

**प्रदेश लोक सेवा आयोग**  
**कोशी प्रदेश, विराटनगर**

प्रदेश निजामती सेवा अन्तर्गत प्राविधिक तर्फ प्रदेश स्वास्थ्य सेवा विविध समूह, बायोमेडिकल इन्जिनियरिङ उपसमूह, अधिकृतस्तर सातौं तह, बायोमेडिकल इन्जिनियर पदको अन्तर तह तथा खुला प्रतियोगितात्मक परीक्षाको पाठ्यक्रम

**पाठ्यक्रमको रूपरेखा:** यस पाठ्यक्रमको आधारमा निम्नानुसार दुई चरणमा परीक्षा लिइने छ :

**प्रथम चरण:** लिखित परीक्षा

पूर्णाङ्क: २००

**द्वितीय चरण:** सामूहिक परीक्षण र अन्तर्वार्ता

पूर्णाङ्क :- ४०

**परीक्षा योजना (Examination Scheme)**

**प्रथम चरण: लिखित परीक्षा**

पत्र	विषय	पूर्णाङ्क	उत्तीर्णाङ्क	परीक्षा प्रणाली	प्रश्न संख्या अङ्कभार	समय
प्रथम	बायोमेडिकल इन्जिनियरिङ्ग	१००	४०	वस्तुगत बहुवैकल्पिक प्रश्न (MCQs)	१००x१=१००	१ घण्टा १५ मिनेट
द्वितीय	सम्बन्धी	१००	४०	विषयगत (Subjective)	१०x१०=१००	३ घण्टा

**द्वितीय चरण: सामूहिक परीक्षण र अन्तर्वार्ता**

विषय	पूर्णाङ्क	परीक्षा प्रणाली	समय
सामूहिक परीक्षण (Group Test)	१०	सामूहिक छलफल (Group Discussion)	३० मिनेट
अन्तर्वार्ता	३०	मौखिक	

**द्रष्टव्य :**

- लिखित परीक्षाको माध्यम भाषा नेपाली वा अंग्रेजी अथवा नेपाली र अंग्रेजी दुवै हुनेछ।
- प्रथम पत्र र द्वितीय पत्रको लिखित परीक्षा छुट्टाछुट्टै हुनेछ।
- वस्तुगत बहुवैकल्पिक (Multiple Choice) प्रश्नहरूको गलत उत्तर दिएमा प्रत्येक गलत उत्तर बापत २० प्रतिशत अङ्क कट्टा गरिनेछ। तर उत्तर नदिएमा त्यस बापत अङ्क दिइने छैन र अङ्क कट्टा पनि गरिने छैन।
- बहुवैकल्पिक प्रश्नहरू हुने परीक्षामा कुनै प्रकारको क्याल्कुलेटर (Calculator) प्रयोग गर्न पाइने छैन।
- विषयगत प्रश्नहरूको हकमा तोकिएको अंकको एउटा लामो प्रश्न वा एउटै प्रश्नका दुई वा दुई भन्दा बढी भाग (Two or more parts of a single question) वा एउटा प्रश्न अन्तर्गत दुई वा बढी टिप्पणीहरू (Short notes) सोध्न सकिने छ।
- द्वितीय पत्रमा (विषयगत प्रश्न हुनेका हकमा) प्रत्येक खण्डका लागि छुट्टाछुट्टै उत्तरपुस्तिकाहरू हुनेछन्। परीक्षार्थीले प्रत्येक खण्डका प्रश्नहरूको उत्तर सोही खण्डको उत्तरपुस्तिकामा लेख्नुपर्नेछ।
- यस पाठ्यक्रम योजना अन्तर्गतका पत्र/विषयका विषयवस्तुमा जेसुकै लेखिएको भएतापनि पाठ्यक्रममा परेका कानून, ऐन, नियम तथा नीतिहरू परीक्षाको मितिभन्दा ३ महिना अगाडि (संशोधन भएका वा संशोधन भई हटाइएका वा थप गरी संशोधन भई कायम रहेकालाई यस पाठ्यक्रममा परेको सम्झनु पर्दछ।
- पाठ्यक्रम लागू मिति: २०८१/६/२२**

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प्रथम र द्वितीय पत्र बायोमेडिकल इन्जिनियरिङ सम्बन्धी

