

Khulna University of Engineering & Technology
B. Sc. Engineering 3rd Year 2nd Term Examination, 2017
Department of Biomedical Engineering

BME 3241
Magnetic and Nuclear Imaging

Time: 3 hours

Full Marks: 210

- N.B.** i) Answer **ANY THREE** questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) What is MRI? "Hydrogen atoms are best for MRI"- justify this statement. (09)
- b) "Production of net magnetization of human body is zero in general state"- justify this statement. (07)
- c) What do you mean by Larmor frequency? How it relates with external magnetic field strength? (06)
- d) Briefly discuss about the results of Zeeman interaction. (07)
- e) What is excitation pulse? Why we need excitation pulse in MRI? (06)
2. a) What happens after turn off the excitation? Explain. (08)
- b) What happens if the time between successive RF pulses are insufficient for complete recovery of net magnetization? (08)
- c) What do you mean by resonance absorption? Why T1 and T2 relaxation are also known as spin-lattice and spin-spin relaxation respectively? (09)
- d) What is pulse sequence? Briefly explain the manufacturing process of super conductive electromagnet. (10)
3. a) What do you mean by magnet quality? How can you compensate magnetic field distortions? (07)
- b) What is gradient field? What are the parameters for assessing gradient system performance? Explain. (10)
- c) What is readout gradient? Explain the readout process. (08)
- d) What is the relationship between slice thickness and slice selection gradient amplitude? (05)
- e) What happens if we avoid phase encoding step in MRI? (05)
4. a) What do you mean by spatial resolution of MRI? What are the relationship among spatial resolution, field of view and voxel size? (08)
- b) What is Magnetic Resonance Angiography (MRA)? Briefly discuss about phase contrast angiography. (08)

- c) Write short notes on: (09)
- (i) PD-weighted imaging.
 - (ii) T1-weighted imaging.
 - (iii) T2-weighted imaging.
- d) Briefly explain the biological effects of time-varying magnetic field in MRI. (05)
- e) What is fMRI? How fMRI works? (05)

Section B

(Answer ANY THREE questions from this section in Script B)

5. a) What do you mean by radioactivity and radioactive decay? Briefly describe radioactive decay processes with examples. (15)
- b) Derive the expression for the radioactive decay and hence define radioactive decay law. Graphically represent the typical decay pattern and influence of decay constant of radioactive decay. (13)
- c) Find the radioactivity of a 1g sample of ^{226}Ra . Given that $t_{1/2}$: 1620 years and Avogadro's number : 6.023×10^{23} . (07)
6. a) What do you mean by absorbed dose? Define SI and traditional units of absorbed dose. (08)
- b) How Gamma rays interact with matter? Briefly describe the interaction of Gamma rays with matter that are important in nuclear medicine. (12)
- c) Develop the mathematical model for attenuation of Gamma rays. (15)
7. a) What do you mean by radionuclide? Briefly describe the risk of radionuclide exposure. (10)
- b) Draw a schematic diagram of ^{99}Mo - $^{99\text{m}}\text{Tc}$ generator. Briefly describe the working principle of ^{99}Mo - $^{99\text{m}}\text{Tc}$ generators. (13)
- c) Briefly describe the operating principle of a gas field radiation detector. (07)
- d) Write short note on Geiger-Muller Counter. (05)
8. a) Briefly describe the nuclear medicine imaging systems. (06)
- b) Briefly describe the image reconstruction procedure using Iterative Reconstruction. (14)
- c) What do you mean by Scintillation detector? Briefly describe the working principle of a Scintillation detector. (10)
- d) What are the limitations of PET scan. (05)

BME 3213
Biomechanics

Time: 3 hours

Full Marks: 210

- N.B.** i) Answer **ANY THREE** questions from each section in separate scripts.
 ii) Figures in the right margin indicate full marks.
 iii) Assume reasonable data if missing any.
 iv) Table or chart may be supplied on request.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) A 51 kg cylinder C rests on a smooth inclined plane shown in Fig. 1(a). For a tension in the rope of 260N, find the inclination of the plane and the plane reaction. (17)

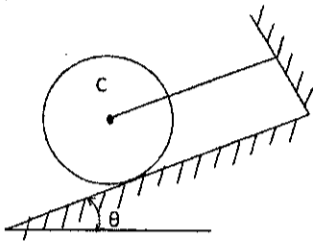


Fig. 1(a)

