SUMMER– 2018 EXAMINATION

Model Answer **Subject Code:** 22219

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.		**Attempt any FIVE of the following:**	**10 M**
	a)	**Enlist different forms of corrosion.** **Ans:** 1. Galvanic Corrosion 2. Uniform Corrosion 3. Stress Corrosion 4. Pitting Corrosion 5. Crevice Corrosion 6. Intergranular Corrosion 7. Fatigue Corrosion 8. Erosion Corrosion	**02 M**
	b)	**List any two applications of stainless steel.** **Ans:** 1. Hip nails 2. Bone plates 3. Intramedullary pins 4. Heart valves 5. Cardiac pacemaker electrodes 6. Screws 7. Nuts, bolts 8. Orthopedic implants (knee, hip, ankle joint replacement).	**02 M**
	c)	**Enlist different types of biomaterials.** **Ans:** 1. Polymer 2.Metals 3.Ceramics 4.Composites	**02 M**

	d)	**Define biocompatibility.** **Ans:** The ability of a material to perform with an appropriate host response in a specific application. **OR** Biocompatibility represents the ability of a material to be accepted by a living organism. **OR** The quality of not having toxic or injurious effects on biological systems.	**02 M**
	e)	**Enlist the materials used in sutures.** **Ans:** 1. Synthetic polymers 2. Collagen 3. Polypropylene 4. Polyamide (Nylon) 5. Polyethylene 6. Silicon 7. Wax 8. PTFE 9. Gelatin	**02 M**
	f)	**Name the implants which are related to fixation devices.** **Ans:** 1. Screws 2. Nuts 3. Bolts 4. Plates 5. Wire 6. Pins 7. Intramedullary nails	**02 M**
	g)	**Give mechanical properties of teeth.** **Ans:**	**02 M**

	Density (g/cm^3)	**Compressive Strength (Mpa)**	**Young's Modulus (GPa)**	**Thermal Conductivity(W/mk)**
Enamel	2.2	241	48	0.82
Dentin	1.9	138	13.5	0.59

Table: Mechanical properties of teeth

2.		**Attempt any THREE of the following:**	**12 M**
	a)	**List any two properties and two applications of biodegradable polymers in biomedical field.** **Ans:** **Properties of biodegradable polymers:** 1. Stable and durable 2. Strong 3. Non-toxic 4. Good biocompatibility 5. Capable of controlled rates of degradation. 6. Capable of maintaining good mechanical integrity until degraded. **Applications of biodegradable polymers:** 1. Drug delivery system 2. Tissue engineering (making artificial tissue) 3. Orthopedic applications (knee, hip, ankle joint replacement) 4. Repair of cartilage, ligaments and tendons.	**02 M** **02 M**

b) **List any four mechanical properties of bone.** **04 M**

Ans:

	Direction of test	Modulus of elasticity (Gpa)	Tensile strength (Mpa)	Compressive strength (Mpa)
Leg bone	Longitudinal			
Femur		17.2	121	167
Tibia		18.1	140	159
Fibula		18.6	146	123
Arm bones	Longitudinal			
Humerus		17.2	130	132
Radius		18.6	149	114
Ulna		18	148	117
Vertebrae	Longitudinal			
Cervical		0.23	3.1	10
Lumbar		0.16	3.7	5
Spongy bone		0.09	1.2	1.9
Skull	Tangential Radial	-	-	- 97

Table: Mechanical properties of bone

c) **Describe different types of catheters in detail.** **04 M**

Ans:

Types of Catheters:

