Assignment_2

The due date for submitting this assignment has passed.

Due on 2021-02-07, 23:59 IST.

As per our records you have not submitted this assignment.

1) An infinitely long duct of uniform cross-section carries mean flow of Mach number $M_0 = 0.1$ along the positive x direction where sound speed $c_0 = 343.14 m \cdot s^{-1}$. The effective speed of propagation of acoustic disturbances along the direction of the flow is given by *1 point*

- 377.45 m/s
- 343.14 m/s
- 308.83 m/s
- 346.57 m/s

No, the answer is incorrect.
Score: 0
Accepted Answers:
377.45 m/s

2) In Q.1, the effective speed of propagation of acoustic disturbances opposite to the direction of the flow is given by *1 point*

- 377.45 m/s
- 343.14 m/s
- 308.83 m/s
- 346.57 m/s

No, the answer is incorrect.
Score: 0
Accepted Answers:
308.83 m/s

3) The 3-D Helmholtz equation in Cartersian co-ordinates is given by *1 point*

- $\frac{\partial^2 \tilde{p}}{\partial x^2} + \frac{\partial^2 \tilde{p}}{\partial y^2} + \frac{\partial^2 \tilde{p}}{\partial z^2} + k_0^2 \tilde{p} = 0$
- $\frac{\partial^2 \tilde{p}}{\partial x^2} + \frac{\partial^2 \tilde{p}}{\partial y^2} + \frac{\partial^2 \tilde{p}}{\partial z^2} = \frac{1}{c_0^2} \frac{\partial^2 \tilde{p}}{\partial t^2}$
- $\frac{\partial^2 \tilde{p}}{\partial r^2} + \frac{1}{r} \frac{\partial \tilde{p}}{\partial r} + \frac{1}{r^2} \frac{\partial^2 \tilde{p}}{\partial \theta^2} + \frac{\partial^2 \tilde{p}}{\partial z^2} = \frac{1}{c_0^2} \frac{\partial^2 \tilde{p}}{\partial t^2}$
- $\frac{\partial \tilde{p}}{\partial x} + \frac{\partial \tilde{p}}{\partial y} + \frac{\partial \tilde{p}}{\partial z} + \tilde{p} = 0$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{\partial^2 \tilde{p}}{\partial x^2} + \frac{\partial^2 \tilde{p}}{\partial y^2} + \frac{\partial^2 \tilde{p}}{\partial z^2} + k_0^2 \tilde{p} = 0$

4) The transverse or higher-order mn^{th} mode of a rectangular wave guide with rigid-walls is given by *1 point*

- $\cos\left(\frac{m\pi x}{b}\right) \cos\left(\frac{n\pi y}{h}\right)$
- $\sin\left(\frac{m\pi x}{b}\right) \sin\left(\frac{n\pi y}{h}\right)$
- $\cos\left(\frac{m\pi x}{b}\right) \sin\left(\frac{n\pi y}{h}\right)$
- $\sin\left(\frac{m\pi x}{b}\right) \cos\left(\frac{n\pi y}{h}\right)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\cos\left(\frac{m\pi x}{b}\right) \cos\left(\frac{n\pi y}{h}\right)$

5) The rigid-wall boundary conditions for a circular waveguide of radius R_0 is given by *1 point*

- $\frac{d}{dr} J_m(k_r r)\Big|_{r=R_0} = 0$
- $J_m(k_r R_0) = 0$
- $\alpha J_m(k_r r) + \beta \frac{d}{dr} J_m(k_r r)\Big|_{r=R_0} = 0$
- $\cos(m\theta) = 0$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{d}{dr} J_m(k_r r)\Big|_{r=R_0} = 0$

6) Consider a circular duct of radius R_0 equal to 50 mm. At sound speed $c_0 = 343.14 m \cdot s^{-1}$, its first cut-on frequency (in Hz) is given by *1 point*

- 1500 Hz
- 2009 Hz
- 1250 Hz
- 2500 Hz

No, the answer is incorrect.
Score: 0
Accepted Answers:
2009 Hz

7) Consider the following statement: *1 point*
In a rigid-wall duct of a rectangular cross-section filled with a lossless medium, the first mode is the planar wave mode which always propagates without attenuation. Which of the following option is correct:

