

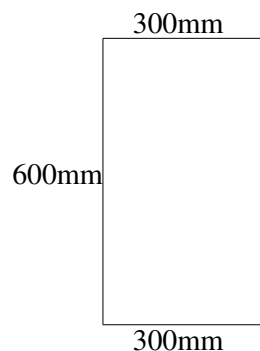
# 2013-AE-''14-26''

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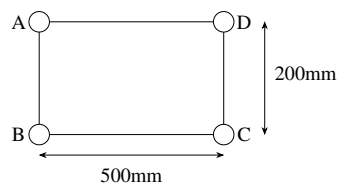
- 1) The critical Mach number for a flat plate of zero thickness, at zero angle of attack, is \_\_\_\_\_
- 2) A damped single degree-of-freedom system is vibrating under a harmonic excitation with an amplitude ratio of 2.5 at resonance. The damping ratio of the system is \_\_\_\_\_
- 3) The cross-section of a long thin-walled member is as shown in the figure. When subjected to pure twist, point A



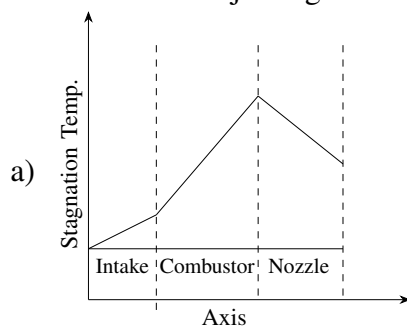
- a) does not move horizontally or axially, but moves vertically
  - b) does not move axially, but moves both vertically and horizontally
  - c) does not move horizontally, vertically or axially
  - d) does not move vertically or axially, but moves horizontally
- 4) The channel section of uniform thickness 2mm shown in the figure is subjected to a torque of 10 Nm. If it is made of a material with shear modulus of 25 GPa, the twist per unit length in radians/m is \_\_\_\_\_

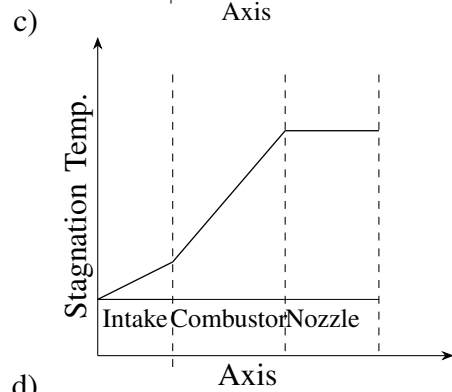
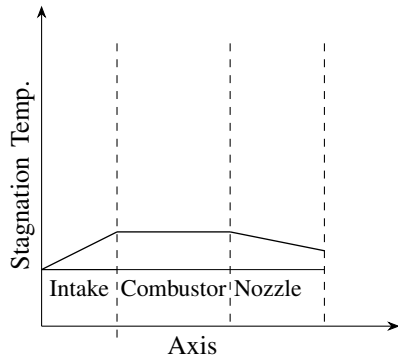
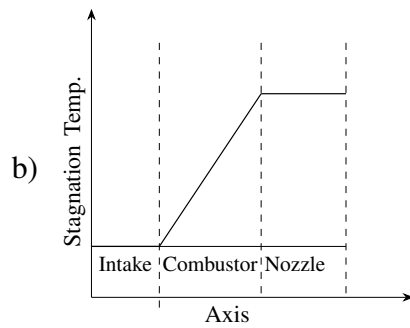


- 5) The stiffened cross-section of a long slender uniform structural member is idealized as shown in the figure below. The lumped areas at A, B, C and D have equal cross-sectional area of 3 cm<sup>2</sup>. The webs AB, BC, CD and DA are each 5 mm thick. The structural member is subjected to a twisting moment of 10 kNm. The magnitudes of the shear flow in the webs,  $q_{AB}$ ,  $q_{BC}$ ,  $q_{CD}$ , and  $q_{DA}$  in kN/m are, respectively



- a) 20, 20, 20, 20  
 b) 0, 0, 50, 50  
 c) 40, 40, 0, 0  
 d) 50, 50, 50, 50
- 6) Consider two engines P and Q. In P, the high pressure turbine blades are cooled with a bleed of 5% from the compressor after the compression process and in Q the turbine blades are not cooled. Comparing engine P with engine Q, which one of the following is NOT TRUE?
- a) Turbine inlet temperature is higher for engine P  
 b) Specific thrust is higher for engine P  
 c) Compressor work is the same for both P and Q  
 d) Fuel flow rate is lower for engine P
- 7) The mass flow rate of air through an aircraft engine is 10 kg/s. The compressor outlet temperature is 400 K and the turbine inlet temperature is 1800 K. The heating value of the fuel is 42 MJ/kg and the specific heat at constant pressure is 1 kJ/kg-K. The mass flow rate of the fuel in kg/s is approximately \_\_\_\_\_
- 8) For a given inlet condition, if the turbine inlet temperature is fixed, what value of compressor efficiency given below leads to the lowest amount of fuel added in the combustor of a gas turbine engine?
- a) 1  
 b) 0.95  
 c) 0.85  
 d) 0.8
- 9) A gas turbine engine is mounted on an aircraft which can attain a maximum altitude of 11 km from sea level. The combustor volume of this engine is decided based on conditions at
- a) sea level  
 b) 8 km altitude  
 c) 5.5 km altitude  
 d) 11 km altitude
- 10) Consider the low earth orbit (LEO) and the geo synchronous orbit (GSO). Then
- a)  $\Delta V$  requirement for launch to LEO is greater than that for GSO, and altitude of LEO is lower than that of GSO  
 b)  $\Delta V$  requirement for launch to LEO is lower than that for GSO, and altitude of LEO is lower than that of GSO  
 c)  $\Delta V$  requirement for launch to LEO is greater than that for GSO, and altitude of LEO is greater than that of GSO  
 d)  $\Delta V$  requirement for launch to LEO is lower than that for GSO, and altitude of LEO is greater than that of GSO
- 11) Which one of the following shows the CORRECT variation of stagnation temperature along the axis of an ideal ram jet engine?





- 12) A rocket motor has a chamber pressure of 100 bar and chamber temperature of 3000 K. The ambient pressure is 1 bar. Assume that the specific heat at constant pressure is 1 kJ/kg-K. Also assume that the flow in the nozzle is isentropic and optimally expanded. The exit static temperature in K is
- 805
  - 845
  - 905
  - 945

*Q.26 to Q.55 carry two marks each*

- 13)  $I = \iint_S (y^2 \hat{i} + z^2 \hat{j} + x^2 \hat{k}) \cdot (x \hat{i} + y \hat{j} + z \hat{k}) dS$ , where  $S$  denotes the surface of the sphere of unit radius centered at the origin. Here  $\hat{i}$ ,  $\hat{j}$  and  $\hat{k}$  denote three orthogonal unit vectors. The value of  $I$  is

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