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GAS DYNAMICS

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MIT, CHENNAI
AIR - 9

VIGNESH CG
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AIR - 11

ADITYA ANIL KUMAR
IIST TRIVANDRUM
AIR - 17

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AIR - 11

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RVCE, BANGALORE
AIR - 14

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Sastra Univ - Tanjore

Vagicharla Dinesh
Lovely Professional Univ - Punjab

Anantha Krishan A.G
Amrita Univ - Coimbatore

HAL DT ENGINEER 2022

Fathima J
MIT - Chennai

Mohan Kumar H
MVJCE - Bangalore

HAL DT ENGINEER 2021

Arathy Anilkumar Nair
Amrita Univ - Coimbatore

Sadsivuni Tarun
Sastra Univ - Tanjore

DRDO & ADA Scientist B

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Dheeraj Sappa
IIEST - Shibpur

F Jahangir
MIT - Chennai

Goutham
KCG College - Chennai

M Kumar
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DGCA Air Safety & Worthiness Officer

Job Position for Recruitment (2023)

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FGIET - Raebareli

Aishwarya PS
BMS College - Bangalore

Anil Kumar Nakkala
Malla Reddy College - Hyderabad

Ayush Boral
KIIT - Bhubaneswar

Dhiraj Rajendra Kapte
Priyadarshini College - Nagpur

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S Komesh
Sathyabama University - Chennai

Shrenith Suhas
IIEST - Shibpur

Ankur Vats
School Of Aeronautics - Neemrana

3. Gas Dynamics

GATE AE - 2007

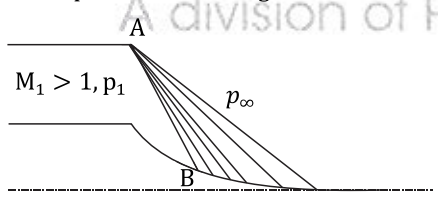
One Mark Questions.

1. Total pressure at a point is defined as the pressure when the flow is brought to rest
   (A) adiabatically
   (B) isentropically
   (C) isothermally
   (D) isobarically

2. Across a normal shock
   (A) both total temperature and total pressure decrease
   (B) both total temperature and total pressure remain constant
   (C) total pressure remains constant but total temperature decreases
   (D) total temperature remains constant but total pressure decreases

Two Marks Questions.

3. An aerospace system shown in the following figure is designed in such a way that the expansion generated at A is completely absorbed by wall B for $p_1 = p_d$, where p_d corresponds to the design condition.



For $p_1 > p_\infty$ which of the following statements is NOT true?
   (A) For $p_1 < p_d$, the expansion fan from A gets reflected from B as a compression wave
   (B) For $p_1 > p_d$, the expansion fan from A gets reflected from B as an expansion wave
   (C) For $p_1 < p_d$, the expansion fan from A gets reflected from B as an expansion wave
   (D) For $p_1 > p_d$, B always sees and expansion

GATE AE - 2008

One Mark Questions.

4. An irrotational and inviscid flow can become rotational on passing through a
   (A) normal shock wave
   (B) oblique shock wave
   (C) curved shock wave
   (D) Mach wave

5. In a convergent-divergent (CD) nozzle of a rocket motor, the wall heat flux is maximum at
   (A) the exit of the divergent portion of the CD nozzle
   (B) the entry to the convergent portion of the CD nozzle
   (C) the throat of the CD nozzle
   (D) the mid-length of the divergent portion of the CD nozzle

Two Marks Questions.

6. Consider steady, inviscid flow in a convergent-divergent (CD) nozzle, with a normal shock in the divergent portion. The static pressure along the nozzle downstream of the normal shock
   (A) remains constant
   (B) increases isentropically to the static pressure at the nozzle exit
   (C) decreases isentropically to the static pressure at the nozzle exit
   (D) can increase or decrease, depending on the magnitude of the static pressure at the nozzle exit

7. In supersonic wind-tunnel design, an oblique shock diffuser is preferred over a normal shock diffuser because
   (A) it reduces total pressure loss
   (B) the flow is slowed down more rapidly
   (C) the flow is accelerated more rapidly
   (D) it increases total pressure loss

GATE AE - 2009

One Mark Questions.

8. For a flow through a Prandtl-Meyer expansion wave
   (A) Mach number stays constant.
   (B) Entropy stays constant.
   (C) Temperature stays constant.
   (D) Density stays constant.

9. An aircraft is flying at M = 2 where the ambient temperature around the aircraft is 250 K. If the specific heat ratio for air $\gamma = 1.4$, the stagnation temperature on the surface of the aircraft is
   (A) 200 K (C) 350 K
   (B) 450 K (D) 1450 K

Two Marks Questions.