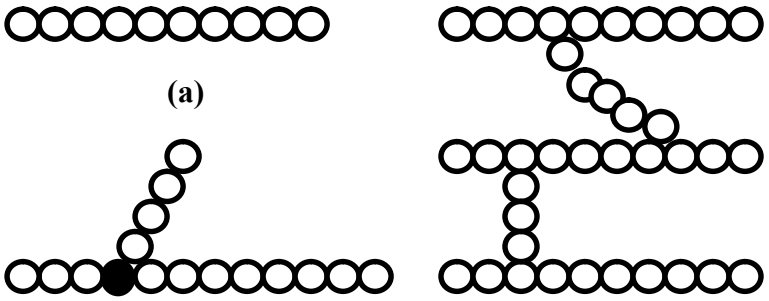
1. **Robinson catheter:** Robinson catheter is a flexible catheter used for short term drainage of urine. It is made using red rubber latex or silicone.
2. **Whistle tip catheter:** It is used in ureter pyelography to occlude the ureteral orifice and prevent backflow from the ureter during and following the injection of an opaque medium. It is made using polyvinyl chloride (PVC) or nylon tubing was cut to a suitable length, sterilized and then used as a catheter.
3. **Pezzer catheter:** Its uses include the drainage of urine from the bladder through the urethra or insertion through a blood vessel into the heart for diagnostic purposes. It is made using polymers like soft plastic, silicone rubber and latex.
4. **Malecot catheter:** Malecot catheter used to provide drainage following open renal or bladder surgeries. It is made using silicone or latex.
5. **Foley catheter:** A Foley catheter is a thin, sterile tube inserted into the bladder to drain urine. It is made using silicone or coated natural latex , Coatings include PTFE, hydrogel or a silicone.
6. **Three way Foley catheters:** It is also called retention catheter, they have 2 or 3 lumens that encircle the body of the catheter. One lumen drains the urine through the catheter into a collection bag. The second lumen holds the sterile water when the catheter is inflated and is also used to deflate the balloon. The third lumen may be used to instill medications into the bladder or provide a route for continuous bladder irrigation. It is used for drainage of urine after bladder surgeries. Also it is used to help remove tissue chips, blood clots and other debris from the bladder after surgery. It is made using silicone or coated natural latex; Coatings include PTFE, hydrogel or a silicone.
7. **Coude catheter:** Coude catheters have a rounded curved tip (elbowed) used in older male patients with enlarged prostates which partially obstruct the urethra. Used to drain the urine from the bladder. It is made using polyvinyl, silicone, and

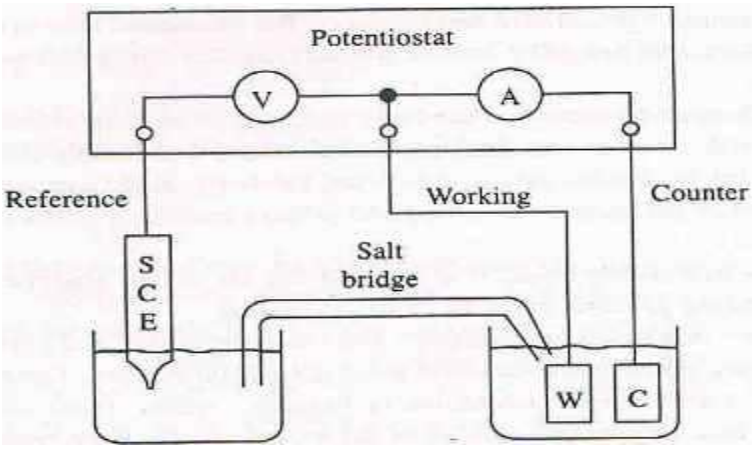
		red rubber latex. 8. **Metal stylet:** Metal Stylet catheter used as ureteric catheter for ureteric meatotomy. (The opening at the tip of the penis is called the urethral meatus. Sometimes this opening is too small, making it hard for your child to pass urine. A meatotomy (or meatoplasty) is the procedure done to enlarge this opening. It is made using stainless steel. 9. **Council catheter:** A council-tip catheter allows for wire-guided placement through an end whole drainage port (lumen) at the tip of the catheter. This provides a direct route for the wire from the drainage port through the lumen of the catheter for advancement of the catheter over the wire. It is made using silicone or red rubber latex.	
	d)	**Describe in-vitro method used to test biomaterial biologically.** **Ans:** 1. **Tissue culture method:** The growth of portion of the intact tissue without prior cellular dissociation. This method usually utilizes a substrate rather than a suspected technic; exposure to biomaterial is similar to that for true cell culture. 2. **Cell culture:** Roth of initially free dissociated cell. These cells may be grown in to solution or on ager or other media substrate. Exposure to biomaterials may be through direct contact with the bulk materials, contact through an ager. 3. **Organ culture:** The growth of intact organ in vitro. This may vary from the use of fetal bone implant, which can survive without external support system to the use of whole, adults, perfused organs such as kidney or heart. 4. **Blood culture test:** Materials problem in cardiovascular devices are primarily those of inadequate biological performance. This is due to the acute nature of host response. These tests are generally comparative type and examine either coagulation times or homeless rate in either static or dynamic system during or after contact with the foreign material.	**04 M**
3.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a)	**Give any four applications of Ti-based alloys.** **Ans:** 1. Orthopedic implants (knee, hip, ankle joint replacement) 2. Making cardiovascular devices 3. Dental implants 4. Surgical implants 5. Production of hip prostheses. 6. Making of fracture equipment. 7. Manufacturing of implants. 8. Making of bone screws and plates.	**04 M**
	b)	**Describe various testing and evaluation process for different dental implants.** **Ans:** The testing and evaluation of dental implants involves several stages. 1. First, materials are tested for toxicity by implantation subcutaneously in rats for periods of time up to 30 days and through tissue culture tests. 2. The second step is to test the devices in an animal model. Of all animals, the baboon is considered the most preferred experimental animal in dental-implant studies, since its physiology and immunological responses are very similar to those of humans. 3. In general, the clinical condition of dental implants is evaluated by using radiographs, gingival tone, pocket depth and mobility. A stereo-photogrammetric method of measuring the extent of tissue changes and mobility of Subperiosteal	**04 M**

