NUMS

NATIONAL UNIVERSITY OF MEDICAL SCIENCES

# NUMS MDCAT-2025 SYLLABUS

Paper-I: (Biology, Chemistry, Physics, English)

Paper-II: (Psychological TEST)

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## PREAMBLE

National University of Medical Sciences (NUMS) endeavors to set supreme bench mark for the NUMS Entry Test for admission to its Constituent, Affiliated and all Military (Armed Forces) Administered Medical and Dental Colleges. To afford level playing field to all the aspiring candidates, the minimum criteria for the syllabus is the "must know knowledge", based on the common topics approved by various curriculum regulatory authorities in Pakistan. At the same time, being highly competitive examination, the candidates are advised to have a broad-based study and not restrict themselves to limited syllabi only.

One of the greatest challenges was to devise a common syllabus which encompasses not only the content taught in the premedical years but to note the topics missing from various syllabi. The NUMS MDCAT syllabus will not favor any group or place another to any disadvantage.

NUMS MDCAT is designed to evaluate the problem solving, critical thinking, and knowledge of natural, behavioral, and social sciences concepts and principles of a candidate required to the study of medicine. NUMS MDCAT will be a standardized multiple-choice paper-based examination. NUMS MDCAT will also test the aspirants" other abilities like intuitive and critical thinking skills.

Whereas the subject contents are quality assured through diverse and experienced faculty, the psychological test component of NUMS MDCAT evaluates a candidate from the perspective of aptitude and mental robustness to face the highly challenging medical studies.

## 2. STRUCTURE, WEIGHTAGE AND DIFFICULTY LEVELS

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| **STRUCTURE** | • Paper-I Total number of MCQs: 150<br>• Paper-I Duration of MDCAT: **2 hours & 45 minutes**<br>• Paper-II Total number of MCQ: 50<br>• Paper-II Duration of Psychological Test: **15 minutes**<br>• Format: Paper-based MCQs<br>• Minimum pass marks for Medical College Admission: **55%**<br>• Minimum pass marks for Dental College Admission: **50%**<br>• No negative marking |

| **SUBJECT** | **No of MCQ** |
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| **PAPER-I** | |
| Biology | 65 |
| Chemistry | 40 |
| Physics | 30 |
| English | 15 |
| **Total** | **150** |
| **PAPER-II** | |
| Psychological Test | 50 |
| **Grand Total** | **200** |

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| **DIFFICULTY LEVEL** | • 15 % MCQs -------- Easy<br>• 70 % MCQs -------- Moderate<br>• 15 % MCQs -------- Hard |

- **Note: in Biology, Chemistry and Physics section 70 % questions will be recall and 30 % will be application level.**
- Paper 1 : *One Best Answer MCQ with **4 options***
- Paper 2 : (psychological test) : *One Best Answer MCQ with **7 options***

# 3. SECTION 1: BIOLOGY

## 1.1 Content List for Biology

| Sr. No | Content |
|---|---|
| 1 | Biodiversity (a cellular life/ variety of life) |
| 2 | Bio-energetic |
| 3 | Biological Molecules |
| 4 | Cell Structure and function |
| 5 | Coordination and control/ nervous & chemical Coordination |
| 6 | Diversity among Animals |
| 7 | Enzymes |
| 8 | Evolution |
| 9 | Life process in Animals & Plants (nutrition/ gaseous exchange/ transport) |
| 10 | Prokaryotes |
| 11 | Reproduction |
| 12 | Support & movement |
| 13 | Variation & genetics/ inheritance |

## 1.2 Subtopics & Learning Objectives

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| **1**<br><br>**BIODIVERSITY (ACELLULAR LIFE/ VARIETY OF LIFE)** | SUBTOPICS<br>• Classification of viruses<br>• Discovery of viruses<br>• Structure of viruses • Viral disease (for example AIDS) |
| | **LEARNING OBJETIVES**<br>1.1 Trace the discovery of virus<br>1.2. Classify viruses on basis of their structure/ number of strands/ diseases/ host etc.<br>1.3. Identify symptoms, mode of transmission and cause of viral disease (AIDS) |
| **2**<br>**BIOENERGETICS** | **SUBTOPICS**<br>• Anaerobic respiration (respiration without oxygen)<br>• Electron transport chain<br>• Glycolysis/glycolytic pathway/aerobic respiration<br>• Light dependent and light independent phases/reactions,<br>• Oxidative phosphorylation /cyclic and non- cyclic phosphorylation,<br>• Photosynthesis, |

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| | • Production of ATP<br>• Role of light, water, CO2, /factors effecting photosynthesis |
| | **LEARNING OBJECTIVES**<br>2.1. Explain the process of photosynthesis<br>2.2. Explain the role of factors (light, water, CO2) affecting photosynthesis 2.3. Explain light dependent and independent phases/reaction<br>2.4. Differentiate among Electron transport chain, phosphorylation, glycolysis, aerobic and anaerobic respiration |
| **3**<br>**BIOLOGICAL MOLECULES** | **SUBTOPICS**<br>• Introduction to biological molecules<br>• Water<br>• Carbohydrates<br>• Proteins<br>• Lipids<br>• Conjugated molecules (glycolipids, glycoproteins) |
| | **LEARNING OBJECTIVES**<br>3.1. Define and classify biological molecules.<br>3.2. Discuss the importance of biological molecules<br>3.3. Describe biologically important properties of water (polarity, hydrolysis, specific heat, water as solvent and reagent, density, cohesion/ionization) 3.4. Discuss carbohydrates: monosaccharides (glucose), oligosaccharides (cane sugar, sucrose, lactose), polysaccharides (starches, cellulose, glycogen) 3.5. Describe proteins: amino acids, structure of proteins<br>3.6. Describe lipids: phospholipids, triglycerides, alcohol and esters (acylglycerol)<br>3.7. Give an account of RNA<br>3.8. Discuss conjugated molecules (glycol lipids, glycol proteins) |
| **4**<br>**CELL STRUCTURE & FUNCTION** | **SUBTOPICS**<br>• Cell wall,<br>• Cytoplasm and cell organelles<br>- Nucleus<br>- Endoplasmic reticulum<br>- Mitochondria<br>- Golgi apparatus/ golgi complex / golgi bodies<br>- Lysosomes<br>- Plastids/chloroplasts<br>- Vacuoles<br>• Prokaryote and eukaryote<br>• Fluid mosaic model |
| | **LEARNING OBJECTIVES**<br>4.1. Compare the structure of typical animal and plant cell<br>4.2. Compare and contrast the structure of prokaryotic cells with eukaryotic cells |

