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प्रश्नपुस्तिका सीरीज
Question Booklet Series

A

M. A./M. Sc. (Final) EXAMINATION, 2021

(New Course)

MATHEMATICS

Paper Second

(Fluid Dynamics)

Time : 1 : 30 Hours] **[Maximum Marks : 100**

जब तक कहा न जाए, इस प्रश्न पुस्तिका को न खोलें

निर्देश :

1. परीक्षार्थी अपने अनुक्रमांक, विषय एवं प्रश्नपुस्तिका की सीरीज का विवरण यथास्थान सही-सही भरें, अन्यथा मूल्यांकन में किसी भी विसंगति की दशा में उसकी जिम्मेदारी स्वयं परीक्षार्थी की होगी।
2. **इस प्रश्नपुस्तिका में 60 प्रश्न हैं जिनमें से केवल 50 प्रश्नों के उत्तर परीक्षार्थियों द्वारा दिये जाने हैं। प्रत्येक प्रश्न के चार वैकल्पिक उत्तर प्रश्न के नीचे दिये गये हैं। इन चारों में से केवल एक ही उत्तर सही है। जिस उत्तर को आप सही या सबसे उचित समझते हैं, अपने उत्तर पत्रक (O.M.R. ANSWER SHEET) में उसके अक्षर वाले वृत्त को काले या नीले बाल प्वाइंट पेन से पूरा भर दें। यदि किसी परीक्षार्थी द्वारा निर्धारित प्रश्नों से अधिक प्रश्नों के उत्तर दिये जाते हैं तो उसके द्वारा हल किये गये प्रथमतः यथानिर्दिष्ट प्रश्नोत्तरों का ही मूल्यांकन किया जायेगा।**
3. प्रत्येक प्रश्न के अंक समान हैं। आपके जितने उत्तर सही होंगे, उन्हीं के अनुसार अंक प्रदान किये जायेंगे।
4. सभी उत्तर केवल ओ० एम० आर० उत्तर पत्रक (O.M.R. ANSWER SHEET) पर ही दिये जाने हैं। उत्तर पत्रक में निर्धारित स्थान के अलावा अन्यत्र कहीं पर दिया गया उत्तर मान्य नहीं होगा।
5. ओ० एम० आर० उत्तर पत्रक (O.M.R. ANSWER SHEET) पर कुछ भी लिखने से पूर्व उसमें दिये गये सभी अनुदेशों को सावधानीपूर्वक पढ़ लिया जाये।
6. परीक्षा समाप्ति के उपरान्त परीक्षार्थी कक्ष निरीक्षक को अपनी प्रश्नपुस्तिका बुकलेट एवं ओ० एम० आर० शीट पृथक्-पृथक् उपलब्ध कराने के बाद ही परीक्षा कक्ष से प्रस्थान करें।

महत्वपूर्ण : प्रश्नपुस्तिका खोलने पर प्रथमतः जाँच कर देख लें कि प्रश्नपुस्तिका के सभी पृष्ठ भलीभाँति छपे हुए हैं। यदि प्रश्नपुस्तिका में कोई कमी हो, तो कक्ष निरीक्षक को दिखाकर उसी सीरीज की दूसरी प्रश्नपुस्तिका प्राप्त कर लें।

1. A fluid motion is said to be rotational, if :

(A) $W \neq \text{curl } q = 0$

(B) $W = \text{curl } q \neq 0$

(C) $W \neq \text{curl } q \neq 0$

(D) None of the above

2. $\frac{dx}{\xi} = \frac{dy}{\eta} = \frac{dz}{\zeta}$ are the differential equations of :

(A) Path lines

(B) Vortex lines

(C) Stream line

(D) None of the above

3. Eulerian equation of continuity :

(A) $\frac{d\rho}{\partial t} - \rho.\nabla q = 0$

(B) $\frac{d\rho}{\partial t} + \rho.\nabla q \neq 0$

(C) $\frac{d\rho}{\partial t} + \rho.\nabla q = 0$

(D) $\frac{d\rho}{\partial t} - \rho.\nabla q \neq 0$

4. Equation of path line is :

(A) $\frac{dr}{dt} = \hat{i}\frac{dx}{dt} + \hat{j}\frac{dy}{dt} + \hat{k}\frac{dz}{dt}$

