

Reg.No. _____

**Karunya UNIVERSITY**

(Karunya Institute of Technology & Sciences)

(Declared as Deemed-to-be University under Sec.3 of the UGC Act, 1956)


End Semester Examination – Nov/Dec – 2016

Code : 14AE2021
Sub. Name : Gas Dynamics

Semester : 2016-17 ODD
Duration : 3hrs
Max. marks : 100

ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**Use of Gas Table is Permitted.**

Q. No.	Sub Div.	Questions	Course Outcome	Marks
1.	a.	How does speed of sound depend on gas pressure?	CO 1	1
	b.	Arrange the speed of sound in increasing order for Air at (i) pressure 1 bar and density 1.225 Kg/m^3 (ii) pressure 6 bar and density 6.125 Kg/m^3 (iii) pressure 10 bar and density 8.575 Kg/m^3	CO 1	1
	c.	Find the speed of sound for gas Atomic Oxygen O at temperature 300K.	CO 1	2
	d.	Find the speed of sound for gas Molecular Oxygen O_2 at temperature 300K.	CO 1	2
	e.	Derive continuity equation in Cartesian coordinates (x, y, z).	CO 2	1
(OR)				
2.	a.	How does speed of sound depend on gas temperature?	CO 1	1
	b.	In which case speed of sound is greater – H_2 gas at 300K or N_2 gas at 300K	CO 1	1
	c.	Find the speed of sound for gas Atomic Hydrogen H at temperature 300K.	CO 1	2
	d.	Find the speed of sound for gas Molecular Hydrogen H_2 at temperature 300K.	CO 1	2
	e.	Derive Energy equation in Cartesian coordinates (x, y, z).	CO 2	1
(OR)				
3.	a.	For Normal shock, the post shock Mach number M_2 is given by (a) $M_2 < 1$ (b) $M_2 > 1$ (c) $M_2 = 1$	CO 1	1
	b.	For Oblique shock, the post shock Mach number M_2 is given by (a) $M_2 < 1$ (b) $M_2 > 1$ (c) $M_2 = 1$ (d) Can not say	CO 1	1
	c.	Write the Prandtl Relation for normal shock. Define the various variables.	CO 2	2
	d.	Calculate the post shock density ρ_2 in terms of free stream density ρ_1 for Normal shock with free stream Mach number M_1 5 and specific heat ratio 1.4.	CO 2	2
	e.	Derive Rankine-Hugoniot relations (relation between pre-shock and post-shock conditions) for Normal Shock.	CO 2	1
(OR)				
4.	a.	For Normal shock, the post shock density is related pre-shock density as (a) $\rho_2 < \rho_1$ (b) $\rho_2 > \rho_1$ (c) $\rho_2 = \rho_1$	CO 1	1
	b.	For Oblique shock, the post shock velocity deflected (a) towards the shock (b) away from the shock (c) does not deflect	CO 1	1
	c.	Write the Prandtl Relation for normal shock. Define the various variables.	CO 2	2
	d.	Calculate the post shock density ρ_2 in terms of free stream density ρ_1 for Normal shock with free stream Mach number M_1 10 and specific heat ratio 1.2.	CO 2	2
	e.	Derive the relation for flow deflection angle for oblique shock in terms of Shock angle β , Pre-shock Mach number M_1 and specific heat ratio .	CO 2	1
5.	a.	In Shock Polar x and y axes denote (a) Angle β and θ for oblique shock	CO 1	1

