GATE - 2014- AE

EE1030 : Matrix Theory
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1) For a given fuel flow rate and thermal efficiency, the take-off thrust for a gas turbine engine burning aviation turbine fuel (considering fuel-air ratio $f << 1$) is
   a) Directly proportional to exhaust velocity
   b) Inversely proportional to exhaust velocity
   c) Independent of exhaust velocity
   d) Directly proportional to the square of the exhaust velocity

2) For a fifty percent reaction axial compressor stage, following statements are given:
   I. Velocity triangles at the entry and exit of the rotor are symmetrical
   II. The whirl or swirl component of absolute velocity at the entry of rotor and entry of stator are same.
   Which of the following options are correct?
   a) Both I and II are correct statements
   b) I is correct but II is incorrect
   c) I is incorrect but II is correct
   d) Both I and II are incorrect

3) A small rocket having a specific impulse of $200s$ produces a total thrust of $98kN$, out of which $10kN$ is the pressure thrust. Considering the acceleration due to gravity to be $9.8m/s^2$, the propellant mass flow rate in kg/s is
   a) 55.1
   b) 44.9
   c) 50
   d) 60.2

4) The thrust produced by a turbojet engine
   a) Increases with increasing compressor pressure ratio
   b) Decreases with increasing compressor pressure ratio
   c) Remains constant with increasing compressor pressure ratio
   d) First increases and then decreases with increasing compressor pressure ratio

5) The moment coefficient measured about the centre of gravity and about aerodynamic centre of a given wing-body combination are 0.0065 and -0.0235 respectively. The aerodynamic centre lies 0.06 chord lengths ahead of the centre of gravity. The lift coefficient for this wing-body is _____.

6) The vertical ground load factor on a stationary aircraft parked in its hangar is:
   a) 0
   b) -1
   c) Not defined
   d) 1

7) Under what condition should a glider be operated to ensure minimum sink rate?
   a) Maximum $\frac{C_L}{C_D}$
   b) Minimum $\frac{C_L}{C_D}$
   c) Maximum $\frac{C_D}{C_L^{\frac{3}{2}}}$
   d) Minimum $\frac{C_D}{C_L^{\frac{3}{2}}}$

8) In most airplanes, the Dutch roll mode can be excited by applying
   a) a step input to the elevators
   b) a step input to the rudder
   c) a sinusoidal input to the aileron
   d) an impulse input to the elevators

9) Considering **R** as the radius of the moon, the ratio of the velocities of two spacecraft orbiting moon in circular orbit at altitudes **R** and **2R** above the surface of the moon is _____.

10) If $[A] = \begin{bmatrix} 3 & -3 \\ -3 & 4 \end{bmatrix}$. Then $\det\left(-[A]^2 + 7[A] - 3[I]\right)$ is
   a) 0
   b) -324
   c) 324
   d) 6

11) For the periodic function given by

$$f(x) = \begin{cases} -2, & -\pi < x < 0 \\ 2, & 0 < x < \pi \end{cases}$$

with $f(x + 2\pi) = f(x)$, using Fourier series, the sum

$$s = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots$$

converges to

a) 1
b) $\frac{\pi}{3}$
c) $\frac{\pi}{4}$
d) $\frac{\pi}{5}$

12) Let Γ be the boundary of the closed circular region A given by $x^2 + y^2 \leq 1$. Then

$$I = \int_{\Gamma} \left(3x^3 - 9xy^2\right) ds$$

(where ds means integration along the bounding curve) is

a) π
b) $-\pi$
c) 1
d) 0

13) Solution to the boundary-value problem

$$-9\frac{d^2u}{dx^2} + u = 5x, \ 0 < x < 3$$

with $u(0) = 0$, $\left.\frac{du}{dx}\right|_{x=3} = 0$ is

a) $u(x) = \frac{15e}{1+e^2}\left(e^{-\frac{x}{3}} - e^{\frac{x}{3}}\right) + 5x$
b) $u(x) = \frac{15e}{1+e^2}\left(e^{-\frac{x}{3}} + e^{\frac{x}{3}}\right) + 5x$
c) $u(x) = -\frac{15\sin\left(\frac{x}{3}\right)}{\cos(1)} + 5x$
d) $u(x) = -\frac{15\sin\left(\frac{x}{3}\right)}{\cos(1)} - \frac{5}{54}x^3$