**Section- A**

**1. Cell Biology, Immunology**

- 1.1 Cell biology: Cell growth, apoptosis and oncogenic transformation, cell signaling
- 1.2 Biomolecules: Proteins, carbohydrates, lipids, nucleic acid
- 1.3 Molecular biology and genetics: DNA, RNA and Protein synthesis; Techniques of genetic engineering
- 1.4 Immunology: Types of immunity, Antigen and antibody, Antigen-Antibody reactions

**2. Human Anatomy and Physiology**

- 2.1 Introduction to Human Body: Understanding of body design at structure-function level; Interpretation of the molecular cell biology to the development of body organs & system; Understanding of Disease Mechanism. The Cells, Tissues & Organization of the Body; Understanding of structure & function of different types of cells & tissues; Cell to cell transport mechanisms
- 2.2 Blood: Composition of Blood; Erythrocytes (RBCs), leukocytes (WBCs) and platelets and their functions; Clotting factors; Hematopoiesis; Hematopoietic stem cell; Differentiation and maturation of haematoblast into RBCs, WBCs and Platelets; Hemostasis, Components of coagulation cascades;
- 2.3 The Cardiovascular System: Understanding of Anatomy of heart & blood vessels; Study of blood supply of heart or coronary circulation; Blood circulation from different organs to the heart & from the heart to different organs; Outline the heart functions; Understanding of cardiac cycle, cardiac output & blood pressure; Learning of conduction system of heart
- 2.4 The Respiratory System: Understanding of Anatomy-physiological relationship of upper respiratory tract, Lungs & its topography. Pleura & pleural cavity; Learning of lung functions; Mechanism of breathing, types of breathing & control of respiration; Understanding of Ventilation & Lung volumes Gas transfer & diffusion.
- 2.5 The Digestive System: Understanding of digestion, secretion & absorption capacity of gut, Structure-function relationship of liver, biliary tract & gall bladder, Pancreas & its functions; Revision of Metabolic functions of body
- 2.6 The Urinary System: Topography of Kidneys; Microanatomy of kidney; Role of kidney in salt-water balance Structure-function relationship of ureter, bladder & urethra; Control of bladder function Renal & urinary diseases.
- 2.7 The Nervous System: Understanding the microanatomy of nerve cells (Neurons); Functions of nerve cells, impulse generation, Neuromuscular transmission; Structure of central nervous system and areas of brain.

**3. Implantable Devices**

- 3.1 Cardiovascular Implants: Heart valves: Single leaflet, Bi-leaflet, Bioprosthetic; Vascular grafts: Artificial and biological; Stents, catheters and cannulas; Pacemakers; Inferior venacava filters; Intra-aortic balloon pump; Ventricular assist device