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| | 4.3 Outline the structure and function of the following organelles: nucleus, endoplasmic reticulum, golgi apparatus, mitochondria<br>4.4. Discuss fluid mosaic model of cell membrane |
| **5<br>COORDINATION & CONTROL/ NERVOUS & CHEMICAL COORDINATION** | **SUBTOPICS**<br>• Nervous system<br>- Nerve impulse<br>- Steps involved in nervous coordination<br>- Neurons (Structure and Types)<br>• Transmission of action potential between cells–synapse<br>- Electrical synapses<br>- Chemical synapses<br>- Transmission of nerve impulse across synapse<br>• Hormones<br>• Endocrine glands<br>• Feedback mechanism<br>- Positive feedback mechanism<br>- Negative feedback mechanism<br>• Reflexes and reflex arc<br>• Levels of the spinal cord and its main functions<br>• Parts of the brain with their main functions |
| | **LEARNING OBJECTIVES**<br>5.1. Recognize receptors as transducers sensitive to various stimuli.<br>5.2. Define neurons<br>5.3. Explain the structure of a typical neuron (cell body, dendrites, axon and myelin sheath and Schwann cells)<br>5.4. Define nerve impulse<br>5.5. List the levels of the spinal cord<br>5.6. List the functions of the spinal cord<br>5.7. Classify reflexes<br>5.8. Briefly explain the functions of components of a reflex arc<br>5.9. List the main parts of the brain (e.g., components of brain stem, mid brain, cerebellum, cerebrum)<br>5.10. Describe the functions of each part |
| **6<br>DIVERSITY AMONG ANIMALS** | **SUBTOPICS** • Characteristics and diversity among the animals (animal phyla, characteristics) |
| | **LEARNING OBJETIVES**<br>6.1. Describe general characteristic of animals |
| **7<br>ENZYMES** | **SUBTOPICS**<br>• Introduction/characteristics of enzymes<br>• Mechanism of action of enzymes<br>• Factors effecting rate of enzyme action<br>• Enzyme inhibition |
| | **LEARNING OBJECTIVES**<br>7.1. Describe the distinguishing characteristics of enzymes<br>7.2. Explain mechanism of action of enzymes |

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| | 7.3. Describe effects of factor on enzyme action (temperature, pH, concentration)<br>7.4. Describe enzyme inhibitors |
| **8**<br>**EVOLUTION** | **SUBTOPICS**<br>• Concepts of evolution<br>• Inheritance of acquired characteristics<br>• Darwinism‟<br>• Darwin‟s theory evolution<br>• Neo-Darwinism‟s<br>• Evidence of evolution |
| | **LEARNING OBJECTIVES**<br>8.1. Explain origin of life according to concept of evolution<br>8.2. Describe the theory of inheritance of acquired characters, as proposed by Lamarck.<br>8.3. Explain the theory of natural selection as proposed by Darwin |
| **9**<br>**LIFE PROCESSES IN ANIMALS & PLANTS (NUTRITION/ GASEOUS EXCHANGE/ TRANSPORT)** | **SUBTOPICS**<br>• Carnivorous plants/parasitic nutrition (pitcher plant, venus fly trap, sundew)<br>• Water and mineral uptake by roots, xylem and phloem<br>• Osmotic pressure/potential<br>• Cardiovascular system (including human heart structure, blood vessels)<br>• Respiratory system<br>• Digestive system<br>• Immune & system<br>• Lymphatic system |
| | **LEARNING OBJECTIVES**<br>9.1. Discuss the examples of carnivorous plants (pitcher plant, venus fly trap, sundew)<br>9.2. Describe osmotic pressure and its importance in life processes in animals and plants<br>9.3. Describe water and minerals uptake by roots, xylem and phloem<br>9.4. List general structure of human heart<br>9.5. Define the phases of a cardiac cycle<br>9.6. List the differences and functions of capillaries, arteries and veins 9.7. Describe lymphatic system (organs, nodules, vessels)<br>9.8. Define and discuss the functions and importance of main components of immune system<br>9.9. Discuss the functions of main part of respiratory system<br>9.10. Discuss the role of surfactant in gas exchange<br>9.11. Discuss the process of gas exchange in human lungs<br>9.12. List the parts of human digestive system<br>9.13. Explain the functions of the main parts of the digestive system including associated structures and glands |

