Assignment_6

The due date for submitting this assignment has passed.

Due on 2021-03-03, 23:59 IST.

As per our records you have not submitted this assignment.

1) The equation governing acoustic wave propagation in a gradually varying duct is given by the Webster's horn equation. For an exponential duct with radius profile $r(z) = r(0)e^{mz}$, the acoustic wave equation takes the form *1 point*

- $\frac{d^2p}{dz^2} + 2m\frac{dp}{dz} + k_0^2\, p = 0$
- $\frac{d^2p}{dz^2} + \frac{2}{z}\frac{dp}{dz} + k_0^2\, p = 0$
- $\frac{d^2p}{dz^2} + k_0^2\, p = 0$
- $\frac{d^2p}{dz^2} + \frac{dp}{dz} + k_0^2\, p = 0$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{d^2p}{dz^2} + 2m\frac{dp}{dz} + k_0^2\, p = 0$

2) For the exponentially varying horn considered in the previous problem, plane waves of frequency f_0 will propagate provided *1 point*

- $f_0 \geq \frac{mc_0}{2\pi}$
- $f_0 \leq \frac{mc_0}{2\pi}$
- propagation will occur at all frequencies
- $f_0 \geq \frac{m^2c_0}{2\pi}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$f_0 \geq \frac{mc_0}{2\pi}$

3) The Webster's horn equation has an analytical solution only for specific shape or profile variation. *1 point*

- True
- False
- cannot say
- depends on the frequency

No, the answer is incorrect.
Score: 0

Accepted Answers:
True

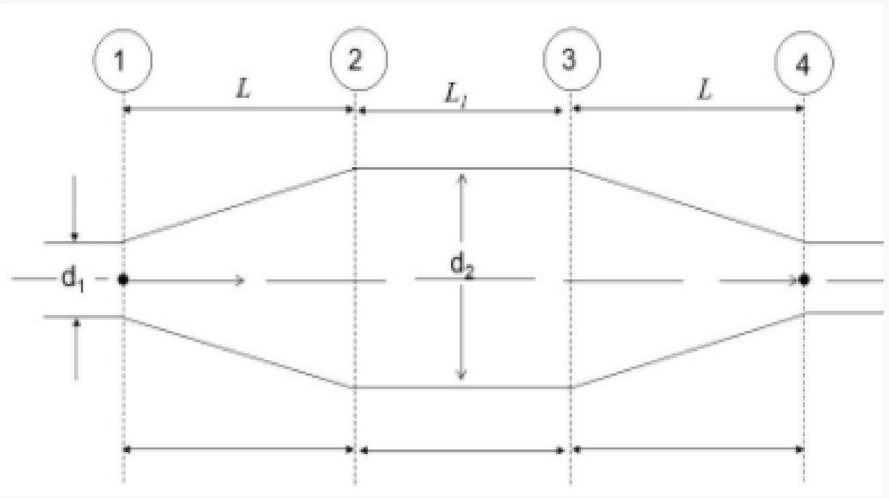
4) Consider the conical duct muffler shown below, where the sub-system transfer matrices are shown below: *1 point*

$$[\mathbf{T_1}] = \begin{bmatrix} \frac{d_2}{d_1}\cos k_0L - \frac{m}{k_0d_1}\sin k_0L & jY_1\frac{d_1}{d_2}\sin k_0L \\ \frac{j}{Y_1}\frac{d_2}{d_1}\left(1+\frac{m^2}{k_0^2d_1d_2}\right)\sin k_0L - \frac{jm}{k_0d_1Y_1}\frac{d_2}{d_1}\left(1-\frac{d_1}{d_2}\right)\cos k_0L & \frac{m}{k_0d_2}\sin k_0L + \frac{d_1}{d_2}\cos k_0L \end{bmatrix},$$

$$\mathbf{m} = \frac{\mathbf{d_2 - d_1}}{\mathbf{L}}$$

$$[\mathbf{T_2}] = \begin{bmatrix} \cos k_0L_1 & jY_2\sin k_0L_1 \\ \frac{j}{Y_2}\sin k_0L_1 & \cos k_0L_1 \end{bmatrix}$$

The overall [T] matrix between the upstream point 1 and downstream point 4 is given by



- $[T_{overall}] = [\mathbf{T_1}][\mathbf{T_2}][\mathbf{T_1}]^{-1}$
- $[T_{overall}] = [\mathbf{T_1}][\mathbf{T_2}][\mathbf{T_1}]$
- $[T_{overall}] = [\mathbf{T_1}][\mathbf{T_2}]$
- $[T_{overall}] = [\mathbf{T_2}][\mathbf{T_1}][\mathbf{T_2}]$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$[T_{overall}] = [\mathbf{T_1}][\mathbf{T_2}][\mathbf{T_1}]^{-1}$