10. Which of the following statements are true for flow across a stationary normal shock?
   P. Stagnation temperature stays constant.
   Q. Stagnation pressure decreases.
   R. Entropy increases.
   S. Stagnation pressure increases.
   T. Stagnation temperature increases.
   (A) P, Q, R (C) R, S, T
   (B) Q, R, S (D) S, T, P

GATE AE - 2010

One Mark Questions.

11. For a flow across an oblique shock which of the following statements is true?
   (A) Component of velocity normal to shock decreases while tangential component increases.
   (B) Component of velocity normal to shock increases while tangential component decreases.
   (C) Component of velocity normal to shock is unchanged while tangential component decreases.
   (D) Component of velocity normal to shock decreases while tangential component is unchanged.

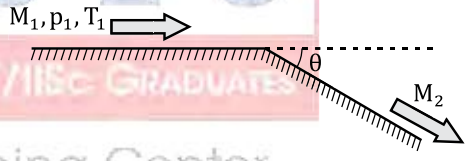
GATE AE - 2011

Two Marks Questions.

12. Consider the inviscid, adiabatic flow of air at free stream conditions, $M_1 = 2$, $p_1 = 1$ atm and $T_1 = 288$ K around a sharp expansion corner ($\theta = 20°$) as shown below. The Prandtl-Meyer function, ν, is given as a function of Mach number, M, as

$$\nu(M) = \sqrt{\frac{\gamma+1}{\gamma-1}}\tan^{-1}\sqrt{\frac{\gamma-1}{\gamma+1}(M^2-1)} - \tan^{-1}\sqrt{M^2-1}$$

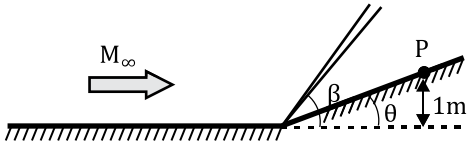
Assume air to be calorically perfect with $\gamma = 1.4$. The Mach number, M_2, downstream of the expansion corner is approximately



   (A) 2.00 (C) 2.83
   (B) 1.76 (D) 3.14

Common Data for Questions 13 and 14:

Consider an inviscid, adiabatic flow of air at free stream Mach Number, $M_\infty = 2$, across a compression corner ($\theta = 20°$) as shown. The free stream total enthalpy is $h_{0\infty} = 810$ kJ kg^{-1} Assume that air is calorically perfect with $\gamma = 1.4$, R = 287 J kg^{-1}K^{-1}.



13. The shock angle β is

(A) = 20° (C) = 30°
(B) > 20° and < 30° (D) > 30°

14. The total temperature at point P is

(A) 806.37 K (C) 1612.74 K
(B) 1128.92 K (D) 2257.84 K

GATE AE - 2012

One Mark Questions.

15. The shadowgraph flow visualization technique depends on

(A) the variation of the value of density in the flow.
(B) the first derivative of density with respect to spatial coordinate.
(C) the second derivative of density with respect to spatial coordinate.
(D) the third derivative of density with respect to spatial coordinate.

16. The Mach angle for a flow at Mach 2.0 is

(A) 30° (C) 60°
(B) 45° (D) 90°

Two Marks Questions.

17. An oblique shock wave with a wave angle β is generated from a wedge angle of θ. The ratio of the Mach number downstream of the shock to its normal component is

(A) $\sin(\beta - \theta)$ (C) $\sin(\theta - \beta)$
(B) $\cos(\beta - \theta)$ (D) $\cos(\theta - \beta)$

18. In a closed-circuit supersonic wind tunnel, the convergent-divergent (C-D) nozzle and test section are followed by a C-D diffuser to swallow the starting shock. Here, we should have the

(A) diffuser throat larger than the nozzle throat and the shock located just at the diffuser throat.
(B) diffuser throat larger than the nozzle throat and the shock located downstream of the diffuser throat.
(C) diffuser throat of the same size as the nozzle throat and the shock located just at the diffuser throat.
(D) diffuser throat of the same size as the nozzle throat and the shock located downstream of the diffuser throat.

GATE AE - 2013

One Mark Questions.

19. Which one of the following statements is NOT TRUE for a supersonic flow?

(A) Over a gradual expansion, entropy remains constant
(B) Over a sharp expansion corner, entropy can increase
(C) Over a gradual compression, entropy can remain constant
(D) Over a sharp compression corner, entropy increases

20. Consider a compressible flow where an elemental volume of the fluid is $\delta\vartheta$, moving with velocity $\vec{V}$. Which one of the following expressions is TRUE?