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| **10 PROKARYOTES (KINGDOM MONERA)** | **SUBTOPICS**<br>• Cellular Structure of bacteria<br>• Shape and size of bacteria<br>• Importance and control of bacteria |
| | **LEARNING OBJECTIVES**<br>10.1. Describe cellular structures of bacteria<br>10.2. Explain diversity in shape and size in bacteria<br>10.3. Highlight the importance of bacteria and control of harmful bacteria |
| **11 REPRODUCTION** | **SUBTOPICS**<br>• Male reproductive system<br>• Female reproductive system (including menstrual cycle)<br>• Sexually transmitted diseases |
| | **LEARNING OBJECTIVES**<br>11.1. Describe the functions of various parts of the male & female reproductive systems and the hormones that regulate those functions<br>11.2. Describe the menstrual cycle (female reproductive cycle) emphasizing the role of hormones<br>11.3. List the common sexually transmitted diseases along with their causative agents and main symptoms |
| **12 SUPPORT & MOVEMENT** | **SUBTOPICS**<br>• Cartilage<br>• Types of muscles - Skeletal muscles - Cardiac muscles - Smooth muscles<br>• Structure of skeletal muscles<br>• Mechanism of skeletal muscle contraction<br>• Types of joints<br>• Arthritis |
| | **LEARNING OBJECTIVES**<br>12.1. Define cartilage, muscle and bone<br>12.2. Explain the main characteristics of cartilage and bone along with functions of both<br>12.3. Compare characteristics of smooth muscles, cardiac muscles and skeletal muscles<br>12.4. Explain the ultra-structure of skeletal muscles<br>12.5. Describe in brief the process of skeletal muscle contraction<br>12.6. Classify joints<br>12.7. Define arthritis |
| | **SUBTOPICS**<br>• Mendel's law of inheritance<br>• Gregor John Mendel and his work<br>• Mendel's experiment<br>• Inheritance of single trait<br>• Mendel's principles of inheritance<br>• Inheritance of two traits |

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| **13<br>VARIATION & GENETICS/ INHERITANCE** | • Law of independent assortment<br>• Scope of independent assortment in variation<br>• Statistics and probability relevant to genetics<br>• Multiple alleles<br>• Gene linkages and crossing over<br>• Sex linkages in drosophila<br>• Sex linkage in human<br>• Genetics of hemophilia |
| | **LEARNING OBJECTIVES**<br>13.1. Associate inheritance with the laws of Mendel.<br>13.2. Explain the law of independent assortment, using a suitable example. 13.3. Describe the terms gene linkage and crossing over<br>13.4. Explain how gene linkage counters independent assortment and crossing-over modifies the progeny<br>13.5. Describe the concept of sex-linkage.<br>13.6. Briefly describe Inheritance of sex –linked traits<br>13.7. Analyze the inheritance of hemophilia. |

# 4. SECTION 2: CHEMISTRY

## 2.1. Content List for Chemistry

| Sr. No | Content |
|---|---|
| 1 | Introduction to fundamental concepts of chemistry |
| 2 | Atomic Structure |
| 3 | Gases |
| 4 | Liquids |
| 5 | Solids |
| 6 | Chemical Equilibrium |
| 7 | Reaction Kinetics |
| 8 | Thermo-chemistry and Energetics of chemical reactions |
| 9 | Electrochemistry |
| 10 | Chemical bonding |
| 11 | S and p block elements |
| 12 | Transition Elements |
| 13 | Fundamental principles of organic chemistry |
| 14 | Chemistry of Hydrocarbons |
| 15 | Alkyl halides |
| 16 | Alcohols & phenols |
| 17 | Aldehydes and Ketones |
| 18 | Carboxylic acid |
| 19 | Macromolecules |

## 2.2. Subtopics & Learning Objectives

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| | **SUBTOPICS**<br>• Atomic mass<br>• Empirical formula<br>• Molecular formula<br>• Concept of mole<br>• Construction of mole ratios as conversion factors in stoichiometry calculations |

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| **1**<br>**INTRODUCTION OF FUNDAMENTAL CONCEPTS OF CHEMISTRY** | • Avogadro"s number<br>• Important assumptions of stoichiometric calculations<br>• Stoichiometry<br>• Limiting reactant<br>• Percentage yield |
| | **LEARNING OBJETIVES**<br>1.1. Construct mole ratios from balanced equations for use as conversion factors in stoichiometric problems.<br>1.2. Perform stoichiometric calculations with balanced equations using moles, representative particles, masses and volumes of gases (at STP).<br>1.3. Explain the limiting reagent in a reaction,<br>1.4. Calculate the maximum number of product(s) produced and the amount of any unreacted excess reagent.<br>1.5. Given information from which any two of the following may be determined, calculate the third: theoretical yield, actual yield, percentage yield.<br>1.6. Calculate the theoretical yield and the percent yield when given the balanced equation, the amounts of reactants and the actual yield |
| **2**<br>**ATOMIC STRUCTURE** | **SUBTOPICS**<br>• Concept of orbital"s<br>• Electronic configuration<br>• Discovery and properties of proton (positive rays)<br>• Quantum numbers<br>• Shapes of orbital"s |
| | **LEARNING OBJECTIVES**<br>2.1. Describe discovery and properties of proton (positive rays)<br>2.2. Define photon as a unit of radiation energy.<br>2.3. Describe the concept of orbitals.<br>2.4. Distinguish among principle energy levels, energy sub-levels, and atomic orbitals.<br>2.5. Describe the general shapes of s, p, and orbitals.<br>2.6. Describe the hydrogen atom using the quantum theory.<br>2.7. Use the Aufbau Principle, the Pauli Exclusion Principle, and Hund"s Rule to write the electronic configuration of the atoms.<br>2.8. Write electronic configuration of atoms. |
| | **SUBTOPICS**<br>• Properties of gases<br>• Gas laws<br>• Boyle"s law<br>• Charles"s law<br>• General gas equation<br>• Kinetic molecular theory of gases<br>• Ideal gas equation |
| | **LEARNING OBJECTIVES** |