(B) $\frac{dr}{dt} = \hat{i}\frac{du}{dt} + \hat{j}\frac{dv}{dt} + \hat{k}\frac{dw}{dt}$

(C) $\frac{dr}{dt} = \hat{i}\frac{dx}{dt} - \hat{j}\frac{dy}{dt} - \hat{k}\frac{dz}{dt}$

(D) $\frac{dr}{dt} = \hat{i}\frac{du}{dt} - \hat{j}\frac{dv}{dt} - \hat{k}\frac{dw}{dt}$

5. Equation of continuity in spherical coordinate :

(A) $\frac{d\rho}{dt} + \frac{1}{r^2}\frac{\partial}{\partial r}(\rho u r^2) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\rho u \sin\theta) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\omega}(\rho\omega)$

(B) $\frac{d\rho}{dt} + \frac{1}{r^2}\frac{\partial}{\partial r}(\rho v r^2) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\rho u \sin\theta)$

(C) $\frac{d\rho}{dt} + \frac{1}{r^2}\frac{\partial}{\partial r}(\rho u r^2) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\rho v) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\omega}(\rho\omega)$

(D) $\frac{d\rho}{dt} + \frac{1}{r}\frac{\partial}{\partial r}(\rho u) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(r\sin\theta) + \frac{1}{\rho\omega}\frac{\partial}{\partial\omega}(\rho\omega)$

6. Blood circulation through arteries is :

(A) a stream flow

(B) a laminar flow

(C) a turbulent flow

(D) None of the above

7. Equation of continuity in cylindrical co-ordinate :

(A) $\frac{\partial\rho}{\partial t} + \frac{1}{r\sin\theta}\frac{\partial}{\partial r}(\rho u r) + \frac{1}{r}\frac{\partial}{\partial\theta}(\rho v) + \frac{\partial}{\partial z}(\rho\omega) = 0$

(B) $\frac{\partial\rho}{\partial t} - \frac{1}{r\sin\theta}\frac{\partial}{\partial r}(\rho u r) + \frac{1}{r}\frac{\partial}{\partial\theta}(\rho v) + \frac{\partial}{\partial z}(\rho\omega) = 0$

(C) $\frac{\partial\rho}{\partial t} + \frac{1}{r}\frac{\partial}{\partial r}(\rho u r) + \frac{1}{r}\frac{\partial}{\partial\theta}(\rho v) + \frac{\partial}{\partial z}(\rho\omega) = 0$

(D) $\frac{\partial\rho}{\partial t} + \frac{1}{r}\frac{\partial}{\partial r}(\rho v r) + \frac{1}{r}\frac{\partial}{\partial\theta}(\rho u) + \frac{\partial}{\partial z}(\rho\omega) = 0$

8. If stream function ψ satisfies the Laplace equation, it is a possible case of :
   (A) a circular flow
   (B) a rotational flow
   (C) an irrotational flow
   (D) None of the above

9. A fluid motion is said to be irrotational, then :
   (A) $\xi = \eta = 2\zeta$
   (B) $\xi = 2\eta = \zeta$
   (C) $2\xi = \eta = \zeta$
   (D) $\xi = \eta = \zeta$

10. Circulation along any closed circuit moving in the liquid for all time is :
   (A) 0
   (B) variable
   (C) constant
   (D) 1

11. The imaginary line drawn in the fluid in such a way that the tangent to any point gives the direction of motion at the point is called as :
   (A) Path line
   (B) Stream line
   (C) Streak line
   (D) Filament line

12. An actual path followed by a fluid particle as it moves during a period of time, is called :
   (A) Path line
   (B) Stream line
   (C) Streak line
   (D) Filament line

13. The pressure equation is :
   (A) $\Omega + \int \frac{\partial P}{\rho} - \frac{1}{2}q^2 + \frac{\partial \phi}{\partial t} = F(t)$
   (B) $\Omega + \int \frac{\partial P}{\rho} + \frac{1}{2}q^2 - \frac{\partial \phi}{\partial t} = F(t)$
   (C) $\Omega - \int \frac{\partial P}{\rho} + \frac{1}{2}q^2 - \frac{\partial \phi}{\partial t} = F(t)$
   (D) $\Omega + \int \frac{\partial P}{\rho} - \frac{1}{2}q^2 - \frac{\partial \phi}{\partial t} = F(t)$