		implants technique utilizes stereo photographs to measure quantitatively, the extent of tissue swelling or resorption, as well as, migration of dental implants to an accuracy of 16 μm.	
	c)	**Describe the concept of tissue grafting.** **Ans:** Transplantation involves the removal of cells, tissues or organs from one part of the body and then placing them into another part or another individual. If the graft is returned to the same patient it is termed as autograft, while if it is placed in another individual of the same species, it is termed an allograft or homograft. Tissue transferred to another species is termed as xenograft or heterograft. Autografts are of two types; if it is placed in the same anatomic location from which it is derived, it is termed orthotropic, while if the location of the implant is different from the original site, it is termed heterotropic.	**04 M**
	d)	**List any two properties and applications of silicon rubber.** **Ans:** **Properties of silicon rubber:** 1. Easy to fabricate 2. Less irritating material 3. Highly biocompatible 4. Nontoxic material 5. Easy to use **Applications of silicon rubber:** 1. Used to make catheters. 2. Replacement of destroyed or diseased finger joints. 3. Replacement of carpal bones, toe prostheses and capping temporomandibular joints. 4. Breast augmentation. 5. Maxillofacial surgery (includes nasal supports, jaw augmentation, orbital floor repair, and chin augmentation). 6. Artificial bladder, sphincters and testicles. 7. Making artificial heart valves. 8. Drug delivery system. 9. Middle ear prosthesis.	**02 M** **02 M**
4.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a)	**Explain the use of collagen in dentistry.** **Ans:** 1. Prevention of oral bleeding 2. Support of regeneration of periodontal tissues 3. Promotion of healing of mucosal lining 4. Prevention of migration of epithelial cells 5. Dressing materials 6. Carrier substance for immobilization of various active substances used in dentistry. 7. Decreased seepage of blood during periodontal mucoginvival surgery.	**04 M**
	b)	**Give any two properties and two applications of biopolymers.** **Ans:** **Properties of biopolymers:** 1. Good biocompatibility 2. Nontoxic material	