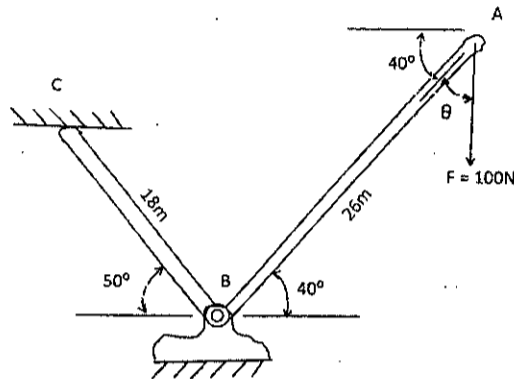


Fig. 1(b)

- b) The bell crank shown in above Fig. 1(b) has a load 100N. If $\theta = 35^\circ$, solve the reaction at B and C. (18)
2. a) Show that the longitudinal stress in a thin walled cylindrical shell of diameter (D) and wall thickness (t) subjected to internal pressure (p) is given by $\sigma_l = \frac{pD}{4t}$. (12)
- b) A cylindrical pressure vessel 400mm in diameter with a wall thickness of 20mm is subjected to an internal pressure of 4.5 MN/m². (12)
- (i) Calculate the tangential and longitudinal stress in the steel.
 (ii) To what value may the internal pressure be increased if the stress in the steel is limited to 120 MN/m².
 (iii) If the internal pressure were increased until the vessel burst, sketch the type of fracture that would occur.
- c) A solid cylinder of diameter d carries an axial load p . Show that its change in diameter is $4pv/\pi Ed$. (11)
3. a) A projectile is fired from the edge of a 150m cliff with an initial velocity of 180m/s at an angle of 30° with the horizontal shown in Fig. 3(a). Neglecting air resistance find: (18)
- (i) The horizontal distance from the gun to point where the projectile strikes the ground.
 (ii) The greatest elevation above the ground reached by the projectile.

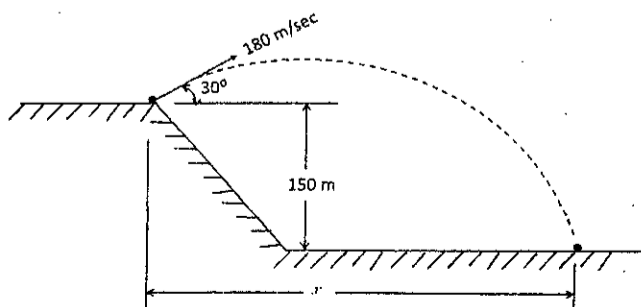


Fig. 3(a)

- b) Block A has a mass of 25kg and block B has a mass of 15kg shown in following Fig. 3(b). (17)
 The coefficient of friction between all surfaces of contact are $\mu_s = 0.20$ and $\mu_k = 0.15$.
 Knowing that $\theta = 25^\circ$ and that the magnitude of the force P applied to block B is 250N,
 determine (i) the acceleration of block A, and (ii) the tension in the cord.

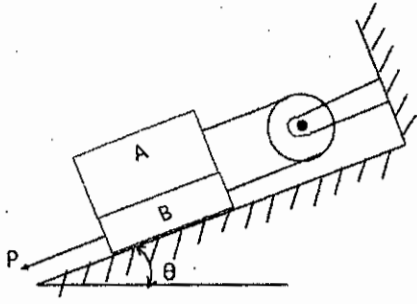


Fig. 3(b)

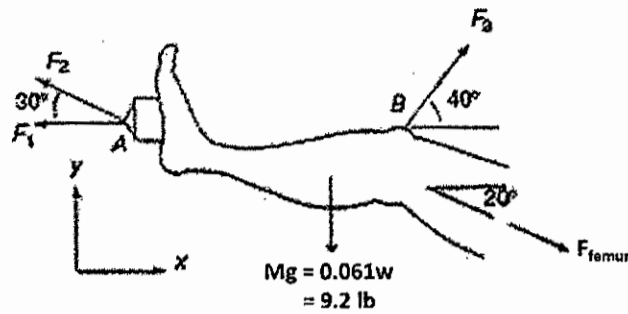


Fig. 4(b)

4. a) What is biomechanics? What are the applications of it? Why is it important to study biomechanics? (08)
- b) Above Fig. 4(b) shows a Russell's traction rig used to apply an axial tensile force to a fractured femur for immobilization. (10)
- (i) What magnitude of weight W must be suspended from the free end of the cable to maintain the leg in static equilibrium?
- (ii) Compute the average tensile force applied to thigh under this conditions.
- c) Describe Westheimer Saccadic eye movement model. (10)
- d) A person weighing 150N has a thigh length of 17cm. Find the moment of inertia of this body segment with respect to its center of mass. (07)

Section B

(Answer ANY THREE questions from this section in Script B)