14. If the axis of doublet is along x-axis and the doublet is at origin, then :
   (A) $\alpha = 0, a = 0$ so that $w \neq \frac{\mu}{z}$
   (B) $\alpha = 0, a \neq 0$ so that $w = \frac{\mu}{z}$
   (C) $\alpha = 0, a = 0$ so that $w = \frac{\mu}{z}$
   (D) $\alpha \neq 0, a = 0$ so that $w = \frac{\mu}{z}$

15. Source and sink are :
   (A) Equal
   (B) Unequal
   (C) Zero
   (D) One

16. The absolute magnitude of source and sink is :
   (A) One
   (B) Zero
   (C) Finite
   (D) Infinite

17. 'The circulation along any closed path moving with the fluid is constant for all times if the external forces are conservative and density ρ is a function of all the pressure P only. It is :
   (A) Kelvin's circulation theorem
   (B) Milne-Thomson-circulation theorem
   (C) Theorem of Blasius
   (D) None of the above

18. When both the source and sink are equal strength, it is called :
   (A) sink
   (B) source
   (C) doublet
   (D) All of the above

19. Fluid motion may be studied by two different methods :
   (A) Lagrangian and Newtonian methods
   (B) Lagrangian and Eulerian methods
   (C) Newtonian and Eulerian methods
   (D) None of the above

20. The irrotational motion of a liquid, occupying a simple connected region has less K. E. Then any other motion consistent with the same normal velocity of the boundary is the statement of the theorem :
(A) Green's theorem
(B) Kelvin's minimum energy theorem
(C) Theorem of Blasius
(D) Stokes' theorem

21. Which expression represents for the general motion of the cylinder ?
(A) $\psi = (Ux - Vy) + \frac{W}{3}(x^2 + y^2) + C$
(B) $\psi = (Vx - Uy) + \frac{W}{2}(x^2 + y^2) + C$
(C) $\psi = (Ux + Vy) + \frac{W}{2}(x^2 + y^2) + C$
(D) $\psi = (Vx + Uy) + \frac{W}{2}(x^2 + y^2) + C$

22. What is the complex potential for the streaming motion past a fixed elliptic cylinder ?
(A) $U(a - b)\cosh\{\zeta - \alpha - i\beta\}$
(B) $U(a + b)\sinh\{\zeta - \alpha - i\beta\}$
(C) $U(a + b)\cosh\{\zeta - \alpha - i\beta\}$
(D) $U(a - b)\sinh\{\zeta - \alpha - i\beta\}$

23. The velocity potential and stream function for a liquid streaming past a fixed elliptic cylinder with velocity U parallel to major axis :
(A) $\phi \neq Ub\,e^{\alpha - \xi}\cos\eta$
(B) $\phi = Ub\,e^{\alpha - \xi}\cos\eta$
(C) $\phi = Ub\,e^{\alpha - \xi}\sin\eta$
(D) None of the above

24. The equation of confocal ellipse is :
(A) $\frac{x^2}{(c\cos\xi)^2} + \frac{y^2}{(c\sin\xi)^2} = 1$
(B) $\frac{x^2}{(\cos\xi)^2} + \frac{y^2}{(\sin\xi)^2} = 1$
(C) $\frac{x^2}{(\cos\xi)^2} + \frac{y^2}{(\sin\xi)^2} = 1$
(D) $\frac{x^2}{(c\cos\xi)^2} + \frac{y^2}{(c\sin\xi)^2} = 1$

25. The kinetic energy of the liquid contained in a rotating elliptic cylinder is :
(A) $T = \frac{\pi}{8}\rho\omega^2 ab\frac{(a^2 - b^2)}{a^2 + b^2}$
(B) $T = \frac{\pi}{6}\rho\omega^2 ab\frac{(a^2 - b^2)^2}{a^2 + b^2}$
(C) $T = \frac{\pi}{8}\rho\omega^2 ab\frac{(a^2 + b^2)^2}{a^2 - b^2}$
(D) $T = \frac{\pi}{2}\rho\omega^2 ab\frac{(a^2 - b^2)^2}{a^2 + b^2}$