- 3.2 Orthopedic Implants: Biomaterials used in orthopedic implants; Total hip Replacement; Total Knee Replacement
  - 3.3 Urology Implants: Materials used in urology implants; Urethral catheters; Urology stents
  - 3.4 Plastic Surgery implants: Materials used in plastic surgery implants; Types and procedures of breast implants; Gels and fillers in plastic surgery
  - 3.5 Different Kinds of Artificial Organs: Artificial Pancreas, Artificial Liver, Artificial Heart and Lungs, Artificial Kidneys, Artificial Hearing Implants, Artificial Skin
  - 3.6 Tissue Engineering: Introduction;
  - 4. Bio-engineering Materials and Components**
    - 4.1 Biomaterials: Introduction to Bio-materials and biocompatibility, Classes of materials used in medicine.
    - 4.2 Metals: Introduction, applications of various metals relating to biomaterials.
    - 4.3 Polymers: Introduction, Types of polymers used in medicine Hydrogel
    - 4.4 Ceramics, Glasses and Composites: Structure, chemistry and properties of ceramics and glasses used in medical devices; Types of bio-ceramics.
    - 4.5 Natural Materials: Different types of natural materials; Collagen: Structure, Physical modification, Chemical Modification, Proteoglycans and glycosaminoglycans
  - 5. Biomechanics**
    - 5.1 Human joints: Classification and forces in joints (elbow, shoulder, hip, knee, spine, ankle, wrist)
    - 5.2 Mechanics of hard tissues: Bone growth and development, fracture mechanics, mechanical properties of cortical and cancellous bones
    - 5.3 Mechanics of soft tissues: Mechanical properties of ligaments & tendons, collagen, elastin; Muscle Mechanics-skeletal and cardiac muscles
- Section- B**
- 6. Medical Imaging**
    - 6.1 X-ray Equipment: X-ray production and methods: X-ray tubes: Stationary and Rotating anode; X-ray control and indicating equipment; Filters and grids; Fluoroscopy: Introduction, Biological Effects of X-rays
    - 6.2 Computed Tomography (CT): Introduction; Basic Principles of CT; Generation of CT; System Components
    - 6.3 Magnetic Resonance Imaging (MRI): Fundamental Concepts; Principles of Parameters of MRI; Basic Principles of MR Imaging and Related Parameters Image formation; Contrast Enhanced MRI; Clinical Application
    - 6.4 Ultrasonography (USG): Physics of Ultrasound; Construction and Properties of Ultrasound Transducer Ultrasonic Beam; Modes of Ultrasound Imaging: Doppler Ultrasound; Clinical Application; Biological Effects of Ultrasound
    - 6.5 Digital Imaging: Introduction, Digital Radiography, PACS (Picture Archiving and Communicating System)
  - 7. Biomedical Instrumentation**
    - 7.1 Fundamental of Medical Instrumentation: Sources of Biomedical Signals; Basic Medical Instrumentation System; Performance Requirements of Medical Instrumentation Systems; Intelligent Medical Instrumentation Systems; General Constraints in Design of Medical Instrumentation; Systems Regulation of Medical Devices

- 7.2 Signals and Electrodes: Bioelectric potential; Resting potential; Action potential; Propagation of action potential; Biological signals; Electrodes, types of Electrodes used in medical applications.
- 7.3 Physiological Transducers: Introduction; Classification of Transducers: Active and Passive; Performance Characteristics of Transducers; Displacement, Position and Motion Transducers, Pressure Transducers; Transducers for Body Temperature Measurement; Photoelectric Transducers; Optical Fiber Transducers; Optical Fiber Sensors; Biosensors; Smart Sensors
- 7.4 Biomedical Recorders: Electrocardiograph (ECG); Electroencephalograph (EEG); Electromyograph (EMG);
- 7.5 Patient Monitoring System: System Concept; Cardiac Monitor, Beside Patient Monitoring Systems, Central Monitors; Measurement of Heart Rate; Measurement of Pulse Rate; Blood Pressure Measurement; Measurement of Temperature; Measurement of Respiration Rate; Catheterization Laboratory Instrumentation
- 7.6 Arrhythmia and Ambulatory Monitoring Instruments: Cardiac Arrhythmias; Arrhythmia Monitor; QRS Detection Techniques; Exercise Stress Testing, Ambulatory Monitoring Instruments
- 7.7 Fetal Monitoring Instruments: Cardiotocograph; Methods of Monitoring Fetal Heart Rate; Monitoring Labor Activity; Recording System
- 7.8 Biomedical Telemetry and Telemedicine: Wireless Telemetry; Single Channel Telemetry Systems; Multi-patient Telemetry; Multi-channel Wireless Telemetry Systems; Implantable Telemetry System; Transmission of Analog Physiological Signals; Telemedicine
- 7.9 Oximeters: Pulse Oximeter: Skin Reflectance Oximeters;
- 7.10 Blood Flowmeters: Electromagnetic Blood Flowmeter; Types of Electromagnetic Blood Flowmeter; Ultrasonic Blood Flowmeters; NMR Blood Flowmeters;
- 7.11 Cardiac Output Measurement: Measurement of Continuous Cardiac Output Derived from Aortic Pressure Waveform; Impedance Technique; Ultrasound Method
- 7.12 Pulmonary Function Analyzers: Pulmonary Function Measurements; Spirometry; Measurement of Volumes; Pulmonary Function Analyzers
- 7.13 Clinical Laboratory Equipment: Medical Diagnosis with Chemical Tests; Spectrophotometry, Spectrophotometer type Instruments; Colorimeters; Biochemistry Analyzers; Electrolyte Analyzers, Centrifuge; Biosafety Cabinet; Autoclave
- 7.14 Blood Gas Analyzers: Acid Base Balance; Blood pH Measurements; Measurement of Blood PCO<sub>2</sub>; Blood pO<sub>2</sub> Measurement; Intra-Arterial Blood Gas Monitoring; A Complete Blood Gas Analyzer
- 7.15 Blood Cell Counters: Methods of Cell Counting; Coulter Counters; Automatic Recognition and Differential Counting of Cells
- 7.16 Audiometers and Hearing Aids: Mechanism of Hearing, Measurement of Sound; Basic Audiometer; Pure Tone Audiometer; Speech Audiometer, Audiometer System Bekesy; Evoked Response Audiometry System; Calibration of Audiometers; Hearing Aids
- 7.17 Cardiac Pacemakers: Need for Cardiac Pacemaker, External Pacemaker; Implantable Pacemakers; Recent Development in Implantable Pacemakers; Pacing System Analyzer
- 7.18 Cardiac Defibrillators: Need for a Defibrillator, DC Defibrillator; Pacer cardioverter-defibrillator, Defibrillator Analyzers
- 7.19 Instruments for Surgery: Principle of Surgical Diathermy; Surgical Diathermy Machine: Monopolar and Bi-polar; Safety Aspects in Electro-surgical Units