- True
- False
- Depends on the sound speed
- Can't say

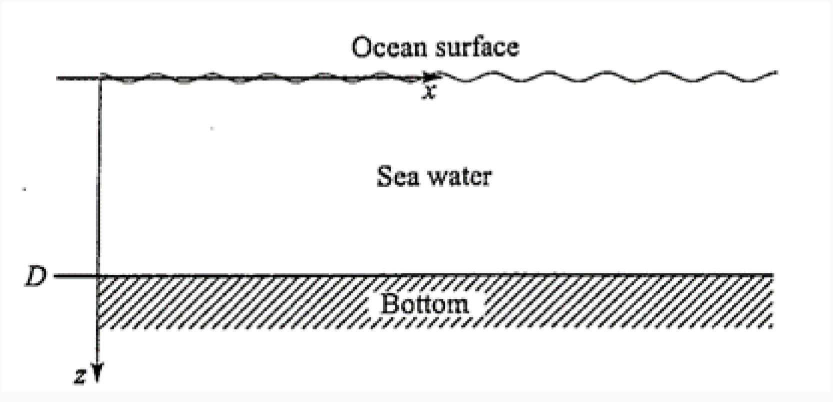
No, the answer is incorrect.
Score: 0
Accepted Answers:
True

8) The relation between the acoustic particle velocity and acoustic pressure is given by *1 point*

- $\rho_0 \frac{\partial \tilde{u}_{z,m,n}}{\partial t} = -\frac{\partial \tilde{p}}{\partial z}$
- $\rho_0 \frac{\partial \tilde{u}_{z,m,n}}{\partial t} = \frac{\partial \tilde{p}}{\partial z}$
- $\rho_0 \frac{\partial \tilde{u}_{z,m,n}}{\partial z} = \frac{\partial \tilde{p}}{\partial t}$
- $\rho_0 \frac{\partial \tilde{u}_{z,m,n}}{\partial z} = -\frac{\partial \tilde{p}}{\partial t}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\rho_0 \frac{\partial \tilde{u}_{z,m,n}}{\partial t} = -\frac{\partial \tilde{p}}{\partial z}$

9) The ocean acts as a *waveguide* for underwater sound. For an elementary analysis, idealize the ocean as having a pressure release surface at $z = 0$ and a rigid bottom at $z = D$ as shown in the figure below. Waves of angular frequency ω can travel through the water in the x direction by bouncing back and forth obliquely between the surface and the bottom. *1 point*



Solve for the wave motion. It is suggested that you start with the wave equation governing the propagation of acoustic pressure disturbances $\tilde{p}$, i.e.,

$$\frac{\partial^2 \tilde{p}}{\partial x^2} + \frac{\partial^2 \tilde{p}}{\partial z^2} - \frac{1}{c_0^2} + \frac{\partial^2 \tilde{p}}{\partial t^2} = 0,$$

and seek a solution of the form $\tilde{p} = Z(z) e^{j(\omega t - \beta x)}$.
The n^{th} wavenumber along the z direction, and the corresponding mode shape function $Z_n(z)$ are respectively, given by

- $k_z = \frac{(2n-1)\pi}{D}$ and $\sin\left(\frac{n\pi z}{D}\right)$
- $k_z = \frac{n\pi}{D}$ and $\sin\left(\frac{n\pi z}{D}\right)$
- $k_z = \frac{n\pi}{D}$ *and* $\cos\left(\frac{n\pi z}{D}\right)$
- $k_z = \frac{(2n-1)\pi}{D}$ *and* $\cos\left(\frac{n\pi z}{D}\right)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$k_z = \frac{n\pi}{D}$ and $\sin\left(\frac{n\pi z}{D}\right)$

10) In the above problem, the mode $Z_n(z)$ will propagate if the excitation frequency f_0 is given by *1 point*

- $f_c > \frac{nc_0}{2D}$
- $f_c > \frac{(2n-1)c_0}{2D}$
- $f_c < \frac{nc_0}{2D}$
- $f_c < \frac{(2n-1)c_0}{2D}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$f_c > \frac{nc_0}{2D}$