

प्रदेश लोक सेवा आयोग, लुम्बिनी प्रदेश
प्रदेश निजामती सेवा तथा स्थानीय सरकारी सेवा अन्तर्गत स्वास्थ्य सेवा, विविध समूह वायोमेडिकल इन्जिनियरिङ्ग उपसमूहका अधिकृत स्तर सातौं तहका पदहरूको खुला, आन्तरिक र अन्तरतह प्रतियोगितात्मक परीक्षाको पाठ्यक्रम

पाठ्यक्रमको रूपरेखा :- यस पाठ्यक्रम योजनालाई दुई चरणमा विभाजन गरिएको छ :

प्रथम चरण :- लिखित परीक्षा (Written Examination)

पूर्णाङ्क :- २००

द्वितीय चरण:- सामूहिक परीक्षण (Group Test) र अन्तर्वार्ता (Interview)

पूर्णाङ्क :- ४०

परीक्षा योजना (Examination Scheme)

प्रथम चरण: लिखित परीक्षा (Written Examination)

पत्र	विषय	पूर्णाङ्क	उत्तीर्णाङ्क	परीक्षा प्रणाली		प्रश्न संख्या X अङ्क	समय
प्रथम	वायोमेडिकल इन्जिनियरिङ्ग	१००	४०	वस्तुगत (Objective)	बहुवैकल्पिक प्रश्न (MCQs)	१०० प्रश्न X १ अङ्क	१ घण्टा ३० मिनेट
द्वितीय	सम्बन्धी विषय	१००	४०	विषयगत (Subjective)	लामो उत्तर	१० प्रश्न X १० अङ्क	३ घण्टा

द्वितीय चरण: सामूहिक परीक्षण (Group Test) र अन्तरवार्ता (Interview)

पत्र / विषय	पूर्णाङ्क	परीक्षा प्रणाली	समय
सामूहिक परीक्षण (Group Test)	१०	सामूहिक छलफल (Group Discussion)	३० मिनेट
अन्तर्वार्ता (Interview)	३०	बोर्ड अन्तरवार्ता (Board Interview)	-

द्रष्टव्य :

- लिखित परीक्षाको माध्यम भाषा नेपाली वा अंग्रेजी अथवा नेपाली र अंग्रेजी दुबै हुनेछ ।
- पाठ्यक्रमको प्रथम पत्र र द्वितीय पत्रको विषयवस्तु एउटै हुनेछ ।
- प्रथम पत्र र द्वितीय पत्रको लिखित परीक्षा छुट्टाछुट्टै हुनेछ ।
- प्रथम तथा द्वितीय पत्रहरूबाट सोधिने प्रश्नसंख्या निम्नसार हुनेछ :

एकाई	१	२	३	४	५	६	७	८	९	१०	११	१२	१३	१४
खण्ड	A							B						
प्रथम पत्रका प्रश्न संख्या	६०							४०						
द्वितीय पत्रका प्रश्न संख्या	६							४						

- वस्तुगत बहुवैकल्पिक (Multiple Choice) प्रश्नहरूको गलत उत्तर दिएमा प्रत्येक गलत उत्तर वापत २० प्रतिशत अङ्क कट्टा गरिनेछ । तर उत्तर नदिएमा त्यस वापत अङ्क दिइने छैन र अङ्क कट्टा पनि गरिने छैन ।
- बहुवैकल्पिक प्रश्नहरू हुने परीक्षामा कुनै प्रकारको Memory युक्त विद्युतीय उपकरण जस्तै:- मोबाइल फोन, क्याल्कुलेटर (Calculator), Smart घडी जस्ता वस्तुहरू प्रयोग गर्न पाइने छैन ।
- विषयगत प्रश्नहरूको हकमा तोकिएको अंकको एउटा लामो प्रश्न वा एउटै प्रश्नका दुई वा दुईभन्दा बढी भाग (Two or more parts of a single question) वा एउटा प्रश्न अन्तर्गत दुई वा बढी टिप्पणीहरू (Short notes) सोध्न सकिनेछ ।
- द्वितीय पत्रमा विषयगत प्रश्न हुनेका हकमा प्रत्येक खण्ड (Section) का 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 यो पाठ्यक्रम स्वीकृत हुँदा कायम रहेकालाई यस पाठ्यक्रममा परेको सम्झनुपर्नेछ ।
- प्रथमचरणको परीक्षाबाट छनौट भएका उम्मेदवारहरूलाई मात्र द्वितीय चरणको परीक्षामा सम्मिलित गराइनेछ ।

११. पाठ्यक्रम स्वीकृत मिति:- २०८१/०४/११

प्रथम र द्वितीय पत्र:- वायोमेडिकल इञ्जिनियरिङ्ग 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 and 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 and 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 and 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 venacava filters, Intraaortic balloon pump and Ventricular assist device
- 3.2 Orthopedic Implants: Biomaterials used in orthopedic implants, Total hip Replacement and Total Knee Replacement

