PAPER2

TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING

EEE 2517

ELECTROACOUSTICS

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: SEPTEMBER 2018

TIME: 2 HOURS

DATE: SEPTEMBER 2018

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Question ONE is compulsory. In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (30mks)

a) Define the term specific acoustic impedance (2mks)

b) Highlight the principal advantages and disadvantages of the direct-radiator type loudspeaker (5mks)

c) A source emits sound waves isotopically. The intensity of the waves 2.5m from the source is $1.91X10^{-4}$ w/m^2. Assuming that the energy of the waves is conserved, find the power of the source. (4mks)

a) A point source emits 30W of sound isotropically. A small microphone intercepts the sound in an area of 0.75cm^2, 200m from the source. Calculate; (6mks)

   i. The sound intensity there

   ii. The power intercepted by the microphone.

d) Explain the reason why when a person talking or singing moves near to a pressure-gradient microphone so that r is small his voice seems to become more "boomy" or "bassy". (2mks)

e) Assume that for the steady state, at a point x = 0, the sound pressure in a one dimensional Outward-traveling wave has the recurrent wave form given by the real part of the equation $p(0,t) = 4e^{j28t} + 2e^{j884t}$

i. What are the particle velocity and the particle displacement as a function of time at x=5m? (8mks)

ii. What are the rms values of these two quantities? (3mks)
Take $\rho_0 = 1.18, c = 344.8\ m/s$

Question TWO (20mks)

a) Differentiate between sound and vibration (2mks)

b) Sketch the direct radiator loudspeaker and briefly explain the stages that the signal undergoes till sound is produced. (6mks)

c) Given 4 generators producing 105 dB, 95 dB, 98 dB and 99 dB, what would be the effective sound pressure level? (3mks)

d) Given $p(t) = k_{sin\omega t}$ Determine the power flow in a freely traveling wave at a fixed point as a function of time. (4mks)

e) Sound is detected when a sound wave causes the eardrum to vibrate. Assume the diameter of the eardrum is about 8.2 mm in humans. When someone speaks to you in a normal tone of voice, the sound intensity at your ear is about 1.2×10^6 W/m^2. Determine the amount of energy delivered to each eardrum each second. (5mks)

Question THREE (20mks)

a) Discuss the three main metrics used to describe the performance of filters (6mks)

b) Briefly discuss the advantages and disadvantages of reactive filters (3mks)

c) A worker is exposed to noise for the duration and dB levels shown in the table. Determine the percentage dosage on (4mks)

i. PEL

ii. HCA

Exposure time (hrs)	*dB level*
2	*90*
1	*95*
1	*85*

Comment on the level of exposure based on the two guidelines (1mk)

f) Find the maximum efficiency of a 2-inch theater horn drive unit designed to operate in the frequency range above 500 Hz with the following Thiele–Small parameters: (6mks)
R_E = 6.4 Ω, Q_{ES} = 0.8, f_S = 250 Hz, S_D = 13.2 cm^2, V_{AS} = 0.1 L.

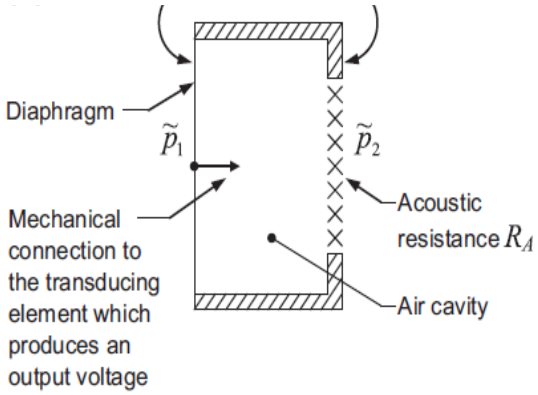
Question FOUR (20mks)

a) Define the term specific acoustic impedance (2mks)
b) Briefly discuss the functions of the following parts of a human ear. (5mks)
   i. Middle ear
   ii. Inner ear
   iii. Outer ear

c) Using the fact that: $\log_{10} A - \log_{10} B = \log_{10}(A/B)$. Show that the difference between two sound intensity levels equals $10\log_{10}\left(I_2/I_1\right)$ (5mks)

d) Below is a sketch of a combination pressure and pressure-gradient microphone consisting of a right enclosure in one side of which is a movable diaphragm connected to a transducing element and in another side of which is an opening with an acoustic resistance RA. Sketch its corresponding acoustic-impedance circuit (3mks)

Δl



e) An ideal moving coil loud speaker produces 4 W of acoustic power into an acoustic load of $4*10^4$ N.s/m^5 when driven from an amplifier with constant voltage output of 1.0V rms. The area of the diaphragm is 100 cm^2. What open-circuit voltage will it produce when operated as a microphone with an rms diaphragm of 10 cm/s^2? (5mks)

Question FIVE (20mks)

a) Explain what you understand by the term masking as used in acoustics (2mks)
b) Briefly discuss the advantages and disadvantages of absorptive filters (5mks)
c) With the aid of equations state the wave equation in one-dimensional cylindrical and spherical coordinates (2mks)
d) The sound intensity of a human sound is $1.0 * 10^{-10\, w/m^2}$ at a distance of 1.0m. Use $I_0 = 1.0 * 10^{-12}$. Determine the sound intensity of a whisper at a distance of 4.0 m. Determine the corresponding sound intensity level (7mks)
e) A loudspeaker diaphragm couples to the throat of an exponential horn that has an acoustic impedance of 200+j300 N.s/m^5. If the area of the loudspeaker diaphragm S_D is 0.09 m^2, determine the mechanical-impedance load on the diaphragm due to the horn (4mks)