KUMARAGURU
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B.E DEGREE EXAMINATIONS: MAY 2018

(Regulation 2015)

Sixth Semester

AERONAUTICAL ENGINEERING

U15AEE005: Viscous Flow Theory

COURSE OUTCOMES

CO1: Gain basic knowledge on incompressible and compressible viscous flows

CO2: Gain basic understanding on laminar, transition and turbulent flows

CO3: Gain basic knowledge on the shock boundary layer interaction.

CO4: Gain industrial problem solving skills for practical application

CO5: To develop creative thinking for launching advanced viscous flow solvers for meeting the future needs of the industries.

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-
PART A (10 x 1 = 10 Marks)

1.

List I	List II
A. The primary controlling parameter of viscous flows	i. Turbulent flow
B. The buoyancy to viscous force acting on a fluid is approximated by	ii. No slip boundary condition
C. Velocity at the wall is zero	iii. Reynolds number
D. High Reynolds number flow	iv. Grashof number.

CO1 [K$_2$]

	A	B	C	D
a)	ii	i	iii	iv
b)	iii	iv	ii	i
c)	ii	iv	iii	i
d)	iii	i	ii	iv

2.   Which of the following flow regimes characterize highly viscous laminar motion with respect to Reynolds number (Re) range?   CO1   [K$_1$]

a) $10^3 <$ Re $< 10^4$ b) $0 <$ Re < 1

c) $10^4 <$ Re $< 10^6$ d)   Re $> 10^6$

3. Which fluid property influences the viscosity to increase always? CO2 [K$_2$]

   a) Pressure b) Temperature

   c) Velocity d) Density

4. The ratio of inertial force to viscous force is defined as _____ CO1 [K$_2$]

   a) Reynolds number b) Mach number

   c) CFL number d) Grashof number

5. Assertion (A): The viscosity of liquids decreases rapidly with temperature. CO2 [K$_2$]

   Reason (R): The viscosity of fluids always increases with pressure

   a) Both A and R are Individually true and b) Both A and R are Individually true but
      R is the correct explanation of A R is not the correct explanation of A

   c) A is true but R is false d) A is false but R is true

6. A laminar-turbulent transition occurs in an internal flow system when Reynolds number is CO4 [K$_1$]
   _____.

   a) 2300 - 4500. b) 10-100

   c) 100-500 d) 500-1000

7. Identify the sequence of dynamic viscosity variations from the lower to the higher values of CO1 [K$_2$]
   the following gases.

      (1) Xenon, (2) Air, (3) Carbon dioxide (4) Hydrogen

   a) 2-4-3-1 b) 1-3-2-4

   c) 3-4-2-1 d) 4-3-2-1

8. The laminar flow of a viscous fluid in the space between two parallel plates is popularly CO4 [K$_1$]
   termed as _____flow.

   a) Couette b) inviscid

   c) incompressible d) potential

9. Assertion (A): In hypersonic flows, due to Shock wave–boundary-layer interactions (SBLI) CO3 [K$_2$]
   there will be high-temperature rise provoked by intense shocks leading to the formation of
   chemically reacting boundary layer.

   Reason (R): Shock wave–boundary-layer interactions (SBLIs) occur when a shock wave and
   a boundary layer converge.

   a) Both A and R are Individually true and b) Both A and R are Individually true but
      R is the correct explanation of A R is not the correct explanation of A

   c) A is true but R is false d) A is false but R is true

10. A flow regime characterized by chaotic changes in pressure and flow velocity is popularly termed as _____ flow.   CO3 [K₂]

   a) turbulent   b) stagnation

   c) inviscid   d) irrotational

PART B (10 x 2 = 20 Marks)
(Answer not more than 40 words)

11. Distinguish between viscous and inviscid fluids.   CO1   [K₂]

12. Distinguish between real and ideal fluids.   CO1   [K₂]

13. What is stagnation point flow?   CO4   [K₁]

14. Sketch a typical velocity profile and boundary layer in the entry region of a tube.   CO4   [K₄]

15. What is Jeffrey-Hamel flow?   CO2   [K₂]

16. What is Couette flow?   CO3   [K₂]

17. At what condition shock waves occur in the viscous flow.   CO3   [K₄]

18. Sketch the viscosity variations of liquid and gases with temperature.   CO3   [K₄]

19. Distinguish between laminar and turbulent flows.   CO5   [K₂]

20. Describe briefly Kolmogorov scale.   CO5   [K₂]

Answer any FIVE Questions:-
PART C (5 x 14 = 70 Marks)
(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. a) Derive the mass conservation equation pertaining to the steady incompressible two-dimensional boundary layer over a flat plate.   (8)   CO1 [K₂]

    b) Explain briefly the conditions of laminar-turbulent transition.   (6)   CO1 [K₆]

22. a) Describe briefly the governing equations invoking for solving the viscous flow problems.   (7)   CO2 [K₂]

    b) Explain briefly the physical modelling efforts for low Reynolds number flows.   (7)   CO4 [K₂]

23. a) Describe briefly Kelvin's theorem.   (7)   CO2 [K₆]

    b) Describe briefly the boundary layer theory.   (7)   CO2 [K₆]

24.	a)	Describe briefly the physical significance of Prandtl Number.	(7)	CO3	[K$_5$]
	b)	Derive the momentum conservation equation pertaining to the steady incompressible two-dimensional boundary layer over a flat plate.	(7)	CO2	[K$_3$]
25.	a)	Describe briefly the shock-boundary layer interaction in an internal flow system.	(7)	CO3	[K$_2$]
	b)	Write down the basic equations for modelling compressible boundary layers.	(7)	CO3	[K$_1$]
26.	a)	Derive an expression for the velocity profile for a steady Couette flow between a fixed and a moving plate.	(7)	CO3	[K$_1$]
	b)	Discuss Reynolds averaged equations of motion for turbulent flow.	(7)	CO3	[K$_6$]
27.	a)	Describe briefly the flow physics during the transition from laminar to turbulent.	(7)	CO5	[K$_2$]
	b)	Describe briefly the efforts involved in modeling turbulent flows and highlight any one of the turbulent models and it practical applications.	(7)	CO5	[K$_1$]

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