

## MANIPAL INSTITUTE OF TECHNOLOGY

## **II SEMESTER M. Tech (BME) DEGREE END-SEMESTER EXAMINATIONS APRIL 2018** SUBJECT: BIOMATERIALS AND ARTIFICIAL ORGAN (BME 5231) (REVISED CREDIT SYSTEM)

## Monday, 23<sup>rd</sup> April 2018: 9 AM to 12 Noon

## **TIME: 3 HOURS**

**MAX. MARKS: 100** 

**Instructions to Candidates:** 

Answer all five full questions. Use separate answer book for Biomaterials (Q.1-2) and Artificial Organ (Q. 3-5)

Why is the implantation of mixed metals (dissimilar metals) usually avoided? 1A. 2+3Explain.

Analyze the impact of 'central blood flow' on the stability of the mechanical heart valves.

- You are asked to design a composite material from carbon fiber and resin for 5 **1B.** fracture plate. The values of the modulus of carbon fiber and resin are 200 GPa and 20 GPa respectively. What volume of carbon fiber will be required to make the modulus of the composite plate 100 GPa? Assume that the fibers are aligned in the direction of the test and  $V_{resin} + V_{fibers} = 1$ .
- Using a spring and Newtonian dashpot, derive an expression for the viscoelastic 1C. 5 + 5behavior of bone as it applies to Maxwell model. Discuss the steps involved in the fixation of dental implants.
- 2A. Explain the effects of the following factors on the mechanical strength of a polymer. 10
  - (i) Molecular weight, (ii) side chain substitution, (iii) crosslinking and (iv) glass transition temperature.
- Analyze the pros and cons of cemented and cement-less implant fixation. 4 **2B**.
- **2C.** Compare (i) laminar and sandwich models of structural composites, (ii) 316 and 3+3316L stainless steel and (iii) calcined and tubular alumina.
- In relation to prosthetic heart valves, explain the term 'profile'. With suitable 6 3A. diagrams, articulate the importance of 'valve profile' in the mitral or aortic positions. Discuss the appropriateness of high or low profile valves in these two positions (example: Starr-Edwards ball valve and St. Judes Bi-leaflet valve).

- 3B. Both IABP and Balloon Angioplasty procedures use balloons mounted at the end of catheters. Discuss the differences and similarities of these two devices, in terms of use, design, materials, testing / validation, compatibility, performance requirements, site of operation, physical dimensions, etc.
- 3C. (i) IABP uses Helium to inflate the balloon. Why can't a more biocompatible 3+3 liquid, such as saline, that will not cause any gaseous embolization even if the balloon ruptures be used instead of Helium? From the design and operations points of view, justify the preference for a gas over a liquid.
  - (ii) In contrast, balloon angioplasty procedure uses a 'liquid' to inflate the angioplasty balloon. In this case, justify the preference for the liquid over a gas.
- **4A.** Explain the terms 'diffusion' and 'convection' as applied to Hemodialysis **3+3+3** procedure.

How does 'ultrafiltration' affect these two processes during dialysis?

Compare and contrast 'Ultrafiltration' and 'Hemofiltration' processes.

- **4B.** What are the general causes of 'loosening' of hip or knee prostheses? **3**
- **4C.** You are the lead designer / researcher to design a 'wearable kidney' system. **8** 
  - i. List all the major performance constraints that have to be taken into account during the design and give imaginative solutions to overcome such constraints.
  - ii. Draw a block diagram showing all the major parts of a wearable kidney system.
- 5A. Explain the role of 'Insulin' and 'Glucagon' in maintaining 'glucose' levels in the 3 body.
- 5B. How is the hemodialysis membrane different from the one used for gas exchange in an oxygenator? Why can't we use a hemodialysis cartridge for supporting a patient in acute lung failure?
- **5C.** List the key functions of the liver.

How can you simulate the functions of the liver using a synthetic system?

Explain the concept of a 'Bio-artificial liver' and explain how a typical bio-system functions.

2+4+6