5. a) What do you mean by hard and soft tissue mechanics? (05)
- b) Describe the different types of cell are present in bone tissue. (10)
- c) Describe the bone formation of intramembranous ossification. (10)
- d) What are the procedural steps to repair of a bone fracture? (10)
6. a) What are the effect of forces in human body? (05)
- b) Derive the stiffness for biological structures of human body. (10)
- c) Describe the different loading systems in biomechanics. (10)
- d) Describe the visco-elastic properties of tissues. (10)
7. a) What are the structures in a synovial joint? Mention the anatomy of hip joint. (10)
- b) Mention the anatomy of knee joint anterior and posterior view. (08)
- c) Describe the features of body movement allowed by synovial joints. (12)
- d) Classify the human joints. (05)
8. a) What is locomotion? What are the major criteria of essential to walk for gait in biomechanics? (15)
- b) What is gait cycle? (05)
- c) Describe the gait cycle in terms of phase analysis for human biomechanics. (15)

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BME 3211
Biomaterials and Prosthetics

Time: 3 hours

Full Marks: 210

- N.B.** i) Answer **ANY THREE** questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.

Section A

(Answer **ANY THREE** questions from this section in Script A) ---

1. a) What is a biomaterial? Considering the definition of a biomaterial, which of the following devices must be made from biomaterials: (05)
(i) Wheelchair; (ii) Pacemaker; (iii) Stethoscope; (iv) Bone graft; (v) Suture .
- b) What are some of the modes by which implants may fail? Suppose the probabilities of failure of a knee replacement in the first year are 5% for infection, 3% for wear, 2% for loosening, 1% for surgical complication and 4% for fracture. Calculate the reliability of the implant during the first year. (08)
- c) Point out the advantages and disadvantages of metals and ceramics. (10)
- d) Discuss the factors which affect fatigue life. (12)
2. a) What do you understand by toughness? From your understanding, compare the toughness of metals, ceramics and polymers with the help of their respective stress-strain curves. (06)
- b) Describe the steps involve in ductile fracture along with a schematic diagram of the steps. (08)
- c) Explain how the rate of loading affects the behavior of a viscoelastic material. (06)
- d) Describe the three stages of creep. (08)
- e) It has been observed that materials tend to fail at much lower stress levels than the theoretically predicted levels. Explain why? (07)
3. a) Explain the working principle of nitinol self-expanding vascular stents. (10)
- b) Identify the problems that may arise if pure magnesium is used for biomedical devices. (05)
- c) Describe the microstructural features which have adverse effects on the mechanical properties of the ASTM F75 cobalt-chromium alloy. (10)
- d) What is the special property of shape memory alloys? Provide an example of a biomedical device in which shape memory effect is exploited and explain the working principle of that device. (10)
4. a) Differentiate between bioinert, biodegradable and bioactive ceramics. (09)
- b) What is the problem associated with using pure zirconia as a biomedical implant? Explain the technique by which this problem can be countered. (10)
- c) Point out the biological activities induced by bioactive glass. Describe how an apatite layer forms on bioactive glass. (13)
- d) Discuss an application of hydroxyapatite. (03)

Section B

(Answer ANY THREE questions from this section in Script B)

5. a) Discuss the characteristics as well as the problem associated with ultra-high molecular weight polyethylene (UHMWPE). (06)
- b) All commercially available bone cements have to be polymerized in site for clinical applications, but straight forward polymerization is not performed. What are the reasons for this? What is done instead of straight forward polymerization? (08)
- c) Suppose, the number-average molecular weight of a polyethylene sample is 40,000. What is the degree of polymerization for this sample? (06)
- d) How do polyglycolic acid (PGA) and polylactic acid (PLA) degrade? Explain how pH affects the degradation of PGA and PLA? (07)
- e) Discuss the classification of polymers based on their molecular structures. (08)
6. a) What is fracture? Enumerate different types of fracture with example. (Draw necessary figures) (15)
- b) What is dialysis? Write down the types of dialysis. Explain the method of peritoneal dialysis. (10)
- c) Write down the indications of using amalgam. (05)
- d) Write a short note on defibrillator. (05)
7. a) What is biodegradable polymers? Point out the application of carbon fibers. (10)
- b) Write down the design criteria of an artificial heart. (10)
- c) What is an artificial cell? Write down the role of artificial cell in cancer treatment. (10)
- d) Write down the properties of mechanical heart valves. (05)
8. a) Draw and label the parts of a tooth. Explain the casting method of dental restorations. (15)
- b) Write down the classification of impression materials. (10)
- c) Creep and stress relaxation both are manifestation of viscoelastic behavior. What is the difference between them? (05)
- d) What is glass transition temperature? "Glass transition temperature is important for polymeric biomaterials."- Provide an example to justify this statement. (05)