		3. Versatility 4. Bio-absorbability 5. Soft 6. Easy availability **Applications of biopolymers:** 1. Tissue engineering 2. Wound healing 3. Drug delivery system 4. Making Sutures 5. Making artificial vessels 6. Making artificial valves 7. Corneal prosthesis 8. Cartilage substitute 9. Dental applications	**02 M** **02 M**
	c)	**List and explain different factors affecting bone formation and bone resorption.** **Ans:** 1. Vascular in growth 2. Bone formation 3. Bone resorption 1. **Vascular in growth:** Fibronectin, endothelial cell growth factor (ECGF) 2. **Bone formation:** Insulin-like growth factor (IGF-1) somatomedin c, platelet-derived growth factor (PDGF), Fibroblast growth factor (FGF) IL-1, ECGF, insulin, bone derived growth factor (BDGF II and I) bone morphogenetic protein (BMP). 3. **Bone resorption:** IL-1, Osteoclast-activating factor: (OAF), parathyroid hormone, PDGF, transforming growth factor B (TGF-B), tumor necrosis factor (TNF), prostaglandin E_2.	**01M** **03 M**
	d)	**Describe different types of sutures.** **Ans:** **Types of sutures:** 1. **Absorbable sutures:** Absorbable sutures are often used internally and will break down harmlessly in the body over time. Absorbable suture includes Polyglycolic Acid sutures, Polyglactin 910, Catgut, Poliglecaprone 25 and Polydioxanone sutures. Absorbable sutures are made from collagen of healthy mammals or from synthetic polymers. 2. **Non-Absorbable sutures:** Non-absorbable sutures used externally and must be manually removed. Non-absorbable sutures include Polypropylene sutures, Nylon (polyamide), Polyester, PVDF, silk and stainless steel sutures. Non-absorbable sutures made from nonbiodegradable materials and encapsulated or body's fibroblasts.	**04 M**
	e)	**Relate the following application with stainless steel alloy, Ti based alloys.** **1. Hip prostheses** **2. Cardiac pacemaker** **3. Bone plate** **4. Screws** **Ans:** **Stainless steel alloy** 1. Bone plate 2. Screws	**02 M**

		Ti based alloys 1. Hip prostheses 2. Cardiac pacemaker	**02 M**
5.		**Attempt any <u>TWO</u> of the following:**	**12 M**
	a)	**Describe different types of corrosion in detail.** **Ans:** 1. **Galvanic Corrosion:** Galvanic corrosion or dissimilar metal corrosion occurs when two different metals are located together in a corrosive electrolyte. A galvanic couple forms between the two metals, where one metal becomes the anode and the other the cathode. The anode, or sacrificial metal, corrodes and deteriorates faster than it would alone, while the cathode deteriorates more slowly than it would otherwise. 2. **Uniform Corrosion:** Uniform corrosion is considered an even attack across the surface of a material and is the most common type of corrosion. This type of corrosion typically occurs over relatively large areas of a material's surface. 3. **Stress Corrosion:** Stress corrosion cracking (SCC) is a result of the combination of tensile stress and a corrosive environment, often at elevated temperatures. Stress corrosion may result from external stress such as actual tensile loads on the metal or expansion/contraction due to rapid temperature changes. It may also result from residual stress imparted during the manufacturing process such as from cold forming, welding, machining, grinding, etc. 4. **Pitting Corrosion:** Pitting results when a small hole, or cavity, forms in the metal, usually as a result of de-passivation of a small area. This area becomes anodic, while part of the remaining metal becomes cathodic, producing a localized galvanic reaction. The deterioration of this small area penetrates the metal and can lead to failure. Pitting corrosion can be caused by a local break or damage to the protective oxide film or a protective coating; it can also be caused by non-uniformities in the metal structure itself. Pitting is dangerous because it can lead to failure of the structure with a relatively low overall loss of metal. 5. **Crevice Corrosion:** Similar to pitting, crevice corrosion occurs at a specific location. This type of corrosion is often associated with a stagnant micro-environment, like those found under gaskets and washers and clamps. Acidic conditions or a depletion of oxygen in a crevice can lead to crevice corrosion. Crevice corrosion can often occur at lower temperatures than pitting. Proper joint design helps to minimize crevice corrosion. 6. **Intergranular Corrosion:** Intergranular corrosion is a chemical or electrochemical attack on the grain boundaries of a metal. It often occurs due to impurities in the metal, which tend to be present in higher contents near grain boundaries. These boundaries can be more vulnerable to corrosion than the bulk of the metal. 7. **Fatigue Corrosion:** Environmental cracking is a corrosion process that can result from a combination of environmental conditions affecting the metal. Chemical, temperature and stress-related conditions can result in produce this type of corrosion. 8. **Erosion Corrosion:** Erosion corrosion is a degradation of material surface due to mechanical action, often by impinging liquid, abrasion by slurry, particles suspended in fast flowing liquid or gas, bubbles or droplets, cavitation, etc.	**06 M**