- 7.20 Laser Applications in Biomedical Field: Principle of Laser, Pulsed Ruby Laser, Nd-YAG Laser; Helium-Neon Laser, Argon Laser, CO<sub>2</sub> Laser, Excimer Lasers; Semiconductor Lasers; Laser Safety
- 7.21 Physiotherapy and Electrotherapy Equipment: High Frequency Heat Therapy; Short-wave Diathermy: Microwave Diathermy; Ultrasonic Therapy Unit; Electrodiagnostic/Therapeutic Apparatus; Pain Relief Through Electrical Stimulation
- 7.22 Hemodialysis Machines: Function of the Kidneys; Artificial Kidney; Dialyzers; Membranes for Hemodialysis; Hemodialysis machine
- 7.23 Lithotripters: The Stone Disease Problem; Conventional Lithotripter Machine; Modern Lithotripter Systems; Extra-corporeal Shock-wave Therapy
- 7.24 Anesthesia Machine Need for Anesthesia; Anesthesia Machine: Introduction and Electronics parts in Anesthesia Machine
- 7.25 Ventilators: Mechanisms of Respiration; Artificial Ventilation Ventilators; Types of Ventilators; Ventilator Terms; Classification of Ventilators; Pressure-volume-flow Diagrams; Modern Ventilators; High Frequency Ventilators Humidifiers, Nebulizers and Aspirators
- 7.26 Automated Drug Delivery Systems: Components of Drug Infusion Systems; Closed-loop Control in Infusion Systems, Examples of Typical Infusion Pumps and syringe pumps
- 7.27 Patient Safety: Electric Shock Hazards; Leakage Currents; Safety Codes for Electromedical Equipment; Electrical Safety Analyzer

### **Section- C**

## **8. Electronic Devices and Circuits**

- 8.1 Integrated Circuit Technology and Device Models
- 8.2 Overview of dc and ac diode models, JFET models, bipolar transistor models, MOS transistor models.
- 8.3 Operational Amplifier Circuits
- 8.4 Bias circuits suitable for IC design.
- 8.5 The differential amplifier
- 8.6 Active loads.
- 8.7 Power Supplies and Voltage Regulators
- 8.8 Half-wave and full-wave rectifiers.
- 8.9 Capacitive filtering.
- 8.10 Zener diodes, bandgap voltage references, constant current diodes.
- 8.11 Zener diode voltage regulators.
- 8.12 Untuned and Tuned Power Amplifiers
- 8.13 Amplifier classification.
- 8.14 Direct-coupled push-pull stages.
- 8.15 Transformer-coupled push-pull stages.
- 8.16 Tuned power amplifiers.
- 8.17 Oscillator Circuits and Filter Circuits:
- 8.18 CMOS inverter relaxation oscillator.
- 8.19 Operation amplifier-based relaxation oscillators.
- 8.20 Voltage-to-frequency converters.
- 8.21 LC Filters, RC Filters, Active Filters