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| **3**<br>**GASES** | 3.1. List the postulates of kinetic molecular theory.<br>3.2. Describe the motion of particles of a gas according to kinetic theory.<br>3.3. State the values of standard temperature and pressure (STP).<br>3.4. Describe the effect of change in pressure on the volume of gas.<br>3.5. Describe the effect of change in temperature on the volume of gas.<br>3.6. Explain the significance of absolute zero, giving its value in degree Celsius and Kelvin.<br>3.7. Derive ideal gas equation using Boyle‟s, Charles‟ and Avogadro‟s law. 3.8. Explain the significance and different units of ideal gas constant.<br>3.9. Distinguish between real and ideal gases |
| **4**<br>**LIQUIDS** | **SUBTOPICS**<br>• Properties of liquids<br>• Intermolecular forces<br>• Hydrogen bonding<br>• Vapor pressure<br>• Boiling point and external pressure |
| | **LEARNING OBJECTIVES**<br>4.1. Describe simple properties of liquids e.g. diffusion, compression, expansion, motion of molecules, spaces between them, intermolecular forces and kinetic energy based on kinetic molecular theory.<br>4.2. Explain physical properties of liquids such as evaporation, vapor pressure, boiling point.<br>4.3. Describe the hydrogen bonding in $H_2O$, $NH_3$ and HF molecules.<br>4.4. Anomalous behavior of water when its density shows maximum at 4 degree centigrade |
| **5**<br>**SOLIDS** | **SUBTOPICS**<br>• Introduction<br>• Types of solids<br>• Ionic solids<br>• Molecular solids<br>• Crystal lattice |
| | **LEARNING OBJECTIVES**<br>5.1. Describe crystal line solids.<br>5.2. Name three factors that affect the shape of an ionic crystal.<br>5.3. Give a brief description of ionic and molecular solids.<br>5.4. Describe crystal lattice.<br>5.5. Define lattice energy. |

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| **6**<br>**CHEMICAL EQUILIBIRIUM** | **SUBTOPICS**<br>• Reversible and irreversible reactions<br>• State of chemical equilibrium<br>• Equilibrium constant expression for important reaction<br>• Applications of equilibrium constant<br>• Solubility product<br>• The Le Chatelier"s principle<br>• Synthesis of ammonia by Haber"s Process<br>• Common ion effect<br>• Buffer solutions<br>• Equilibrium of slightly soluble ionic compounds (solubility product) |
| | **LEARNING OBJETIVES**<br>6.1. Define chemical equilibrium in terms of a reversible reaction.<br>6.2. Write both forward and reverse reactions and describe them acroscopic characteristics of each.<br>6.3. State Le Chatelier"s Principle and be able to apply it to systems in equilibrium with changes in concentration, pressure, temperature, or the addition of catalyst.<br>6.4. Define and explain solubility product.<br>6.5. Define and explain the common ion effect giving suitable examples.<br>6.6. Describe buffer solutions and explain types of buffers.<br>6.7. Explain synthesis of ammonia by Haber"s Process. |
| **7**<br>**REACTION KINETICS** | **SUBTOPICS**<br>• Rate of reaction<br>• Determination of the rate of a chemical reaction<br>• Factors affecting rate of reaction<br>• Specific rate constant or velocity constant<br>• Units of rate constant<br>• Order of reaction and its determination |
| | **LEARNING OBJECTIVES**<br>7.1. Define chemical kinetics.<br>7.2. Explain the terms rate of reaction, rate equation, order of reaction, rate constant and rate determining step.<br>7.3. Explain qualitatively factors affecting rate of reaction.<br>7.4. Given the order with respect to each reactant, write the rate law for the reaction.<br>7.5. Explain the meaning of the terms „activation energy" and activated complex".<br>7.6. Relate the ideas of activation energy and the activated complex to the rate of a reaction.<br>7.7. Explain effects of concentration, temperature and surface area on reaction rates.<br>7.8. Describe the role of the rate constant in the theoretical determination of reaction rate. |

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| **8 THERMOCHEMISTRY & ENERGETICS OF CHEMICAL REACTIONS** | **SUBTOPICS**<br>• System, surrounding and state function<br>• Definitions of terms used in thermodynamics<br>• Standard states and standard enthalpy changes<br>• Energy in chemical reactions<br>• First Law of thermodynamics<br>• Sign of ΔH<br>• Enthalpy of a reaction<br>• Hess‟s law of constant heat summation |
| | **LEARNING OBJECTIVES**<br>8.1. Define thermodynamics.<br>8.2. Classify reactions as exothermic or endothermic.<br>8.3. Define the terms system, surrounding, boundary, state function, heat, heat capacity, internal energy, work done and enthalpy of a substance.<br>8.4. Name and define the units of thermal energy.<br>8.5. Explain the first law of thermodynamics for energy conservation. 8.6. Apply Hess‟s Law to construct simple energy cycles.<br>8.7. Describe enthalpy of a reaction. |
| **9 ELECTROCHEMISTRY** | **SUBTOPICS**<br>• Oxidation number or state<br>• Explanation of electrolysis<br>• Electrode potential<br>• Balancing of redox equations by ion-electron method<br>• Balancing redox equations by oxidation number change method |
| | **LEARNING OBJECTIVES**<br>9.1. Give the characteristics of a redox reaction.<br>9.2. Define oxidation and reduction in terms of a change in oxidation number.<br>9.3. Use the oxidation-number change method to identify atoms being oxidize do reduced in redox reactions.<br>9.4. Define cathode, anode, electrode potential and S.H.E (Standard Hydrogen Electrode).<br>9.5. Define the standard electrode potential of an electrode.<br>9.6. Use the ion-electron method/oxidation number method to balance chemical equations. |
| | **SUBTOPICS**<br>• Energetic of bond formation<br>• Atomic sizes<br>• Atomic radii<br>• Ionic radii<br>• Covalent radii |