(A) $\nabla \cdot \vec{V} = \frac{1}{\delta\vartheta}\frac{D\delta\vartheta}{dt}$

(B) $\nabla \cdot (\nabla \times \vec{V}) = \frac{1}{\delta\vartheta}\frac{D\delta\vartheta}{dt}$

(C) $\nabla \cdot \frac{D\vec{V}}{Dt} = \frac{1}{\delta\vartheta}\frac{D\delta\vartheta}{dt}$

(D) $\vec{V} \cdot (\nabla \times \vec{V}) = \frac{1}{\delta\vartheta}\frac{D\delta\vartheta}{dt}$

Two Marks Questions.

21. Consider a supersonic stream at a Mach number M=2, undergoing a gradual expansion. The stream is turned by an angle of 3 degrees due to the expansion. The following data is given.

M	v (Prandtl-Meyer Function)
1.8	20.73
1.9	23.59
2.0	26.38
2.1	29.10
2.2	31.73
2.3	34.28
2.4	36.75

The Mach number downstream of the expansion is

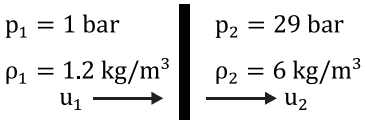
(A) 1.88 (C) 2.11

(B) 2.00 (D) 2.33

GATE AE - 2014

Two Marks Questions.

22. A student needs to find velocity across a stationary normal shock. He measures density and pressure across the shock as shown in the figure below. 1bar = 10^5Pa. (No shock table is needed for the calculations). The value of u_1 in m/s is ___.



GATE AE - 2015

Two Marks Questions.

23. An ideal gas in a reservoir has a specific stagnation enthalpy of h_0. The gas is isentropically expanded to a new specific stagnation enthalpy of $\frac{h_0}{2}$ and velocity u. The flow is one-dimensional and steady.

Then $\frac{u^2}{h_0} =$ _____.

24. For a normal shock, the relation between the upstream Mach number (M_1) and the downstream Mach number (M_2) is given by $M_2^2 = \frac{(\gamma-1)M_1^2+2}{2\gamma M_1^2+1-\gamma}$. For an ideal gas with γ =1.4 , the asymptotic value of the downstream Mach number is _____.

GATE AE - 2016

One Mark Questions.

25. Which of the following statement is NOT TRUE across an oblique shock wave?

(A) Static temperature increases, total temperature remains constant.

(B) Static pressure increases, static temperature increases.

(C) Static temperature increases, total pressure decreases.

(D) Static pressure increases, total temperature decreases.

26. For a completely subsonic isentropic flow through a convergent nozzle, which of the following statement is TRUE?

(A) Pressure at the nozzle exit > back pressure.

(B) Pressure at the nozzle exit < back pressure.

(C) Pressure at the nozzle exit = back pressure.

(D) Pressure at the nozzle exit = total pressure.

Two Marks Questions.

27. Consider 1-D, steady, inviscid, compressible flow through a convergent nozzle. The total temperature and total pressure are T_o, P_o respectively. The flow through the nozzle is choked with a mass flow rate of $\dot{m}_o$. If the total temperature is increased to $4T_o$, with total pressure remaining unchanged, then the mass flow rate through the nozzle

(A) remains unchanged.

(B) becomes half of $\dot{m}_o$.

(C) becomes twice of $\dot{m}_o$.

(D) becomes four times of $\dot{m}_o$.

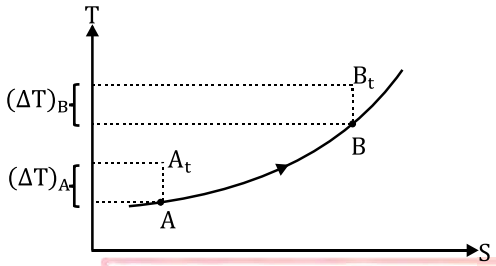
28. In a particular rocket engine, helium propellant is heated to 6000 K and 95% of its total enthalpy is recovered as kinetic energy of the nozzle exhaust. Consider helium to be a calorically perfect gas with specific heat at constant pressure of 5200 J/kgK. The exhaust velocity for such a rocket for an optimum expansion is _____ m/s.

GATE AE - 2017

One Mark Questions.

29. A De Laval nozzle is to be designed for an exit Mach number of 1.5. The reservoir conditions are given as $P_o = 1$ atm(gage), $T_o = 20°C$, γ =1.4. Assuming shock free flow in the nozzle, the exit absolute pressure (in atm) is_____(in three decimal places)

30. Consider a steady one-dimensional flow of a perfect gas with heat transfer in a duct. The T-s diagram (shown below) shows both the static and the stagnation conditions at two locations. A and B, in the duct. A_t and B_t denote stagnation conditions for states A and B, respectively. It is known that $(\Delta T)_A = (\Delta T)_B$. M_A and M_B are the Mach numbers of the flow at locations A and B.



Which of the following statements is true about the flow

(A) Flow is subsonic and $M_A < M_B$.

