

**प्रदेश लोक सेवा आयोग, मधेश प्रदेश**  
**स्वास्थ्य सेवा, विविध समूह, सातौं (७) तह, वायोमेडिकल इन्जिनियर पदको खुला र अन्तर सेवा**  
**प्रतियोगितात्मक लिखित 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**

**प्रथम चरण लिखित परीक्षा योजना (Examination Scheme)**

पत्र	विषय	पूर्णाङ्क	उत्तीर्णाङ्क	परीक्षा प्रणाली	प्रश्न संख्या × अङ्कभार	समय
प्रथम	वायोमेडिकल इन्जिनियरिङ्ग सम्बन्धी	१००	४०	बस्तुगत बहुवैकल्पिकप्रश्न (MCQs)	१००×१=१००	१ घण्टा १५ मिनेट
द्वितीय		१००	४०	विषयगत (Subjective)	१०×१०=१००	३ घण्टा

**द्वितीय चरण**

विषय	पूर्णाङ्क	परीक्षा प्रणाली	समय
सामूहिक परीक्षण (Group Test)	१०	सामूहिक छलफल (Group Discussion)	३० मिनेट
व्यक्तिगत 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 कटौत गरिनेछ । तर उत्तर नदिएमा त्यस बापत अङ्क दिइने छैन र अङ्क कटौतपनि 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 मिति भन्दा ३ महिना अगाडि (संशोधन भएका वा संशोधन भई हटाईएका वा थप गरी संशोधन भई) कायम रहेकालाई यस पाठ्यक्रममा परेको सम्झनु पर्दछ ।
- प्रथमचरणको परीक्षाबाट छनौट भएका उम्मेदवारहरूलाई मात्र द्वितीय चरणको परीक्षामा सम्मिलित गराइनेछ ।
- पाठ्यक्रम लागू मिति: २०८१।०८।१०

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**प्रथम र द्वितीय पत्र:- बायोमेडिकल इन्जिनियरिङ्ग सम्बन्धी**

**Section A**

**1. Cell Biology, Immunology & Tissue Device Interaction**

- 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
- 1.5 Tissue Device Interactions: Inflammation, wound healing and foreign body response; Endothelial cells & ECM-Biomaterial interaction; Blood-biomaterials interaction Bacteria and biomaterials

**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; Appreciation of the Control & regulation of body function: 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; Haematopoiesis; Haematopoietic stem cell; Differentiation and maturation of haematoblast into RBCs, WBCs and Platelets; Hemostasis, Components of coagulation cascades; Extrinsic, intrinsic and common pathway 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: Structure of oral cavity & underlying glands; Teeth systems, functions & abnormalities of teeth; Structure of alimentary system; Functions of stomach, intestine & role of smooth muscle of gut; 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

**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 vena cava filters; Intraaortic balloon pump; Ventricular assist device
- 3.2 Orthopaedic Implants: Biomaterials used in orthopaedic 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 Tissue Engineering: Introduction; Basic procedure of cell culture

**4. Bio-engineering Materials and Components**

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- 4.1 Biomaterials: Introduction to Bio-materials and biocompatibility; Classes of materials used in medicine.
- 4.2 Metals: Introduction, structure, chemistry, mechanical properties and 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
- 5.4 Biofluid Mechanics: Basics of blood rheology; Blood flow and measurement

**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; Bio-potential electrodes; Microelectrodes; Skin surface electrodes
- 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); Biofeedback Instrumentation

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- 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: Ear Oximeter; Pulse Oximeter; Skin Reflectance Oximeters; Intravascular oximeter
- 7.10 Blood Flowmeters: Electromagnetic Blood Flowmeter; Types of Electromagnetic Blood Flowmeter; Ultrasonic Blood Flowmeters; NMR Blood Flowmeters; Laser Doppler Blood Flowmeter
- 7.11 Cardiac Output Measurement: Indicator Dilution Method; Dye Dilution Method; Thermal Dilution Techniques; Measurement of Continuous Cardiac Output Derived from Aortic Pressure Waveform; Impedance Technique; Ultrasound Method
- 7.12 Pulmonary Function Analyzers: Pulmonary Function Measurements; Spirometry; Pneumotachometers; 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; Microscope; Centrifuge; ELISA reader and washer; 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

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- 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 DeMorgan'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

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- 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.
- 10.7 General Introduction of various filters

**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.
- 12.7 Sampling theorem for band-limited signals, effects of aliasing, reconstruction of sampled signals.

**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
- 13.5 Basics of hospital management: Hospital traffic flow; Architectural planning of hospital
- 13.6 Basics of Patient Management system and Laboratory management system

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**14. Engineering Professional Practice**

- 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

**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 × 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 × अङ्क
द्वितीय	(A)	विषयगत (Subjective)	३०	३ प्रश्न × १० अङ्क = ३०
	(B)		३०	३ प्रश्न × १० अङ्क = ३०
	(C)		२०	२ प्रश्न × १० अङ्क = २०
	(D)		२०	२ प्रश्न × १० अङ्क = २०