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| **10**<br>**CHEMICAL BONDING** | • Ionization energy<br>• Electron affinity<br>• Electro negativity<br>• Bond energy<br>• Bond length<br>• Types of bonds<br>• Electrovalent or Ionic Bond<br>• Covalent bond<br>• Co-ordinate or dative covalent bond<br>• Ionic character of covalent bond<br>• Sigma and Pi bond<br>• Hybridization<br>• sp3 -Hybridization<br>• sp2 -Hybridization<br>• sp-hybridization<br>• The Valence Shell Electron Pair Repulsion theory<br>• Postulates of VSEPR theory<br>• Applications of VSEPR theory |
| | **LEARNING OBJECTIVES**<br>10.1. Use VSEPR theory to describe the shapes of molecules.<br>10.2. Describe the features of sigma and pi bonds.<br>10.3. Describe the shapes of simple molecules using orbital hybridization.<br>10.4. Determine the shapes of some molecules from the number of bonded pairs and lone pairs of electrons around the central atom.<br>10.5. Predict the molecular polarity from the shapes of molecules.<br>10.6. Explain what is meant by the term ionic character of a covalent bond.<br>10.7. Describe how knowledge of molecular polarity can be used to explain some physical and chemical properties of molecules.<br>10.8. Define bond energies and explain how they can be used to compare bonds strengths of different chemical bonds.<br>10.9. Define and explain the terms atomic radii, ionic radii, covalent radii, ionization energy, electron affinity, electro negativity, bond energy and bond length. |
| **11**<br>**S AND P BLOCK ELEMENTS** | **SUBTOPICS**<br>• Electronic configuration<br>• Chemical properties of s-block elements<br>• Group1 Elements (Alkali Metals)<br>• Atomic and Physical properties<br>• Trends in reactivity<br>• Group2 Elements (Alkaline earth metals)<br>• Trends in reactivity<br>• Physical and chemical properties |

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| | • Group trends: atomic radii, ionic radii, electro negativity, ionization potential, electropositivity or metallic character, melting and boiling points |
| | **LEARNING OBJECTIVES**<br>11.1. Recognize the demarcation of the periodic table into s block, p block, d block, and f block.<br>11.2. Describe how physical properties like atomic radius, ionization energy, electro negativity, electrical conductivity and melting and boiling points of elements change within a group and within a period in the periodic table.<br>11.3. Describe reactions of Group l elements with water, oxygen and chlorine.<br>11.4. Describe reactions of Group II elements with water, oxygen and nitrogen.<br>11.5. Describe reactions of Group III elements with water, oxygen and chlorine. |
| **12**<br>**TRANSITION ELEMENTS** | **SUBTOPICS**<br>• General characteristics |
| | **LEARNING OBJECTIVES**<br>12.1. Describe electronic structures of elements and ions of d-block elements. |
| **13**<br>**FUNDAMENTAL PRICIPLES OF ORGANIC CHEMISTRY** | **SUBTOPICS**<br>• Classification of organic compound<br>• Isomerism |
| | **LEARNING OBJECTIVES**<br>13.1. Define organic chemistry and organic compounds.<br>13.2. Classify organic compounds on structural basis.<br>13.3. Define functional group.<br>13.4. Explain isomerism and its types. |
| **14**<br>**CHEMISTRY OF HYDROCARBONS** | **SUBTOPICS**<br>• Open chain and closed chain hydrocarbons<br>• Nomenclature of alkanes, alkenes and alkynes<br>• Benzene: Properties, structure, modern representation, reactions, resonance method, electrophilic substitution,<br>• The molecular orbital treatment of benzene. |
| | **LEARNING OBJECTIVES**<br>14.1. Classify hydrocarbons as aliphatic and aromatic.<br>14.2. Describe nomenclature of alkanes.<br>14.3. Define free radical initiation, propagation and termination.<br>14.4. Describe the mechanism of free radical substitution in alkanes exemplified by methane and ethane.<br>14.5. Explain the IUPAC nomenclature of alkenes.<br>14.6. Explain the shape of ethane molecule in terms of sigma and pi C-C bonds.<br>14.7. Describe the structure and reactivity of alkenes as exemplified by ethane. |

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| | 14.8. Define and explain with suitable examples the terms isomerism and structural isomerism.<br>14.9. Explain dehydration of alcohols and dehydrohalogenation of RX for the preparation of ethane.<br>14.10. Describe the chemistry of alkenes by the following reactions of ethene: Hydrogenation, hydrohalogenation, hydration, halogenation, halohydration, polymerization.<br>14.11. Explain the shape of the benzene molecule (molecular orbital treatment).<br>14.12. Define resonance, resonance energy and relative stability.<br>14.13. Compare the reactivity of benzene with alkanes and alkenes. 14.14. Describe addition reactions of benzene and methylbenzene. 14.15. Describe the mechanism of electrophilic substitution in benzene. 14.16. Discuss chemistry of benzene and methylbenzene by nitration, sulphonation, halogenation, Friedal Craft‟s alkylation and acylation. 14.17. Apply the knowledge of positions of substituents in the electrophilic substitution of benzene.<br>14.18. Use the IUPAC naming system for alkynes.<br>14.19. Compare the reactivity of alkynes with alkanes, alkenes and arenes.<br>14.20. Describe the preparation of alkynes using elimination reactions. 14.21. Describe acidity of alkynes.<br>14.22. Discuss chemistry of alkynes by hydrogenation, hydrohalogenation, and hydration.<br>14.23. Describe and differentiate between substitution and addition reactions. |
| **15**<br>**ALKYL HALIDES** | **SUBTOPICS**<br>• Classification of alkyl halides<br>• Nomenclature<br>• Reactions<br>• Mechanism of nucleophilic substitution reaction SN1, SN2, E1 and E2 reaction |
| | **LEARNING OBJECTIVES**<br>15.1. Name alkyl halides using IUPAC system.<br>15.2. Discuss the structure and reactivity of RX.<br>15.3. Describe the mechanism and types of nucleophilic substitution reactions.<br>15.4. Describe the mechanism and types of elimination reactions. |
| | **SUBTOPICS**<br>• Alcohols:<br>- Classification: Primary, secondary and tertiary alcohols<br>-Nomenclature<br>- Reactivity |