		(b) u and v components of velocity before the shock (c) u and v components of velocity after the shock		
	b.	Is the flow across the Expansion fan (a) Isentropic (b) Adiabatic but irreversible (c) Reversible but diabatic	CO 1	1
	c.	Find the turning angle required for Supersonic flow at Mach 2 to attain Mach 3 for air ($\gamma = 1.4$).	CO 2	2
	d.	For a Supersonic stream at Mach 2 expanding by 10° , find the pressure ratio and temperature ratio across the expansion fan.	CO 2	2
	e.	Consider a flat plate in supersonic stream of Mach 3 and pressure 10^5 Pa at angle of attack 5°  i. Find the Mach number on both lower and upper surface ii. Find the pressure on both lower and upper surface iii. Find the normal force acting on the plate	CO 2	8 4 2
(OR)				
6.	a.	For a flow in duct with variable area, with subsonic flow at both ends, the Mach number at minimum area point is (a) $M < 1$ (b) $M > 1$ (c) $M = 1$ (d) $M \leq 1$	CO 1	1
	b.	For a flow in duct with variable area, with supersonic flow at both ends, the Mach number at minimum area point is (a) $M < 1$ (b) $M > 1$ (c) $M = 1$ (d) $M \geq 1$	CO 1	1
	c.	For a flow in variable area duct with subsonic flow, (a) $\frac{du}{u} \leq -\frac{dA}{A}$ (b) $\frac{du}{u} \geq -\frac{dA}{A}$ (c) $\frac{du}{u} = -\frac{dA}{A}$ (d) Can not say where u is flow velocity and A is area of the duct.	CO 1	2
	d.	Complete the relation $\frac{d\rho}{\rho} = \dots \frac{du}{u}$	CO 1	2
	e.	Derive Area Mach number relation for variable area duct flow without friction and heat transfer.	CO 2	1 4
7.	a.	In the context of Fanno flow, define Hydraulic diameter.	CO 1	1
	b.	In a frictionless constant area duct, gas is flowing with $M=0.2$. With addition of heat, what will happen to Mach number. (a) Mach number increases, (b) Mach number decreases (c) Mach number does not change (d) Insufficient information for conclusion to be drawn	CO 1	1
	c.	For Fanno flow, which of these assumptions are valid. (i) Constant area duct, (ii) Perfect Gas, (iii) Friction at the wall, (iv) heat transfer at the wall (a) assumptions (i),(ii) and (iii) above, (b) assumptions (i),(ii) and (iv) above, (c) assumptions (i),(iii) and (iv) above, (d) assumptions (ii),(iii) and (iv) above	CO 1	2
	d.	For Rayleigh flow, which of these assumptions are valid. (i) Constant area duct, (ii) Perfect Gas, (iii) Friction at the wall, (iv) heat transfer at the wall (a) assumptions (i),(ii) and (iii) above, (b) assumptions (i),(ii) and (iv) above, (c) assumptions (i),(iii) and (iv) above, (d) assumptions (ii),(iii) and (iv) above	CO 1	2

	e.	Air flows in perfectly smooth (no friction) duct of square cross-section with side 0.1m. The length of tube is 300m. At the entrance of tube, the conditions are $M=0.3$, $T=72^{\circ}\text{C}$ and pressure of 1 atm. At the exit $M=0.8$. Determine i. Temperature and pressure at the exit ii. the mass flow rate through the duct iii. amount of heat required to be added to the duct	CO 2	6 2 6
(OR)				
8.	a.	Write the Prandtl-Glauert Rule relation for subsonic flow.	CO 1	1
	b.	Write the expression for coefficient of pressure for Linearised Potential flow theory	CO 1	1
	c.	Drag of sinusoidal wavy wall with small amplitude in subsonic (compressible) flow is (a) zero (b) Positive (c) Negative (d) depends upon actual Mach number	CO 2	2
	d.	Drag of sinusoidal wavy wall with small amplitude in supersonic flow is (a) zero (b) Positive (c) Negative (d) depends upon actual Mach number	CO 2	2
	e.	Derive the linearised potential flow equations using assumption of small disturbance.	CO 2	1 4
<u>Compulsory:</u>				
9.	a.	Write the expression for coefficient of pressure for Linearised Potential flow (Supersonic Mach number) theory in terms of the body slope.	CO 1	1
	b.	Under the assumptions of Linearised Potential flow (SUPERSONIC) , lift of thin cambered aerofoil at zero angle of attack is (a) zero (b) Positive (c) Negative (d) depends upon actual Mach number	CO 1	1
	c.	Under the assumptions of Linearised Potential flow (SUPERSONIC) , the Normal force on the thin aerofoil depends upon (a) Camber alone (b) Angle of attack alone (c) Thickness alone (d) On camber and angle of attack	CO 2	2
	d.	Under the assumptions of Linearised Potential flow (SUPERSONIC) , the Axial force on the thin aerofoil depends upon (a) Camber alone (b) Angle of attack alone (c) Thickness alone (d) On camber and thickness	CO 2	2
	e.	A two-dimensional wing as shown below is placed in a stream of Mach number 2.5 at an angle of attack of 2° . Using linearised theory, find C_L and C^D .	CO 2	1 4

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