , the air enters the nozzle at stagnation conditions of **10 bars** and **370 K** , a constant area duct with a length **10 times** diameter is attached to the nozzle outlet , the friction factor in the duct is **0.005**

a- Draw the T-S diagram for the system

b- Compute the receiver pressure that would place a shock wave at the duct exit

c- What is the total change in entropy for the system **(10 Degree)**

6- a- Air enters a constant area duct with a Mach number of **2;** the temperature and pressure are **170K** and **0.7bars**. Heat transfer take place while the flow proceeds down the duct, a convergent section **(A_e/A_i=1.45)** is attached to the outlet of the duct and the exit Mach number from the nozzle is 1, find the amount of the heat transfer and its direction. **(10 Degree)**

b- What do the states on the Fanno line and the Rayleigh line represent? What do the intersection points of these two curves represent? **(5 Degree)**

answer

The Fanno line represents the states which satisfy the conservation of mass and energy equations.

The Rayleigh line represents the states which satisfy the conservation of mass and momentum equations.

The intersections points of these lines represent the states which satisfy the conservation of mass, energy, and momentum equations.