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| **16**<br>**ALCOHOLS AND PHENOLS** | • Phenols:<br>- Physical properties<br>- Nomenclature<br>- Acidity<br>- Reactivity |
| | **LEARNING OBJECTIVES**<br>16.1. Explain nomenclature and structure of alcohols.<br>16.2. Explain the reactivity of alcohols.<br>16.3. Describe the chemistry of alcohols by preparation of ethers and esters.<br>16.4. Explain the nomenclature and structure of phenols.<br>16.5. Discuss the reactivity of phenol and their chemistry by electrophilic aromatic substitution.<br>16.6. Differentiate between an alcohol and phenol. |
| **17**<br>**ALDEHYDES & KETONES** | **SUBTOPICS**<br>• Nomenclature<br>• Preparation<br>• Reactions |
| | **LEARNING OBJECTIVES**<br>17.1. Explain nomenclature and structure of aldehydes and ketones. 17.2. Discuss the preparation of aldehydes and ketones.<br>17.3. Describe reactivity of aldehydes and ketones and their comparison.<br>17.4. Describe acid and base catalyzed nucleophilic addition reactions of aldehydes and ketones.<br>17.5. Discuss the chemistry of aldehydes and ketones by their reduction to alcohols.<br>17.6. Describe oxidation reactions of aldehydes and ketones. |
| **18**<br>**CARBOXYLIC ACIDS** | **SUBTOPICS**<br>• Nomenclature<br>• Classification<br>• Physical properties<br>• Preparations of carboxylic acids<br>• Reactivity |
| | **LEARNING OBJECTIVES**<br>18.1. Describe nomenclature, chemistry and preparation of carboxylic acids.<br>18.2. Discuss reactivity of carboxylic acids.<br>18.3. Describe the chemistry of carboxylic acids by conversion to carboxylic acid derivatives: acyl halides, acid an hydrides, esters, amides and reactions involving inter conversion of these. |
| **19** | **SUBTOPICS**<br>• Proteins<br>• Enzymes |

| MACRO MOLECULES | LEARNING OBJECTIVES<br>19.1. Explain the basis of classification and structure-function relationship of proteins.<br>19.2. Describe the role of various proteins in maintaining body functions and their nutritional importance.<br>19.3. Describe the role of enzymes as biocatalysts |
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# 5. SECTION 3: PHYSICS

## 3.1. Content List for Physics

| Sr. No | Content |
|---|---|
| 1 | Force and motion |
| 2 | Work and energy |
| 3 | Rotational and circular motion |
| 4 | Waves |
| 5 | Thermodynamics |
| 6 | Electrostatics |
| 7 | Current Electricity |
| 8 | Electromagnetism |
| 9 | Electromagnetic Induction |
| 10 | Electronics |
| 11 | Dawn of modern Physics |
| 12 | Atomic spectra |
| 13 | Nuclear Physics |

## 3.2. Subtopics & Learning Objectives

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|---|---|
| | **SUBTOPICS**<br>• Displacement<br>• Velocity<br>• Displacement-time graph<br>• Acceleration<br>• Uniform acceleration<br>• Variable acceleration<br>• Graphical representation of acceleration with velocity time graph<br>• Newton's laws of motion<br>• Newton's first law of motion<br>• Newton's second law of motion<br>• Newton's third law of motion<br>• Linear Momentum<br>• Law of conservation of momentum<br>• Collision |

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| **1**<br>**FORCE AND MOTION** | • Elastic collision<br>• Elastic collision in one dimension<br>• Elastic collision in one dimension under different cases<br>• Projectile motion<br>• Characteristics of projectile motion<br>• Time off light<br>• Maximum height<br>• Horizontal range |
| | **LEARNING OBJETIVES**<br>1.1. Describe displacement.<br>1.2. Describe average velocity of objects.<br>1.3. Interpret displacement-time graph of objects moving along the same straight line.<br>1.4. Define uniform acceleration<br>1.5. Distinguish between uniform and variable acceleration.<br>1.6. Explain that projectile motion is two-dimensional motion in a vertical plane. 1.7. Communicate the ideas of a projectile in the absence of air resistance.<br>1.8. Explain Horizontal component (VH) of velocity is constant.<br>1.9. Acceleration is in the vertical direction and is the same as that of a vertically freefalling object.<br>1.10. Differentiate between the characteristics of horizontal motion and vertical motion<br>1.11. Evaluate, using equations of uniformly accelerated motion for a given initial velocity of frictionless projectile, the following issues: a. How much higher does it go? b. How far would it go along the level land? c. Where would it be after a given time? d. How long will it remain in air? e. Determine for a projectile launched from ground height f. Launch angle that results in the maximum range g. Relation between the launch angles that result in the same range.<br>1.12. Apply Newton‟s laws to explain the motion of objects in a variety of context.<br>1.13. Describe the Newton‟s second law of motion as rate of change of momentum.<br>1.14. Correlate Newton‟s third law of motion and conservation of momentum. 1.15. Solve different problems of elastic and inelastic collisions between two bodies in one dimension by using law of conservation of momentum.<br>1.16. Describe that momentum is conservational situations.<br>1.17. Identify that for a perfectly elastic collision, the relative speed of approach is equal to the relative speed of separation. |
| | **SUBTOPICS**<br>• Work<br>• Energy<br>• Kinetic energy |

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| **2**<br>**WORK AND ENERGY** | • Potential energy<br>• Gravitational potential energy<br>• Power |
| | **LEARNING OBJECTIVES**<br>2.1. Describe the concept of work in terms of the product of force F and displacement d in the direction of force.<br>2.2. Define energy<br>2.3. Explain kinetic energy<br>2.4. Explain the difference between potential energy and gravitational potential energy.<br>2.5. Describe that the gravitational potential energy is measured from a reference level and can be positive or negative, to denote the orientation from the reference levels.<br>2.6. Express power as scalar product of force and velocity.<br>2.7. Explain that work done against friction is dissipated as heat in the environment.<br>2.8. State the implications of energy losses in practical devices |
| **3**<br>**ROTATIONAL AND CIRCULAR MOTION** | **SUBTOPICS**<br>• Angular displacement<br>• Revolution<br>• Degree<br>• Radian<br>• Angular velocity<br>• Relation between linear and angular variables<br>• Relation between linear and angular displacements<br>• Relation between linear and angular velocities<br>• Relation between linear and angular accelerations<br>• Centripetal force<br>• Forces causing centripetal acceleration |
| | **LEARNING OBJECTIVES**<br>3.1. Define angular displacement, express angular displacement in radians.<br>3.2. Define revolution, degree and radian<br>3.3. Define and Explain the term angular velocity<br>3.4. Find out the relationship between the following:<br>a. Relation between linear and angular variables<br>b. Relation between linear and angular displacements<br>c. Relation between linear and angular velocities<br>d. Relation between linear and angular accelerations |
| | **SUBTOPICS**<br>• Progressive waves<br>• Crest<br>• Trough<br>• Amplitude<br>• Wavelength<br>• Time period and frequency |

