UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester Examination in Engineering: June 2015

Module Number: EE5317

Module Name: Sensors, Transducers and Measurement Techniques

[Two Hours]

[Answer **all questions**, questions 1 and 2 carries 5 marks each and question 3 carries 10 marks]

Q1

a) i. What does the acronym MEMS stand for?
ii. Sketch the structure of the MEMS ADXL50 accelerometer and briefly describe its operation.
iii. State a common application of this accelerometer. [3 Marks]

b) Sketch the structure (top view) of a MEMS device that measures rotation. Briefly explain its operation. [2 Marks]

Q2

a) i. State the Seebeck and Peltier effects for a two wire thermoelectric circuit.
ii. Sketch a thermocouple arrangement for measuring the temperature of a furnace situated a long distance away from the measuring instrument. Describe its principle of operation. [2.5 Marks]

b) i. What does the acronym RTD in a RTD temperature sensor stand for?
ii. State the principle that governs the operation of a RTD?
iii. Sketch a four wire RTD circuit and state the advantage of using the four wires for measuring temperature. [2.5 Marks]

Q3

a) i. State two differences between acoustic and electromagnetic wave propagation.
ii. Describe how acoustic waves propagate in air?
iii. What is the speed of these waves?
iv. What is the audible frequency range of acoustic waves in air? [2 Marks]

b) i. Identify the type of acoustic wave that propagates in water?
ii. Define the speed of these waves in water?
iii. Ceramic elements used for constructing acoustic transducers are not piezoelectric in their natural state. Describe how the ceramic elements can be made piezoelectric?
iv. A piezoelectric disk has a diameter of 30 mm and a thickness of 2.5 mm. The compressional and shear speeds of the piezoelectric material are 3700 m/s and 2100 m/s respectively. What is the operating frequency of the disk in MHz? [3 Marks]

c) i. State the three types of elastic waves that propagate in a solid.
ii. State the law that governs the propagation of these waves in a solid?
iii. Express a general equation for this law. [2 Marks]

d) i. An acoustic wave in water is incident on a solid at an angle i° normal to the surface. Describe the elastic wave generation and propagation in the solid.
ii. What are the critical incident angles for the compressional and shear waves?
iii. Describe how a surface wave be generated in the solid? [3 Marks]