(B) Flow is supersonic and $M_A > M_B$

(C) Flow is subsonic and $M_A > M_B$

(D) Flow is supersonic and $M_A < M_B$

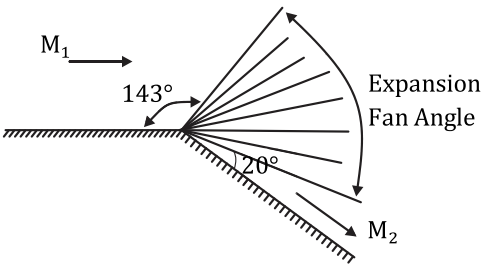
Two Marks Questions.

31. A trace from the schlieren photograph of the flow around a corner reveals the edges of the expansion fan as shown below. The leading and trailing edges of the expansion fan make the angles as shown. Assuming $\gamma = 1.4$, the angle of the expansion fan (in degrees) is_____ (in two decimal places)

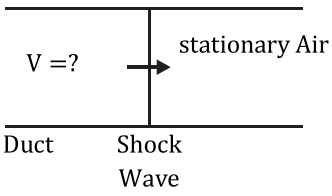
Prandtl Meyer function is given by

$$v(M) = \sqrt{\frac{\gamma+1}{\gamma-1}}\tan^{-1}\sqrt{\frac{\gamma-1}{\gamma+1}(M^2-1)} - \tan^{-1}\sqrt{(M^2-1)}$$

34.



32. A strong normal shock wave, with a pressure ratio of 29 across it, is travelling into stationary air ($\gamma = 1.4$) at T = 280 K in a straight duct (see figure). The magnitude of the velocity of the air induced behind the shock wave is_____m/s. (round to nearest integer)



(Gas constant = 287 J/kgK; Shock wave relations:

Pressure ratio: $\frac{p_2}{p_1} = 1 + \frac{2\gamma}{\gamma+1}(M^2-1)$:

Density ratio: $\frac{\rho_2}{\rho_1} = \frac{(\gamma+1)M^2}{(\gamma-1)M^2+2}$

GATE AE - 2018

One Mark Questions.

33. A shock wave is moving into still air in a shock tube. Which one of the following happens to the air?

(A) static temperature increases, total temperature remains constant.

(B) static temperature increases, total temperature increases.

(C) static temperature increases, total temperature decreases.

(D) static pressure increases, total temperature remains constant.

Two Marks Questions.

Air at 50 kPa pressure and 400 K temperature flows in a duct at Mach 3.0. A part of the flow leaks through an opening on the duct wall into the ambient, where the pressure is 30 kPa. The maximum Mach number achieved in the discharge is _____ (accurate to two decimal places). (Ratio of specific heats of air is $\gamma = 1.4$).

35. Consider a 20° half-angle wedge in a supersonic flow at Mach 3.0 at standard sea-level conditions. If the shock-wave angle on the wedge is 36°, the Mach number of the tangential component of the flow post-shock is _____ (accurate to two decimal places).

GATE AE - 2019

Two Marks Questions.

36. The static pressure ratio across a stationary normal shock is given by

$$\frac{p_2}{p_1} = 1 + \frac{2\gamma}{\gamma+1}(M_1^2 - 1).$$

where M_1 is the upstream Mach number. For a stationary normal shock in air ($\gamma = 1.4, R = 287\,J/kg-K$) with upstream flow conditions given by: speed 800 m/s, static temperature 300 K and static pressure 1 atm, the static pressure downstream of the shock is _____atm. (round off to 2 decimal places).

37. A supersonic flow in a constant area duct at Mach number M_1 encounters a ramp of angle θ_1 (see figure 1). The resulting oblique shock with shock angle β_1 is then reflected from the top wall. For the reflected shock, the turn angle is θ_2 and the shock angle is β_2

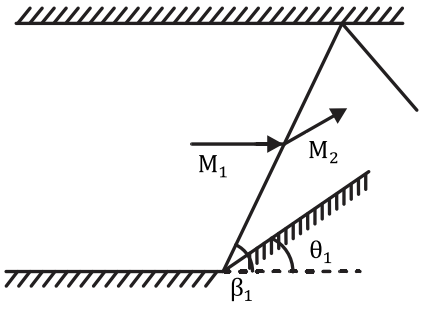
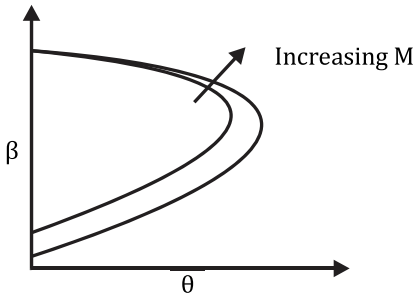


Figure 1



Use the weak shock solution from the $\theta - \beta - M$ plot shown in Figure 2 to choose the correct option from the following.