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| **4**<br>**WAVES** | • Types of progressive waves<br>• Transverse waves<br>• Longitudinal waves<br>• Periodic waves<br>• Transverse periodic waves<br>• Longitudinal periodic waves<br>• Speed of sound in air<br>• Principle of superposition/superposition of sound waves<br>• Stationary waves/standing waves<br>• Stationary waves in a stretched string/fundamental frequency and harmonics<br>• Doppler effect<br>• Observer is moving towards a stationary source<br>• Observer is moving away from a stationary source<br>• When the source is moving towards the stationary observer<br>• When the source is moving away from the stationary observer<br>• Simple harmonic motion (SHM)<br>• Characteristics of simple harmonic motion<br>• Instant aeneous displacement<br>• Amplitude<br>• Vibration<br>• Time period<br>• Frequency |
| | **LEARNING OBJETIVES**<br>4.1. Describe the meaning of wave motion as illustrated by vibrations in ropes and springs.<br>4.2. Demonstrate that mechanical waves require a medium for their propagation while electromagnetic waves do not.<br>4.3. Define and apply the following terms to the wave model; medium, displacement, amplitude, period, compression, rarefaction, crest, trough, wavelength, velocity.<br>4.4. Solve problems using the equation: v=fl.<br>4.5. Describe that energy is transferred due to a progressive wave.<br>4.6. Compare transverse and longitudinal waves.<br>4.7. Explain that speed of sound depends on the properties of medium in which it propagates and describe Newton‟s formula of speed of waves.<br>4.8. Describe the Laplace correction in Newton‟s formula for speed of sound in air.<br>4.9. Identify the factors on which speed of sound in air depends.<br>4.10. Describe the principle of super position of two waves from coherent sources.<br>4.11. Describe the phenomenon of interference of sound waves. |

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| | 4.12. Explain the formation of stationary waves using graphical method<br>4.13. Define the terms, node and antinodes.<br>4.14. Describe modes of vibration of strings.<br>4.15. Describe formation of stationary waves in vibrating air columns.<br>4.16. Explain the principle of Superposition<br>4.17. Explain S.H.M and explain the characteristics of S.H.M. |
| **5**<br>**THERMODYNAMICS** | **SUBTOPICS**<br>• First law of thermodynamics<br>• Specific heat and Molar specific heat/specific heat capacity |
| | **LEARNING OBJECTIVES**<br>5.1. Describe that thermal energies transferred from a region of higher temperature to a region of lower temperature.<br>5.2. Differentiate between specific heat and molar specific heat.<br>5.3. Calculate work done by a thermodynamic system during a volume change. 5.4. Describe the first law of thermodynamics expressed in terms of the change in internal energy, the heating of the system and work done on the system.<br>5.5. Explain that first law of thermodynamics expresses the conservation of energy.<br>5.6. Define the terms, specific heat and molar specific heats of a gas.<br>5.7. Apply first law of thermodynamics to derive Cp–Cv= R. |
| **6**<br>**ELECTROSTATICS** | **SUBTOPICS**<br>• Coulomb‟s law<br>• Coulomb‟s law in material media<br>• Electric field and its intensity<br>• Electric field intensity due to an infinite sheet of charge<br>• Electric field intensity between two oppositely charged parallel plates<br>• Electric potential<br>• Capacitor<br>• Capacitance of a capacitor and its unit<br>• Capacitance of a parallel plate capacitor<br>• Energy Stored in a Capacitor<br>• Charging and Discharging a Capacitor |
| | **LEARNING OBJECTIVES**<br>6.1. State Coulomb‟s law and explain that force between two-point charges is reduced in a medium other than free space using Coulomb‟s law<br>6.2. Describe the concept of an electric field as an example of a field of force<br>6.3. Calculate the magnitude and direction of the electric field at a point due to two charges with the same or opposite signs |

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| | 6.4. Sketch the electric field lines for two-point charges of equal magnitude with same or opposite signs<br>6.5. Describe and draw the electric field due to an infinite size conducting plate of positive or negative charge<br>6.6 Define electric potential at a point in terms of the work done in bringing unit positive charge from infinity to that point<br>6.7. Define the unit of potential<br>6.8. Derive an expression for electric potential at a point due to a point charge 6.9. Demonstrate charging and discharging of a capacitor through a resistance |
| **7<br>CURRENT ELECTRICITY** | **SUBTOPICS**<br>• Ohm‟s Law<br>• Electrical resistance<br>• Specific resistance or resistivity<br>• Effect of temperature on resistance<br>• Temperature coefficient of resistance<br>• Variation of resistivity with temperature<br>• Internal resistance of a supply<br>• Electric power<br>• Unit of electric power<br>• Kilowatt-hours |
| | **LEARNING OBJECTIVES**<br>7.1. Describe the concept of steady current.<br>7.2. State Ohm‟s law.<br>7.3. Define resistivity and explain its dependence upon temperature.<br>7.4. Explain the internal resistance of sources and its consequences for external circuits.<br>7.5. Describe the conditions for maximum power transfer |
| **8<br>ELECTROMAGNETISM** | **SUBTOPICS**<br>• Magnetic field<br>• Magnetic Flux<br>• Magnetic Flux Density |
| | **LEARNING OBJECTIVES**<br>8.1. Define magnetic flux density and its units.<br>8.2. Describe the concept of magnetic flux(Ø) as scalar product of magnetic field(B) and area(A)using the relation ØB=B⊥A=B.A.<br>8.3. Describe quantitatively the path followed by a charged particle hot into a magnetic field in a direction perpendicular to the field.<br>8.4. Explain that a force may act on a charged particle in a uniform magnetic field. |
| | **SUBTOPICS**<br>• Electromagnetic induction |