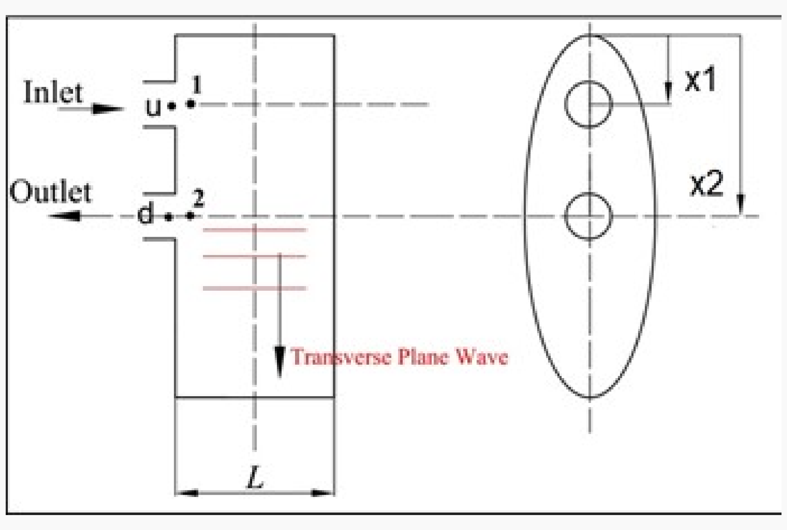
5) The TL loss graph for the above conical muffler configuration assuming planar wave propagation is characterized by *1 point*

- maximum attenuation dome occurring at the lowest frequency followed by rapidly decaying attenuation domes
- attenuation domes and troughs where magnitude of domes diminish at higher frequencies, and the attenuation graph starts from zero dB
- attenuation domes and troughs occurring at regular intervals, and of same magnitude
- constant attenuation graph

No, the answer is incorrect.
Score: 0

Accepted Answers:
attenuation domes and troughs where magnitude of domes diminish at higher frequencies, and the attenuation graph starts from zero dB

6) For the short elliptical muffler, with ports located on the major-axis, a transverse plane wave propagation along the major-axis can be considered where Z_1 and Z_2 are the acoustic impedances at the beginning of the cavities 1 and 2, respectively. The system is shown below. The overall [T] matrix relating the state variables u and d is given by *1 point*



- $\begin{Bmatrix} p_u \\ v_u \end{Bmatrix} = \begin{bmatrix} 1 & 0 \\ Z_1 & 1 \end{bmatrix}[\mathbf{T_{12}}]\begin{bmatrix} 1 & 0 \\ Z_2 & 1 \end{bmatrix}\begin{Bmatrix} p_d \\ v_d \end{Bmatrix}$
- $\begin{Bmatrix} p_u \\ v_u \end{Bmatrix} = \begin{bmatrix} 1 & 0 \\ 1/Z_2 & 1 \end{bmatrix}[\mathbf{T_{12}}]\begin{bmatrix} 1 & 0 \\ 1/Z_1 & 1 \end{bmatrix}\begin{Bmatrix} p_d \\ v_d \end{Bmatrix}$
- $\begin{Bmatrix} p_u \\ v_u \end{Bmatrix} = [\mathbf{T_{12}}]\begin{Bmatrix} p_d \\ v_d \end{Bmatrix}$
- $\begin{Bmatrix} p_u \\ v_u \end{Bmatrix} = \begin{bmatrix} 1 & 0 \\ 1/Z_1 & 1 \end{bmatrix}[\mathbf{T_{12}}]\begin{bmatrix} 1 & 0 \\ 1/Z_2 & 1 \end{bmatrix}\begin{Bmatrix} p_d \\ v_d \end{Bmatrix}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\begin{Bmatrix} p_u \\ v_u \end{Bmatrix} = \begin{bmatrix} 1 & 0 \\ 1/Z_1 & 1 \end{bmatrix}[\mathbf{T_{12}}]\begin{bmatrix} 1 & 0 \\ 1/Z_2 & 1 \end{bmatrix}\begin{Bmatrix} p_d \\ v_d \end{Bmatrix}$

7) Consider the short elliptical muffler configuration above with the following dimensions: *1 point*
$D_1 = 250mm,\ D_2 = 125mm,\ L = 50mm,\ d_0 = 50mm,\ y_1 = 60mm$ and $y_2 = 125mm$. Compute the TL graph (MATLAB) using the segmentation approach assuming plane wave propagation along the major-axis. Take sound speed c0 = 343 m/s. At frequency $f_0 \approx 824Hz,$ the TL graph exhibits

- an attenuation peak and behaves like a side-branch resonator
- a trough and expansion chamber
- an attenuation peak and has an expansion chamber type characteristics
- neither peak nor trough but a finite value

No, the answer is incorrect.
Score: 0

Accepted Answers:
an attenuation peak and behaves like a side-branch resonator