UNIVERSITY OF GHANA

FACULTY OF ENGINEERING SCIENCES

BSc. (ENG) MATERIALS SCIENCE AND ENGINEERING

END OF SECOND SEMESTER EXAMINATIONS: 2012/2013

MSEN 402: NON-DESTRUCTIVE EVALUATION AND FALURE ANALYSIS

(3 CREDITS)

TIME ALLOWED: 3 HOURS

ANSWER ALL QUESTIONS

SECTION A

Choose the correct answer from the following objectives.

Question 1

a. Liquid penetrant testing is based on the principle of:
   i. Polarized sound waves in liquid
   ii. Magnetic domains
   iii. Absorption of x-rays
   iv. Capillary action

b. How is the size of a liquid penetrant indication usually related to the discontinuity it represents:
   i. Larger than
   ii. Smaller than
   iii. Equal to
   iv. Not related to

c. Which of the following statements accurately describes the capabilities of liquid penetrant testing?
   i. Liquid penetrant testing is useful for locating subsurface discontinuities in a test piece
   ii. Liquid penetrant testing is useful for locating discontinuities in porous materials
   iii. Liquid penetrant testing is useful for locating discontinuities which are open to the surface in non-porous materials
   iv. None of the above

d. Which of the following chemical elements are normally held to a minimum in liquid penetrant materials, when testing stainless steel and titanium?
   i. Hydrogen
   ii. Chlorine
   iii. Carbon
   iv. Oil

e. What is the function of an emulsifier?
   i. To remove the excess penetrant
   ii. To develop indications with a post emulsifiable penetrant system
   iii. To assist penetration with a post emulsifiable penetrant system
   iv. To make a post emulsifiable penetrant water washable.

f. Magnetic particle testing is most likely to find subsurface discontinuities in:
   i. Soft steels with high permeability
   ii. Soft steels with low permeability
   iii. Hardened steels with low permeability
   iv. Hardened steels with high permeability

g. Which of the following is not an advantage of magnetic particle testing?
   i. Fast and simple to perform
   ii. Can detect discontinuities filled with foreign material
   iii. Most reliable for finding surface cracks in all types of materials
   iv. Works well through a thin coat of paint

h. The reverse magnetizing force necessary to remove a residual magnetic field from a test piece after it has been magnetically saturated is:
   i. Hysteresis
   ii. Coercive force
   iii. Demagnetizing flux
   iv. Reverse saturation

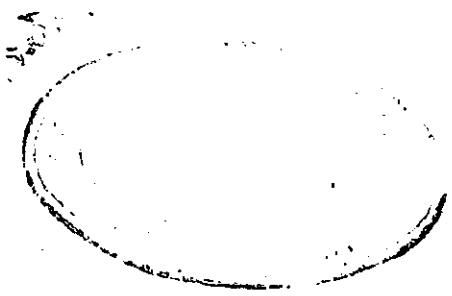
i. Which of the following produces a circular field?
   i. Coil
   ii. Headshot
   iii. Yoke
   iv. All of the above

j. A leakage field is strongest when a discontinuity interrupts the magnetic flux lines at an angle of:
   i. Zero degrees
   ii. 45 degrees
   iii. 90 degrees
   iv. 180 degrees

k. Which of the following is an isotope not artificially produced for industrial radiographic use?
   i. Ir-192
   ii. Ra-226
   iii. Co-60
   iv. All of the above

l. Most of the energy applied to an x-ray tube is converted into:
   i. X-rays
   ii. Light
   iii. Heat
   iv. Ultraviolet radiations

m. An advantage of a gamma ray source is :
   i. Radiation may be turned on or off at will
   ii. Outside power is normally not required
   iii. Less shielding is required than for x-rays
   iv. All of the above



n. X-rays are produced by:
   i. Radioactive isotopes
   ii. The rapid deceleration of electrons
   iii. Ultraviolet radiation of unstable atoms
   iv. All of the above

o. Explain the difference between x and gamma rays
   i. They are both types of electromagnetic radiation
   ii. X-rays are naturally occurring; gamma rays are man made
   iii. X- rays are produced electrically; gamma rays are emitted by disintegrating atomic nuclei
   iv. There is no difference

p. The piezoelectric materials in a search unit which vibrates to produce ultrasonic waves is called:
   i. A backing material
   ii. A lucite wedge
   iii. A transducer element or crystal
   iv. A couplant

q. Sound waves which travel on the surface of a solid in a manner similar to waves on a water surface are called:
   i. Rayleigh waves
   ii. Shear waves
   iii. Primary waves
   iv. Compressive waves

r. As ultrasonic frequency increases:
   i. Wavelength increases
   ii. Wavelength decreases
   iii. Sound velocity increases
   iv. Sound velocity decreases

s. Sound beam intensity is irregular in the area called:
   i. The near field
   ii. The far field
   iii. The beam spread
   iv. The delay line

t. An ultrasonic wave in which particle displacement is 90 degrees to the direction of wave propagation is called a:
   i. Longitudinal wave
   ii. Shear wave
   iii. Compressional wave
   iv. Plate wave

(30 marks)

SECTION B

Question 2

a. Name and describe briefly the six basic steps in the correct sequence of how to conduct a typical liquid penetrant test. **(6 marks)**

b. List four properties of a good penetrant. **(3 marks)**

c. Penetrants can be classified by the method of removing the excess penetrant. List the three classifications. **(3 marks)**

d. How is the excess penetrant removed when solvent removable penetrant is used? **(2 marks)**

Question 3

a. Briefly describe how magnetic particle inspection works. **(2 ½ marks)**

b. What type of magnetization is produced by:
   i. Electromagnetic yoke
   ii. Headshot
   iii. Central conductor
   iv. Coil shot
   v. Prods **(2½ marks)**

c. A magnetic particle inspector is inspecting a part which is 15 inches long by 3 inches in outside diameter. If a five-turn 12 inches diameter coil or cable is used, calculate the coil current to be used if:
   i. The part is positioned towards the side of the coil
   ii. The part is positioned in the centre of the coil. **(9 marks)**

Question 4

a. If frequency remains constant, in what material does sound has the highest velocity: steel, water, or air? **(2 marks)**

b. If the frequency remains constant, in what material does sound has the shortest wavelength: steel, water or air? **(2 marks)**

c. What is the near zone length of a 5 MHz compression probe with a crystal diameter of 15 mm in steel? [Velocity of sound in steel = 5960 m/s] **(5 marks)**

d. What is the beam spread at 6 dB of a 15mm, 5 MHz compression wave probe in steel? [K= 1.08] **(5 marks)**

Question 5

a. X-rays and gamma rays are forms of ionizing radiation. What does this statement mean? **(2 marks)**

b. Describe the processes used to produce X-rays for industrial radiography **(4 marks)**

c. i. List the three main conditions that are desirable to produce sharp shadow images when using an X-ray machine for radiography.

ii. If the focal spot size of an X-ray tube is 0.100 inch and a 3- inch thick part is placed 25 inches from the source, what is the geometric unsharpness? **(4 marks)**

d. The intensity of radiation from a point source decreases as the square of the distance from the source. The dose rate 1 m from a radiation source is $40\,\mu Sv/hr$. What are the dose rates at 2 m and 5 m from the source? **(4 marks)**

Question 6

a. What will be the first concern of a manufacturer designing a new product? **(2 marks)**

b. The first step in conducting any failure analysis is to gain a good understanding of the conditions under which the part was operating.
List the 4 main actions the failure analyst must take to get a good understanding of the conditions. **(4 marks)**

c. In failure analysis, why are chemical analysis and fractography important? **(8 marks)**