(A) $\beta_1 > \beta_2$ (C) $\theta_1 > \theta_2$

(B) $\beta_1 < \beta_2$ (D) $\theta_1 < \theta_2$

GATE AE - 2020

One Mark Questions.

38. Which of the following options can result in an increase in the Mach number of a supersonic flow in a duct?

(A) Increasing the length of the duct

(B) Adding heat to the flow

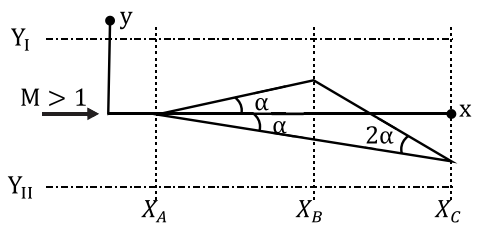
(C) Removing heat from the flow

(D) Inserting a convergent-divergent section with the same cross-sectional area at its inlet and exit planes

Two Marks Questions.

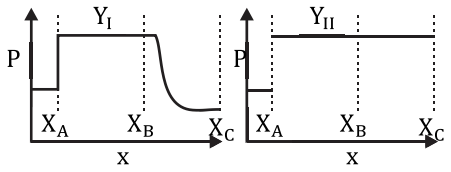
39. A wedge shaped airfoil is placed in a supersonic flow as shown in the figure (not to scale). The corners of the wedge are at

$x = X_A, x = X_B, x = X_C$, respectively

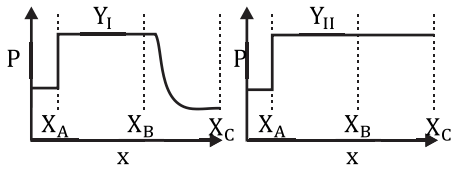


Which one the following represents the correct static pressure profiles along $y = Y_I$ and $y = Y_{II}$?

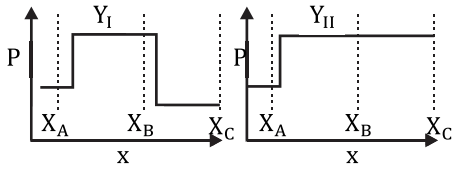
(A)



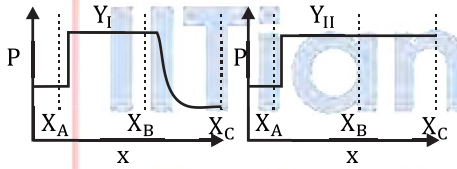
(B)



(C)



(D)

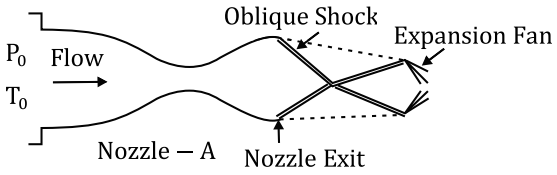


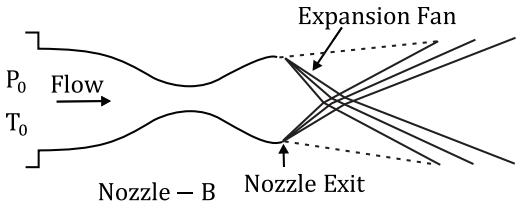
40. An oblique shock is inclined at an angle of 35 degrees to the upstream flow of velocity 517.56 m/s. The deflection of the flow due to this shock is 5.75 degrees and the temperature downstream is 182.46 K. Assume the gas constant R = 287 J/(kg K), specific heat ratio $\gamma = 1.4$. and specific heat at constant pressure $C_P = 1005$ J/(kg K). Using conservation relations, the Mach number of the upstream flow can be obtained as_____ (round off to one decimal place).

GATE AE - 2021

One Mark Questions.

41. The figure shows schematics of wave patterns at the exit of nozzles A and B operating at different pressure ratios.





Nozzles A and B, respectively, are said to be operating in:

(A) over-expanded mode and under-expanded mode

(B) under-expanded mode and perfectly expanded mode

(C) perfectly expanded mode and under-expanded mode

(D) under-expanded mode and over-expanded mode

42. The shape of a supersonic diffuser that slows down a supersonic flow to subsonic flow is

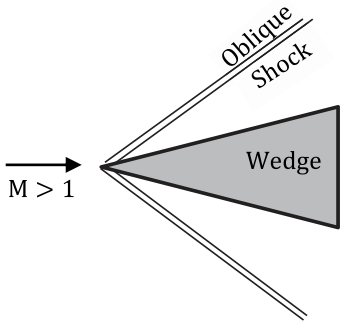
(A) converging

(B) diverging

(C) diverging–converging

(D) converging–diverging

43. Which of the following statement(s) is/are true across an oblique shock (in adiabatic conditions) over a wedge shown below?