	b)	**Explain the process of total knee replacement.** **Ans:** The femoral component consists of a fairly thin, rigid shell with an attached fixation system to bone. The geometry of the femoral shell requires a stiff, high strength, low wear rate material such as metal. The femoral component is fixed to the cortical bone of the femoral shaft. The fixation system may be either PMMA cement or a biological ingrowth type. The tibial portion consists of a broad plateau covering the tibia, consisting of a stiff metal tray supporting a polymeric or fiber reinforced polymer. Repeated tensile loading may cause failure of PMMA-bone interface TKR utilizes a limited number of metallic alloys including cobalt-chromium and titanium alloy. Cobalt-chromium alloy combined with ultrahigh molecular weight polyethylene (UHMWPE) remains the contact surfaces of choice, despite some adverse effects on biocompatibility and mechanical problems. These include creep and fatigue of UHMWPE component due to high stresses and repeated loading and wear of polymeric contact surface due to adhesion of the polymeric surface to the metal.	**06 M**
	c)	**Identify and write down the name of following polymer chain.**  **(a)** **(b)** **(c)** **Ans:** (a) Linear polymer (b) Branched polymer (c) Crosslinked polymer	**02 M** **02 M** **02 M**
6.		**Attempt any <u>TWO</u> of the following:**	**12 M**
	a)	**Describe electrokinetic theory in detail.** **Ans:** When a material with a charged surface is placed in a solution with ions, a diffused layer of oppositely charged ions (counter ions) appears close to the surface. The electrical double layer is the Stern theory, which describes the change in potential Ψ as the distance from the surface increases. The distance from the surface is Debye length γ. Materials acquiring charge due to many reasons, example: Metals develop a surface potential due to surface oxidation. The presence of the electrical double layer gives rise to electrokinetic phenomena when either the particles or the medium moves. The streaming potential and electro osmosis owe their existence to the electrical double layer. Electro osmosis is observed when an electrical potential is applied to the opposite ends of porous plug in a liquid medium. A flow of liquid through plug occurs. The streaming potential is the converse. Forced motion of liquid through a porous plug generates an electrical potential, called Zeta potential (ζ). The Zeta potential is the electrical potential at the plane of shear in the liquid. Measurements of ζ potential have been useful for determining characteristics of blood vessels. The surface properties are among the most important material properties that a biomaterial possesses. This is due to the fact that	**06 M**

		when a device is implanted into tissues, the surface chemistry will determine to a large extent how the material and the tissues, or fluids interact.	
	b)	**Explain the process of total hip replacement.** **Ans:** A hip replacement consists of femoral component that is a ball mounted on a shaft & an acetabular component having a socket into which ball is placed. Cobalt - Chromium & Titanium-Aluminum-Vanadium alloys or alpha alumina are used by different manufacturer for the femoral component & high molecular weight polyethylene to cover the socket. Several design types with different stem lengths are available. Boutin (1974) had reported several hundred successful clinical cases using a ceramic ball on a metallic stem femoral component & a matching alumina acetabular component. Boutins devices were all fixed in the bony tissues with standard PMMA cement. Subsequently the HDHMW polyethylene cups were introduced along with ceramic balls attached to metallic stem. The number of alternative combinations of materials are use in total hip replacement include Metal- Metal, Metal- HDHMW polyethylene, Ceramic- HDHMW polyethylene, Ceramic- Ceramic.	**06 M**
	c)	**Draw labelled experimental setup for measurement of corrosion rate and give use of potentiometer in it.** **Ans:**  **Fig: Experimental setup for measurement of corrosion rate** A small current is passed from the implant material (working electrode), at a fixed potential (voltage) through an electrolyte solution to an auxiliary electrode and back through an ammeter to the power supply. The potential difference between the implant material and a reference electrode is measured directly with a potentiometer. In a general a linear relation between current and potential is observed to 10 mV. The corrosion rate is determined from the slope of this line, using the appropriate equation. This technique is very sensitive and accurate for small rates with very small applied current (0.001 A/cm^2). The potential of test specimen or working electrode (W) is measured relative to a saturated calomel electrode (SCE). The potential is controlled by the potentiostat, and the current flow between the working electrode and counter electrode (C) associated with thus potential is monitored.	**03 M** **03 M**