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| **9**<br>**ELECTROMAGNETIC INDUCTION** | • Faraday"s Law<br>• Lenz"s Law<br>• Lenz"s Law and conservation of energy<br>• Generating Electricity-Alternating Current Generator<br>• Transformers |
| | **LEARNING OBJECTIVES**<br>9.1. State Faraday"s law of electromagnetic induction.<br>9.2. Account for Lenz"s law to predict the direction of an induced current and relate to the principle of conservation of energy.<br>9.3. Describe the construction of a transformer and explain how it works.<br>9.4. Describe how set-up and step-down transformers can be used to ensure efficient transfer of electricity along cables. |
| **10**<br>**ELECTRONICS** | **SUBTOPICS**<br>• Rectification |
| | **LEARNING OBJECTIVES**<br>10.1. Define rectification and describe the use of diodes for half and full wave rectifications. |
| **11**<br>**DAWN OF MODERN PHYSICS** | **SUBTOPICS**<br>• The particle model of light |
| | **LEARNING OBJECTIVES**<br>11.1. Explain the particle model of light in terms of photons with particular energy |
| **12**<br>**SPECTRA** | **SUBTOPICS**<br>• Atomic spectra/ line spectrum |
| | **LEARNING OBJECTIVES**<br>12.1. Describe and explain Atomic spectra/ line spectrum |
| **13**<br>**NUCLEAR PHYSICS** | **SUBTOPICS**<br>• Spontaneous and random nuclear decay/the law of radioactive decay<br>• Half Life and rate of decay<br>• Biological effects of radiation<br>• Biological and medical uses of radiation |
| | **LEARNING OBJECTIVES**<br>13.1. Describe as impel model for the atom to include protons, neutrons and electrons.<br>13.2. Identify the spontaneous and random nature of nuclear decay.<br>13.3. Describe the term half-life and solve problems using the equation<br>13.4. Describe biological effects of radiation state and explain the different medical uses of radiation. |

## 6. SECTION 4: ENGLISH

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| **AIM** | The aim of English section of MDCAT is to measure the applicants" skills in English language and to evaluate how prepared them are for undertaking graduate studies in medicine in English. The test applies a common standard to everyone to be able to evaluate the preparation of the applicants from different sectors, regions and socioeconomic backgrounds.<br><br>The benchmarks for the test have been developed in the light of the Syllabus used in HSSC and CIE. Since the students who take the MDCAT come from a wide range of educational contexts, the test comprises items that may be applied to a broadband of language competencies that are not exclusive to one particular type of Syllabus. |
| **OBJECTIVES** | 1. To ensure complete alignment between the English Syllabus used in various sectors at the HSSC and CIE level and the test items<br>2. To create a balance of items from different benchmarks of the English Syllabi outlined for MDCAT<br>3. To make sure that difficult and ambiguous items beyond the scope of high school education are not included<br>4. To design the test specifications<br>5. To design, select, and arrange test task items |

## 4.1. Benchmarks & Content

| OBJECTIVE | BENCHMARK | CONTENT |
|---|---|---|
| 1.Comprehend key vocabulary | Use one or more of the following strategies to determine meaning of key vocabulary:<br>1.1 contextual clues and illustrations<br>1.2 background or prior knowledge<br>1.3 morphology, syntax, phonics, knowledge of word relationships<br>1.4 knowledge of synonyms, antonyms, homophones | High and low frequency words from the course book or to be selected from similar contexts or the contexts the HSSC and CIE students may be familiar with. |
| 2.Demonstrate control of tenses and sentence structure | 2.1 Use correct tenses and sentence structure in writing<br>2.2 Identify mistakes in the use of tenses and sentence structure in written texts | All present, past tenses Four types of sentences, Conditionals Types of clauses Fragments |

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| 3. Demonstrate ability to differentiate between correct and incorrect structure of sentences & Use of writing conventions of spelling, capitalization and Punctuation | 3.1 Identify sentences with correct grammatical and style structures<br>3.2 Identify sentences with incorrect grammatical and style structures<br>3.3 Identify Use inappropriate capitalization and punctuation such as semi colons, commas in a series, apostrophes in possessives, proper nouns, and abbreviations | Use the texts prescribed/ used in HSSC or CIE for differentiating between correctly and incorrectly written sentences. The test items to be selected from the type of texts written by HSSC and CIE students and from the contexts common to both the streams |
| 4. Demonstrate correct use of subject-verb agreement & of articles and prepositions | 4.1. Use correct subject-verb agreement in written texts<br>4.2 Identify mistakes in the use of subject verb-agreement in written texts<br>4.3 Use appropriate articles and prepositions in different written contexts<br>4.4 Identify mistakes in the use of articles and prepositions in sentences or short texts<br>4.5 Select the appropriate article or preposition for a particular context | Use the texts prescribed/ used in HSSC or CIE for selecting test items as well as determining the degree of their complexity<br><br>The test items to be selected from the contexts common to the texts at HSSC and CIE level |
| 5. Demonstrate ability to identify mistakes in sentences or short written texts. These errors could be of inappropriate word order, vocabulary etc. | 5.1 Identify errors of word order, style, vocabulary etc. in sentences | Use the texts and sentences prescribed/ used in HSSC or CIE for differentiating between correctly and incorrectly written sentences |
| 6. Demonstrate ability to comprehend short written text and select the most appropriate responses | 6.1 Comprehend simple, brief passages<br>6.2 Select the most suitable responses to the questions posed (text- explicit) | Use the texts prescribed/ used in HSSC or CIE as samples for reading comprehension |