(A) Total pressure decreases

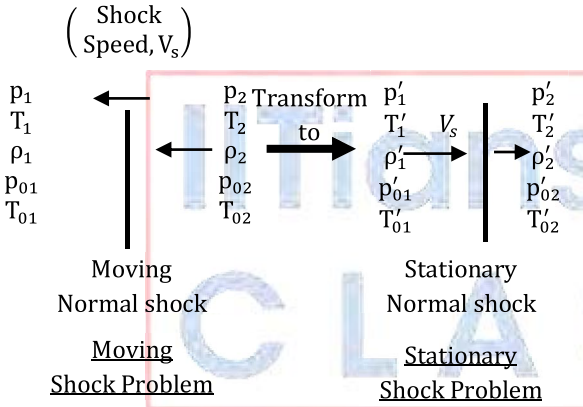
(B) Mach number based on velocity tangential to the shock decreases

(C) Total temperature remains constant

(D) Mach number based on velocity tangential to the shock remains the same and that based on velocity normal to the shock decreases

Two Marks Questions.

44. A shock moving into a stationary gas can be transformed to a stationary shock by a change in reference frame, as shown in the figure. Which of the following is/are true relating the flow properties in the two reference frames?



(A) $T_1' > T_1, T_{01}' > T_{01}, p_{01}' > p_{01}, \rho_2' > \rho_1'$

(B) $T_1' = T_1, T_2' < T_{01}, p_{01}' > p_{01}, \rho_2' = \rho_2$

(C) $T_1' < T_1, p_1' > p_1, p_{01}' > p_{01}, \rho_2' > \rho_1$

(D) $T_1' = T_1, p_2 > p_{01}, T_{01}' > T_{01}, p_{01}' > p_{01}$

GATE AE - 2022

One Mark Questions.

45. The point of maximum entropy on a Fanno-curve in a Temperature-Entropy (T-s) diagram represents the

(A) maximum flow Mach number

(B) minimum flow Mach number

(C) sonic Mach number

(D) normal shock in the flow

46. Across an oblique shock wave in a calorifically perfect gas,

(A) the stagnation enthalpy changes

(B) the stagnation entropy changes

(C) the stagnation temperature changes

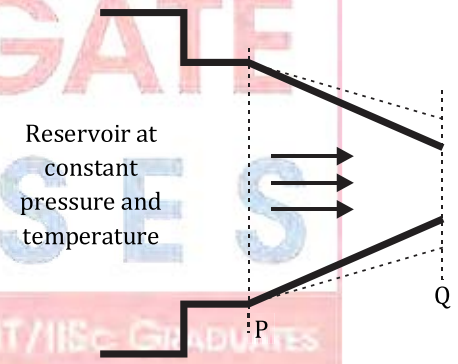
(D) the speed of sound changes

Two Marks Questions.

47. A convergent nozzle fed from a constant pressure, constant temperature reservoir, is discharging air to atmosphere at 1 bar (absolute) with choked flow at the exit (marked as Q).

Flow through the nozzle can be assumed to be isentropic.

If the exit area of the nozzle is increased while all the reservoir parameters and ambient conditions remain the same, then at steady state



(A) the nozzle will remain choked

(B) the nozzle will be un-choked

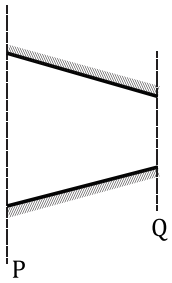
(C) the Mach number at section P will increase

(D) the Mach number at section P will decrease

48. In a converging duct, area and velocity at section P are 1 m^2 and 15 m/s, respectively. The temperature of the fluid is 300 K. Air flow through the nozzle can be assumed to be inviscid and isothermal. Characteristic gas constant is 287 J/(kg-K) and ratio of specific heats is 1.4 for air.

To ensure that the air flow remains incompressible (Mach number, M $\leq$ 0.3) in the

duct, the minimum area required at section Q is ____ m^2 (rounded off to two decimal places).

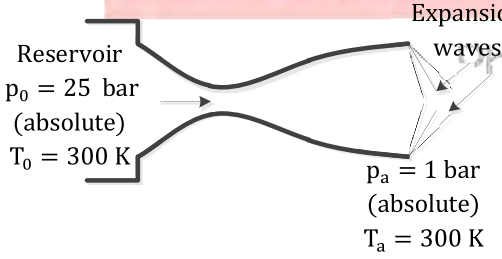


49. A convergent-divergent nozzle with adiabatic walls is designed for an exit Mach number of 2.3. It is discharging air to atmosphere under the conditions indicated in the figure.

Flow through the nozzle is inviscid, the characteristic gas constant for air is 287 J/(kg-K), and γ =1.4.