26. A circular cylinder is moving in a liquid at rest : https://www.csjmuonline.com
(A) Zero
(B) Infinity
(C) Finite
(D) None of the above

27. Newtonian fluid is one in which the viscosity :
(A) remains constant with time and power input
(B) increases with level of power input
(C) decreases with level of power input
(D) None of the above

28. The viscous nature of a non-Newtonian fluid :
(A) remains constant with rate of deformation
(B) increases exponentially with rate of deformation
(C) decreases with rate of deformation
(D) None of the above

29. The Navier-Stokers equation represents :
(A) Newtonian fluid
(B) Viscous fluid
(C) Non-Newtonian fluid
(D) Real fluid

30. The Navier-Stokes' equation for viscous fluid is :

(A) $\frac{dq}{dt} = F + \frac{1}{\rho}\nabla p + \nu\left[\nabla_q^2 + \frac{1}{3}\nabla(\nabla.q)\right]$

(B) $\frac{dq}{dt} = F - \frac{1}{\rho}\nabla p + \nu\left[\nabla_q^2 + \frac{1}{2}\nabla(\nabla.q)\right]$

(C) $\frac{dq}{dt} = F - \frac{1}{\rho}\nabla p + \nu\left[\nabla_q^2 + \frac{1}{3}\nabla(\nabla.q)\right]$

(D) $\frac{dq}{dt} = F - \frac{1}{\rho}\nabla p + \nu\left[\nabla_q^2 - \frac{1}{3}\nabla(\nabla.q)\right]$

31. The rate of dissipation of energy is :

(A) $4\mu\iiint\left(\xi^2 + \eta^2 + \tau^2\right)dx\,dy\,dz$

(B) $\mu\iiint\left(\xi^2 + \eta^2 + \tau^2\right)dx\,dy\,dz$

(C) $3\mu\iiint\left(\xi^2 + \eta^2 + \tau^2\right)dx\,dy\,dz$

(D) $2\mu\iiint\left(\xi^2 + \eta^2 + \tau^2\right)dx\,dy\,dz$

32. The dimension of coefficient of viscosity :

(A) $\frac{L^2}{T}$

(B) $\frac{M}{LT^2}$

(C) $\frac{M}{LT}$

(D) $\frac{ML}{T}$

33. The boundary layer theory was introduced by :

(A) Kelvin

(B) Prandtl

(C) Stokes

(D) None of the above

34. The thickness of the boundary layer δ is of the order :

(A) ν

(B) $\sqrt{\nu}$

(C) $\nu^{\frac{2}{3}}$

(D) ν^2

35. When a circular cylinder of radius a moves in an infinite mass of liquid, with velocity v, then the value of ϕ and ψ respectively are :

(A) $\frac{va^2}{r}\cos\theta$ and $\frac{-va^2}{r}\sin\theta$

(B) $\frac{va^2}{r}\sin\theta$ and $\frac{-va^2}{r}\cos\theta$

(C) $\frac{va^2}{r}\cos\theta$ and $\frac{va^2}{r}\sin\theta$

(D) $\frac{va^2}{r}\sin\theta$ and $\frac{va^2}{r}\cos\theta$

36. If k be the circulation in the circulation of the vortex, then :

(A) $W = \frac{ik}{2\pi}\log z$

(B) $W = -\frac{ik}{2\pi}\log z$

(C) $W = \frac{k}{2\pi}\log z$

(D) $W = \frac{k}{\pi}\log z$

37. The differential equation of the vortex line are given by :

(A) $\frac{dx}{x} = \frac{dy}{y} = \frac{dz}{z}$

(B) $\frac{dx}{u} = \frac{dy}{v} = \frac{dz}{w}$

(C) $\frac{dx}{\xi} = \frac{dy}{\eta} = \frac{dz}{\zeta}$

(D) $\frac{du}{dt} + \frac{dv}{dt} + \frac{dw}{dt}$

38. A liquid with in the cylinder, of which circle is a cross section, is said to form a :

(A) Linear Vortex

(B) Rectilinear Vortex

(C) Parallel Vortex

(D) None of the above

39. The result of Routh's theorem's is :

(A) $\psi_1(x, y) = \psi_2\{\xi, \eta_1\} + \frac{k}{4\pi} \log \left|\frac{d\zeta}{dz}\right|_1$