## **9. Digital Electronics and Microprocessors**

- 9.1 Logic Gates: truth tables and Boolean expressions
- 9.2 Universal gates and gate conversion
- 9.3 DE Morgan's theorem
- 9.4 Combinational Logic Devices
- 9.5 Encoder and Decoder
- 9.6 Multiplexer and Demultiplexer
- 9.7 Half and Full: Adder and Subtractor
- 9.8 Sequential Logic Devices
- 9.9 Counters: types and characteristics
- 9.10 Registers: SISO, SIPO, PISO, PIPO
- 9.11 Digital clocks and frequency counter
- 9.12 Bus Structure and Memory Devices
- 9.13 Bus structure, synchronous and asynchronous data bus, address bus, bus timing
- 9.14 Static and dynamic RAM, ROM, PROM, EPROM, EEPROM
- 9.15 Input/Output Interfaces for serial communication
- 9.16 Asynchronous interface: ASCII code, baud rate, start bit, stop bit, parity bit Synchronous interface
- 9.17 Physical communication standard
- 9.18 Interrupt vector and descriptor table
- 9.19 Interrupt service routine requirements
- 9.20 Interrupt priority: Maskable and Non-maskable interrupts, software interrupts, traps and exceptions

## **10. Digital Signal Processing**

- 10.1 Introduction to Discrete Signal and Systems
- 10.2 Discrete signals unit impulse, unit step, exponential sequences.
- 10.3 Linearity, shift invariance, casualty.
- 10.4 Convolution summation and discrete systems, response to discrete inputs.
- 10.5 Stability, sum and convergence of power series.
- 10.6 Sampling continuous signals - spectral properties of sampled signals.

## **11. Control Systems**

- 11.1 System Modeling
- 11.2 Differential equation and transfer function
- 11.3 State-space formulation of differential equations, matrix notation
- 11.4 Mechanical components and Electrical components: mass, spring, damper, inductance, capacitance, resistance, sources, motors, tachometers, transducers, operational amplifier circuits
- 11.5 Linearized approximations
- 11.6 Frequency domain characterization of systems
- 11.7 Bode amplitude and phase plots, Effects of gain and time constants on Bode diagrams, Stability from the Bode diagram
- 11.8 Nyquist plots, Correlation between Nyquist diagrams and real time response of systems: stability, relative stability, gain and phase margin, damping ratio

**12. Communication Systems**

- 12.1 Analog and digital communication sources, transmitters, transmission channels and receivers.
- 12.2 Types and reasons for modulation.
- 12.3 Representation of Communication Signals and Systems
- 12.4 Frequency Modulation (FM) and Phase Modulation (PM)
- 12.5 Distortion, noise, and interference.
- 12.6 Nyquist sampling theory, sampling of analog signals, spectrum of a sampled signal.

**Section- D****13. Medical Industry Management**

- 13.1 Introduction to Medical Industry concept: Classification of medical devices: Class I, IIa, IIb, III; Introduction to ISO, CE marking, FDA
- 13.2 Selection and purchase and management of medical equipment: Need analysis; Specification preparation
- 13.3 Various procurement methods: Direct purchase, Sealed quotation, Tender, Incoming inspection and commissioning
- 13.4 Preventive maintenance; Corrective maintenance; AMC (Annual Maintenance Contract); CMC (Comprehensive Maintenance Contract); Decommissioning of the medical equipment.
- 13.5 Basics of hospital management: Hospital traffic flow; Architectural planning of hospital
- 13.6 Basics of Patient Management system and Laboratory management system
- 13.7 Biomedical Waste Management System

**14. Engineering Professional Practice and Provincial Laws relating to personnel administration**

- 14.1 Codes of ethics and guidelines for professional engineering practice
- 14.2 Relationship of the engineering profession to basic science and technology
- 14.3 Relationship of the engineering profession to other professions
- 14.4 प्रदेश निजामती सेवा ऐन, २०७९ (कोशी प्रदेश)
- 14.5 स्थानीय सरकारी सेवा (गठन तथा सञ्चालन) ऐन, २०८० (कोशी प्रदेश)
- 14.6 प्रदेश लोक सेवा आयोग ऐन, २०७६ (कोशी प्रदेश)

