

ACOUSTICS SPECIMEN EXAMINATION PAPER

DECEMBER 1998

Time allowed - 2 hours

SECTION A Answer all questions

1. Simplify

(i) $(-3x^2)^3$

(ii) $\frac{2ab^2}{(2ab)^2}$

(iii) $(64t^3)^{\frac{2}{3}}$

(vi) $\frac{(x^2 + 2x + 1)(x - 1)}{(x^2 - 1)(x + 1)}$

2. Express as single fractions in their simplest forms:-

(i) $\frac{x}{2} + \frac{1}{x}$

(ii) $\frac{x}{x+1} - \frac{3}{x+2}$

(iii) $x + \frac{2}{x-3} - \frac{3}{x^2 - 4x + 3}$

3. Factorise completely

(i) $t^6 - t^4$

(ii) $x^2 - 9x + 18$

(iii) $3ax - 4bx + 3ay - 4by$

4. Make the specified variable the subject of the formula:-

(i) $S = 2\pi r^2 + 2\pi rh$; h

(ii) $P = \sqrt{\frac{a-b}{a+b}}$; a

5. A periodic function is defined by

$$f(x) = \begin{cases} x^2, & 0 < x \leq 1 \\ 0, & 1 < x \leq 2 \end{cases}$$

with period $T = 2$.

Sketch a graph of this function over the range $0 \leq x \leq 6$.

6. Solve the equations

(i) $\frac{1}{3-s} = \frac{4}{s+1}$

(ii) $2x^2 - x - 3 = 0$

(iii) $7 - 2x - 3x^2 = 0$

7. Solve the inequalities

(i) $7x - 12 \geq 2x - 6$

(ii) $(2x + 1)(x - 2) < 0$

(iii) $\frac{5-2x}{4} > 2x$

8. Solve the simultaneous equations

(i) $7x + 11y = 4, \quad 8x - 4y = -12$

(ii) $3x - 5y = 9, \quad 1.5x - 2.5y = 4$

(iii) $3x + 4y = 0, \quad 2x - 3y = 0$

9. Solve the following equations, giving all the solutions in $0^\circ \leq \theta \leq 360^\circ$:

(i) $\sin \theta = \frac{1}{2}$

(ii) $\cos \theta = -0.7$

(iii) $3 \tan \theta - 2 = 0$

10. Express as partial fractions:

(i) $\frac{3s+1}{(s+1)(s-3)}$

(ii) $\frac{x^2+x+1}{(x-1)^2(x+1)}$

(ii) $\frac{3x+7}{x^2+4x+4}$

SECTION B
Answer 2 questions

1. Given the formulas

$$dB(SIL) = 10 \log_{10} \left(\frac{I_1}{I_0} \right)$$

where $I_0 = 10^{-12} \text{ W/m}^2$

and
$$dB(SPL) = 20 \log_{10} \left(\frac{p_1}{p_0} \right)$$

where $p_0 = 2 \times 10^{-5} \text{ Pa}$

Answer the following questions

- (a) (i) What intensity I_1 corresponds to $80dB(SIL)$?
- (ii) How many $dB(SIL)$ corresponds to a sound intensity of $2 \times 10^{-10} \text{ W/m}^2$?
- (iii) What pressure P_1 corresponds to $70dB(SPL)$?
- (iv) How many $dB(SPL)$ corresponds to a pressure of $5.0 \times 10^4 \text{ Pa}$?
- (b) (i) The sound pressure level of a .45 calibre Colt revolver is measured as $80dB(SPL)$ at ten paces. If two identical revolvers are fired simultaneously what is the resulting sound pressure level in $dB(SPL)$?
- (ii) Subtract $74dB(SIL)$ from $81dB(SIL)$.

2. (a) Find all the values of θ between 0° and 360° such that

(i) $\sin \theta = -0.5$ (ii) $\cos \theta = -0.6$ (iii) $\tan \theta + 1 = 0$

- (b) Use the addition formulae to show that:-

(i) $\sin \left(\frac{3\pi}{2} - \theta \right) = -\cos \theta$ (ii) $\tan(\pi + \theta) = \tan \theta$

Show the results on a diagram.

- (c) (i) Combine the two waves $x_1(t) = 0.5 \cos 365t$ and $x_2(t) = 0.5 \cos 278t$ and sketch the resulting wave form.
- (ii) Express $5 \sin 5t$ and $12 \cos 5t$ in the form $A \cos(\omega t + \alpha)$ and $A \sin(\omega t - \alpha)$ ($\alpha > 0$).

3. (a) Given the functions $f(x) = \frac{1}{4}x + 1$, $g(x) = 3x - 4$ and $h(x) = \sqrt{x + 1}$
State

- | | | |
|---------------------------|-------------------------|----------------------------|
| (i) $f(g(x))$ | (ii) $g(f(x))$ | (iii) $g(h(x))$ |
| (iv) $h(g(x))$ | (v) $[f(x)]^2$ | (vi) $f(x) + g(x)$ |
| (vii) $f^{-1}(x)$ | (viii) $g^{-1}(x)$ | (ix) $g^{-1} \circ f^{-1}$ |
| (x) $f^{-1} \circ g^{-1}$ | (xi) $(g \circ f)^{-1}$ | (xii) $(f \circ g)^{-1}$ |

- (b) Sketch $g(x) = x^3$ for $-2 \leq x \leq 2$

Sketch

- | | | |
|-----------------|-----------------|------------------|
| (i) $g(x) + c$ | (ii) $g(x + c)$ | (iii) $g(x) - c$ |
| (iv) $g(x - c)$ | (v) $g^{-1}(x)$ | |

(where c is a real number).

- (c) The horizontal distance travelled x , and the vertical height y , of a projectile fired at an angle of 45° are related by

$$y = x - \frac{gx^2}{V_0^2}$$

Consider the case when a projectile is fired with an initial velocity V_0 of 100 ms^{-1} .

Assume g has a value of 9.8 ms^{-2}

- (i) Sketch the trajectory of the particle.
(ii) Calculate the values of x at which the projectile has a height of 225m.