(B) $\psi_2(x, y) = \psi_1\{\xi, \eta_1\} + \frac{k}{4\pi} \log \left|\frac{d\zeta}{dz}\right|_1$

(C) $\psi_2(x, y) = \psi_1(x, y) + \frac{k}{4\pi} \log \left|\frac{d\zeta}{dz}\right|_1$

(D) $\psi_1(x, y) = \psi_2(x, y) + \frac{k}{4\pi} \log \left|\frac{d\zeta}{dz}\right|_1$

40. The combination of a source and a vortex is known as :
(A) Parallel vortex
(B) Circular vortex
(C) Spiral vortex
(D) None of the above

41. When the circulation round the vortex is anticlockwise the strength K is taken to be :
(A) Negative
(B) Positive
(C) Both (A) and (B)
(D) None of the above

42. In motion of any vortex the path of a vortex is a :
(A) Stream line
(B) Path line
(C) Streak line
(D) Vortex line

43. Rank line combined vortex consist of a circular vortex with axis vertical in a mass of a liquid which is moving :
(A) perpendicular
(B) rotationally
(C) irrotationally
(D) parallel

44. The coefficient of kinematic viscosity is :
(A) $\nu = \frac{\rho}{\mu}$
(B) $\rho = \frac{\mu}{\nu}$
(C) $\nu = \frac{\mu}{\rho}$
(D) $\nu = \mu\rho$

45. Drag coefficient is a function of :
(A) Laminar flow
(B) Mach's number
(C) Froude's number
(D) Reynolds' number

46. There will be a trunsition from laminar flow to turbulent flow :
(A) Reynolds' number is the same
(B) Reynolds' number decreases
(C) Reynolds' number increases
(D) Froude's number increases

47. The Bernoulli's equation in fluid dynamics is valid for :
(A) Compressible flow
(B) Continuous flow
(C) Transient flow
(D) Viscous flow

48. With the decrease in the viscosity Reynolds' number :
(A) Increases
(B) Decreases
(C) Same
(D) Independent

49. In the case of the study of laminar flow between parallel planes in the equation $\mu x = \frac{1}{2}\frac{dP}{dy} y^2 + Ay + b$ if $\frac{dP}{dx} = \text{const.}$ non-zero and both the walls are at rest, then the flow is called :
(A) Plane Couette flow
(B) Plane Poiseuille flow
(C) Generalised Plane Coutte flow
(D) None of the above

50. At critical pressure ratio, the velocity at the throat of a nozzle is :
(A) equal to the sonic speed
(B) less than sonic speed
(C) more than sonic speed
(D) None of the above

51. A shock wave is produced when :
(A) a subsonic flow changes to sonic flow
(B) a sonic flow changes to supersonic flow
(C) a supersonic flow changes to subsonic flow
(D) None of the above

52. The flow is said to be subsonic when Mach's number is :
(A) equal to unity
(B) less than unity
(C) greater than unity
(D) None of the above

53. The sonic velocity is largest in which of the following ?
(A) Water
(B) Kerosene
(C) Steel
(D) Air

54. Which of the following is the basic equation of compressible fluid ?
(A) Continuity equation
(B) Momentum equation
(C) Energy equation
(D) All of the above

55. Level nozzle is a :
(A) Convergent nozzle
(B) Divergent nozzle
(C) Convergent-divergent nozzle
(D) None of the above

56. A normal shock wave :
(A) is reversible
(B) is irrversible
(C) is isentropic
(D) occurs when approaching flow is supersonic

57. In case of Couette flow, the fluid flow is between two large flat parallel plates with :
(A) Top plate moving and bottom plate fixed
(B) Bottom plate moving and top plate fixed
(C) Both the plates fixed
(D) Both the plates moving

58. The sonic velocity in a fluid medium is directly proportional to :
(A) Pressure
(B) Square root of temperature
(C) Mach's number
(D) None of the above

59. The region outside the Mach cone is called :
(A) Control volume
(B) Zone of action
(C) Zone of silence
(D) None of the above

60. Across a normal shock :
(A) The volume and pressure decrease
(B) The pressure and temperature rise
(C) The density and temperature decrease
(D) The entropy remains constant