**अंकभार विभाजन (Marks Division)**

प्रथम र द्वितीय पत्रको लागि यथासम्भव निम्नानुसार प्रश्नहरू सोधिने छ।

प्रथम पत्र (वस्तुगत)				
पत्र	खण्ड (Section)	परीक्षा प्रणाली	अङ्कभार	प्रश्न संख्या X अङ्क
प्रथम	(A)	बहुवैकल्पिक प्रश्न (MCQs)	३०	३० प्रश्न x १ अङ्क= ३०
	(B)		३०	३० प्रश्न x १ अङ्क= ३०
	(C)		३०	३० प्रश्न x १ अङ्क= ३०
	(D)		१०	१० प्रश्न x १ अङ्क= १०
द्वितीय पत्र (विषयगत)				
पत्र	खण्ड (Section)	परीक्षा प्रणाली	अङ्कभार	प्रश्न संख्या X अङ्क
द्वितीय	(A)	विषयगत (Subjective)	३०	३ प्रश्न x १० अङ्क= ३०
	(B)		३०	३ प्रश्न x १० अङ्क= ३०
	(C)		२०	२ प्रश्न x १० अङ्क= २०
	(D)		२०	२ प्रश्न x १० अङ्क= २०

### अन्तिम चरण (Final Examination): सामूहिक परीक्षण (Group Test)

सामूहिक परीक्षण व्यक्तित्व परीक्षण (Personality Test) को एक अंश हो। निजामती सेवाको क्षेत्रविस्तार तथा कार्य पद्धति परिवर्तन समेत भैरहेको सन्दर्भमा नेपाल तथा प्रदेश सरकारका नीति, योजना, कार्यक्रम आदि माथि विचार-विमर्श, छलफल गरी तिनको अझै बढी प्रभावकारी तथा कार्यान्वयनयोग्य समाधान पहिल्याउने सम्बन्धमा उम्मेदवारहरूको क्षमता पहिचान गर्नु यस परीक्षणको मूल उद्देश्य हो। यसको लागि छलफल, विचार-विमर्श गरी परिस्थिति बुझ्न सक्ने, निर्णय दिने, जनतालाई क्रियाशील बनाउने, चित्त बुझाउने, निर्धारित लक्ष्य अनुसार काम गर्ने/गराउनेजस्ता कामका लागि लेखन क्षमताका साथसाथै समस्यालाई यथार्थपरक ढंगले पहिचान गर्न सक्ने, वाक्पटुता, शिष्टता, तर्कशक्तिको पनि आवश्यकता पर्दछ। त्यसैले यस परीक्षणमा उम्मेदवारहरूको बौद्धिक क्षमता, संचार सीप, समूह गतिशीलता, व्यवहार, व्यक्तित्व, मनोवृत्ति, क्रियाशीलता, निर्णयशक्ति, समस्या समाधान क्षमता, नेतृत्व क्षमता, समय व्यवस्थापन तथा व्यक्तित्वमा भएका अन्य गुणहरूको आंकलन अर्थात् परीक्षण र मूल्याङ्कन गर्नको लागि उम्मेदवारहरूलाई कुनै समसामयिक विषय/सवाल/समस्यामा सामूहिक छलफल गरी प्रभावकारी र कार्यान्वयनयोग्य समाधान निकाल्न दिइन्छ। यस परीक्षामा समावेशीकरण, गरीबी निवारण, सामूहिक सौदावाजी, महिला सशक्तीकरण, नेतृत्व मूल्याङ्कन, वातावरणीय मूल्याङ्कन जस्ता कुनै एउटा विषय छलफलका लागि दिइन्छ।

सामूहिक छलफल (Group Discussion) प्रयोजनको लागि गरिने परीक्षण १० पूर्णाङ्क र ३० मिनेट अवधिको नेताविहिन सामूहिक छलफल (Leaderless Group Discussion) को रूपमा सञ्चालन गरिने छ। दिइएको प्रश्न वा Topic का विषयमा पालैपालोसँग निर्दिष्ट समयभित्र समूहबीच छलफल गर्दै प्रत्येक उम्मेदवारले व्यक्तिगत प्रस्तुति (Individual Presentation) गर्नु पर्नेछ। यस परीक्षणमा मूल्याङ्कनको लागि आयोगका पदाधिकारी तथा विषय विज्ञ सहित ३ जना भन्दा बढीको समिति रहनेछ।