When the reservoir pressure is 25 bar (absolute), and temperature is 300 K, Prandtl-Meyer expansion waves appear at the nozzle exit as shown.

The minimum percentage change in the reservoir pressure required to eliminate the wave system at the nozzle exit under steady state is _____%.



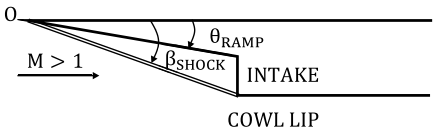
GATE AE - 2023

One Mark Questions.

50. The ratio of the speed of sound in H_2 (molecular weight 2 kg/kmol) to that in N_2 (molecular weight 28 kg/kmol) at temperature 300 K and pressure 2 bar is ____. (round off to two decimal places)

Two Marks Questions.

51. A supersonic aircraft has an air intake ramp that can be rotated about the leading edge O such that the shock from the leading edge meets the cowl lip as shown in the figure. Select all the correct statement(s) as per oblique shock theory when the flight Mach number M is increased.



(A) It is always possible to find a ramp setting θ_{RAMP} such that the shock still meets the cowl lip (β_{SHOCK} remains the same).

(B) If θ_{RAMP} is held fixed, the shock angle β_{SHOCK} will increase.

(C) If M exceeds a critical value, it would NOT be possible to find a ramp setting θ_{RAMP} such that the shock still meets the cowl lip (β_{SHOCK} remains the same).

(D) Shock angle $\beta_{SHOCK} < \sin^{-1}(1/M)$

52. A perfect gas stored in a large reservoir exhausts into the atmosphere through a convergent duct. The reservoir pressure is P_0 and temperature is T_0. The jet emerges from the nozzle at choked conditions with average velocity u, Mach number M, pressure p, temperature T, and density ρ. If the reservoir pressure is increased, then

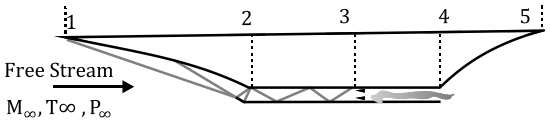
(A) u, M, p, T, and ρ increase

(B) u, p, T, and ρ increase, but M remains the same

(C) u, M, and T remain the same, but p and ρ increase

(D) u, M, T and ρ remain the same, but p increases

53. A scramjet engine features an intake, isolator, combustor, and a nozzle, as shown in the schematic. Station 3 indicates the combustor entry point. Assume stagnation enthalpy to be constant between Stations 1 and 3, and air to be a calorically perfect gas with specific heat ratio γ. Select the correct expression for Mach number M_3 at the inlet to the combustor from the options given.



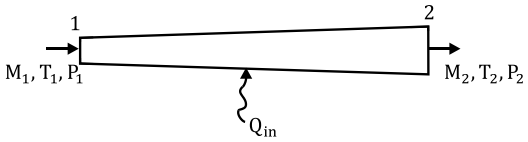
(A) $M_3 = M_\infty \sqrt{\left(\frac{2}{\gamma-1}\right)\left(\frac{T_\infty}{T_3}-1\right)}$

(B) $M_3 = \sqrt{\left(\frac{2}{\gamma-1}\right)\left\{\frac{T_\infty}{T_3}\left[1+\left(\frac{\gamma-1}{2}\right)M_\infty^2\right]-1\right\}}$

(C) $M_3 = M_\infty \sqrt{\frac{T_\infty}{T_3}}$

(D) $M_3 = \sqrt{\left(\frac{\gamma+1}{2}\right)\left(\frac{T_\infty}{T_3}-1\right)M_\infty^2 - 1}$

54. Consider a one-dimensional inviscid supersonic flow in a diverging duct with heat addition (Q_{in}) as shown. Which of the following statement(s) is/are always TRUE?



(A) Mach number, $M_2 > M_1$

(B) Stagnation pressure, $P_1^0 > P_2^0$

(C) Static pressure, $P_2 > P_1$

(D) Stagnation temperature, $T_1^0 < T_2^0$

GATE AE - 2024

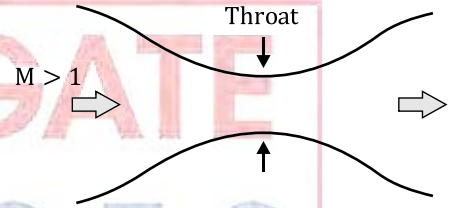
One Mark Questions.

55. On Day 1, an aircraft flies with a speed of V_1 m/s at an altitude where the temperature is T_1 K. On Day 2, the same aircraft flies with a speed of $\sqrt{1.2}\,V_1$ m/s at an altitude where the temperature is $1.2\,T_1$ K. How does the Mach number M_2 on Day 2 compare with the Mach number M_1 on Day 1?