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- 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 and Basic procedure of cell culture

4. Bio-engineering Materials and Components

- 4.1 Biomaterials: Introduction to Bio-materials and biocompatibility and 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 and 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 and Blood flow and measurement

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 and Biological Effects of X-rays
- 6.2 Computed Tomography (CT): Introduction, Basic Principles of CT, Generation of CT and 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 and 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 and Biological Effects of Ultrasound
- 6.5 Digital Imaging: Introduction, Digital Radiography and 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 and 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 and Skin surface electrodes
- 7.3 Physiological Transducers: Introduction, Classification of Transducers, Active and Passive; Performance Characteristics of Transducers, Displacement, Position and

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Motion

Transducers, Pressure Transducers, Transducers for Body Temperature Measurement, Photoelectric Transducers, Optical Fiber Transducers, Optical Fiber Sensors, Biosensors and Smart Sensors

- 7.4 Biomedical Recorders: Electrocardiograph (ECG), Electroencephalograph (EEG), Electromyograph (EMG) and Biofeedback Instrumentation
- 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 and Catheterization Laboratory Instrumentation
- 7.6 Arrhythmia and Ambulatory Monitoring Instruments: Cardiac Arrhythmias, Arrhythmia Monitor, QRS Detection Techniques, Exercise Stress Testing and Ambulatory Monitoring Instruments
- 7.7 Fetal Monitoring Instruments: Cardiotocograph, Methods of Monitoring Fetal Heart Rate, Monitoring Labor Activity and 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 and Telemedicine
- 7.9 Oximeters: Ear Oximeter, Pulse Oximeter, Skin Reflectance Oximeters and Intravascular Oximeter
- 7.10 Blood Flowmeters: Electromagnetic Blood Flowmeter, Types of Electromagnetic Blood Flowmeter, Ultrasonic Blood Flowmeters, NMR Blood Flowmeters, Laser Doppler and 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 and Ultrasound Method
- 7.12 Pulmonary Function Analyzers: Pulmonary Function Measurements, Spirometry Pneumotachometers, Measurement of Volumes and 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 and Autoclave
- 7.14 Blood Gas Analyzers: Acid Base Balance, Blood pH Measurements, Measurement of Blood PCO₂, Blood pO₂ Measurement, Intra-Arterial Blood Gas Monitoring and 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 and Hearing Aids
- 7.17 Cardiac Pacemakers: Need for Cardiac Pacemaker, External Pacemaker, Implantable Pacemakers, Recent Development in Implantable Pacemakers and Pacing System Analyzer
- 7.18 Cardiac Defibrillators: Need for a Defibrillator, DC Defibrillator, Pacer – cardioverter-defibrillator and 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, CO₂ Laser, Excimer Lasers,

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अधिकृत स्तर सातौं तहका पदहरूको खुला, आन्तरिक र अन्तरतह प्रतियोगितात्मक परीक्षाको पाठ्यक्रम

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 and Electrical Safety Analyzer

Section B

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.
- 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

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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

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

सामूहिक छलफल (Group Discussion)

प्रथम चरणको लिखित परीक्षाबाट छनौट भएका उम्मेदवारहरूलाई मात्र लिइने सामूहिक परीक्षण (Group Test) को प्रयोजनको लागि गरिने परीक्षणको पूर्णाङ्क १० र समय ३० मिनेटको हुने छ जुन नेताविहीन सामूहिक छलफल (Leaderless Group Discussion) को रूपमा अवलम्बन गरिने छ । दिइएको प्रश्न वा Topics का विषयमा पालैपालोसँग निर्दिष्ट समयभित्र समूहविच छलफल गर्दै प्रत्येक उम्मेदवारले व्यक्तिगत प्रस्तुति (Individual Presentation) गर्नुपर्ने छ। यस परीक्षणमा मूल्याङ्कनको लागि देहाय अनुसारको समिति रहनेछ :

आयोगका अध्यक्ष वा सदस्य	-अध्यक्ष
आयोगका सदस्य	-सदस्य
दक्ष/विज्ञ (१ जना)	-सदस्य

सामूहिक छलफलमा दिइने नमुना प्रश्न वा Topic

उदाहरणको लागि उर्जा सङ्कट, गरिबी निवारण, स्वास्थ्य बीमा, खाद्य सुरक्षा, प्रतिभा पलायन, प्राविधिक तथा व्यावसायिक शिक्षा, शैक्षिक गुणस्तर, महिला हिंसा, लागु पदार्थ दुर्ब्यसन, सार्वजनिक खरिद, लागु पदार्थ ओसार पसार, मानव बेचबिखन रोकथाम आदि जस्ता विषयहरूमध्ये कुनै एक विषय मात्र दिइने छ ।