Assume ideal gas behavior for air. Also assume the ratio of specific heats and molecular weight of air to be the same on both the days.

(A) $M_2 = 0.6M_1$
(B) $M_2 = M_1$
(C) $M_2 = 1/\sqrt{1.2}M_1$
(D) $M_2 = \sqrt{1.2}M_1$

56. Consider a steady, isentropic, supersonic flow (Mach number M > 1) entering a Convergent-Divergent (CD) duct as shown in the figure. Which one of the following options correctly describes the flow at the throat?



(A) Can only be supersonic
(B) Can only be sonic
(C) Can either be sonic or supersonic
(D) Can only be subsonic

57. Consider steady, incompressible, inviscid flow past two airfoils shown in the figure. The coefficient of pressure at the trailing edge of the airfoil with finite angle, shown in figure (I), is C_{P_I} while that at the trailing edge of the airfoil with cusp, shown in figure (II), is $C_{P_{II}}$. Which one of the following options is TRUE?

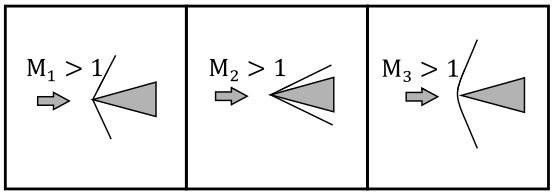
(I) Training edge with finite angle

(II) Training edge with cusp

(A) $C_{P_I} < 1, C_{P_{II}} < 1$ (C) $C_{P_I} = 1, C_{P_{II}} < 1$
(B) $C_{P_I} = 1, C_{P_{II}} = 1$ (D) $C_{P_I} < 1, C_{P_{II}} = 1$

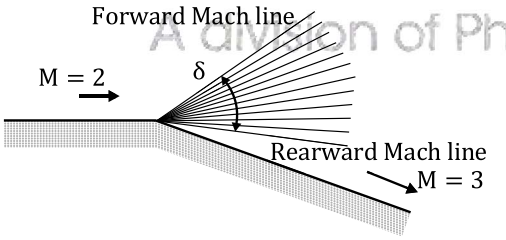
Two Marks Questions.

58. Shock structures for flow at three different Mach numbers over a given wedge are shown in the figure below. Assuming that only the weak shock solutions are possible for the attached oblique shocks, which one of the following options is TRUE?



(A) $M_1 < M_2 < M_3$ (C) $M_1 < M_3 < M_2$
(B) $M_1 > M_2 > M_3$ (D) $M_3 < M_1 < M_2$

59. Air flowing at Mach number M = 2 from left to right accelerates to M = 3 across an expansion corner as shown in the figure. What is the value of δ (the angle between the Forward and Rearward Mach lines) in degrees? The values of the Prandtl-Meyer functions are $\nu(3)$ = 49.76° and $\nu(2)$ = 26.38°.



(A) 23.38 (C) 53.38
(B) 19.47 (D) 33.91

60. Consider the following Fanno flow problem: Flow enters a constant area duct at a temperature of 273 K and a Mach number 0.2 and eventually reaches sonic condition (Mach number =1) due to friction.
Assume $\gamma = 1.4$. The static temperature at the location where sonic condition is reached is_____ K (rounded off to 2 decimal places).

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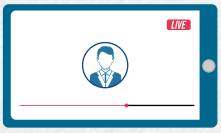

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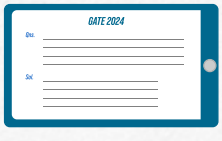

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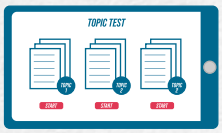

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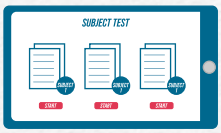

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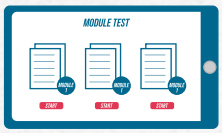

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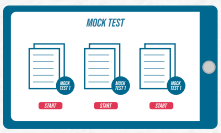

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6	B	7	A	8	B	9	B	10	A
11	D	12	C	13	D	14	A	15	C
16	A	17	A	18	B	19	B	20	A
21	C	22	1705 to 1720	23	0.99 to 1.01	24	0.37 to 0.39	25	D
26	C	27	B	28	7690 to 7710	29	0.540 to 0.560	30	B
31	48.00 to 49.00	32	1341 to 1343	33	B	34	3.30 to 3.40	35	1.90 to 2.20
36	5.95 to 6.10	37	B	38	C	39	D	40	1.9 to 2.1
41	A	42	D	43	A; B; C	44	D	45	C
46	B, D	47	A, C	48	0.14 to 0.15	49	49 to 51 or -51 to -49	50	3.5 to 4.0
51	A	52	C	53	B	54	B, D	55	B
56	C	57	C	58	D	59	D	60	227.0 to 231.0

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