UNIVERSITY OF CALCUTTA

Notification No. CSR/ 60 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 13.07.2018 (vide Item No.11) approved the Syllabus of Two-Year (Four-Semester) M.Sc. Course of Study in Neuroscience under CBCS in S.N. Padhan Center for Neurosciences and in the affiliated Colleges offering Post-Graduate Courses under this University, as laid down in the accompanying pamphlet.

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 17th August, 2018

(Debabrata Manna)
Deputy Registrar (Acting)

S. N. Pradhan Center for Neurosciences

University of Calcutta

Syllabus

&

Regulations

M. Sc. in Neuroscience

2018

CONTENT

**** The course will follow the regulation frame published by the University time to time.***

ORIENTATION OF COURSES IN FOUR SEMESTERS (2 years) FOR M. SC. IN NEUROSCIENCE

Subject Code	Theory/ Practical /Project	Subject	Marks	Credit
1st SEMESTER *(CORE COURSES)*				
NS CC11-(TH)-P01	Theory	Biomolecules, Enzymes & Instrumentation	50	4
NS CC12-(TH)-P02	Theory	Cell Biology, Molecular Biology, Stem cells & Neurodevelopment Biology	50	4
NS CC13-(TH)-P03	Theory	Neuroanatomy & Neurophysiology, Neuroimmunology	50	4
NS CC14-(PR)-P04	Practical	(a) Biomolecules & Instrumentation (b) Cell biology & (c) Enzymology	50	4
NS CC15-(PR)-P05	Practical	(a) Neuroanatomy (b) Neurophysiology	50	4
		Total	250	20
2nd SEMESTER *(CORE COURSES)*				
NS CC21-(TH)-P06	Theory	Metabolism, Neuroendocrinology & Neuropharmacology	50	4
NS CC22-(TH)-P07	Theory	Neurogenetics & Molecular Diagnostics, Evolutionary Neurosciences	50	4
NS CC23-(TH)-P08	Theory	Biostatistics, Computer application & Neuroinformatics	50	4
NS CC24-(PR)-P09	Practical	(a) Metabolism (b) Neuroendocrinology & Neuropharmacology	50	4
NS CC25-(PR)-P10	Practical	(a) Neurogenetics & Molecular Diagnostics (b) Informatics	50	4
Total			250	20
Summer project: Student will opt their DSEC for their 4th Semester curriculum based on merit and will be assigned for summer projects.Students will present summer project in 4th Semester under DSEC curriculum.				
3rd SEMESTER *(CORE COURSES & GENERIC ELECTIVE COURSES)*				
NS CC31-(TH)-P11	Theory	Psychology, Behaviour & Cognition	50	4
NS CC32-(TH)-P12	Theory	Genomics & Proteomics, Clinical & Molecular Neuropathology	50	4
NS CC33-(PR)-P13	Practical	(a) Behaviour & Cognition (b) Genomics & Proteomics	50	4
NS GEC31-(TH)-P14	Theory	CBCC-X or other codes Students will opt subjects offered by other Departments	50	4
NS GEC32-(TH)-P15	Theory	CBCC-Y or other codes Students will opt subjects offered by other Departments	50	4
Total			250	20
4th SEMESTER *(CORE COURSES & DISCIPLINE SPECIFIC ELECTIVE COURSES)*				
NS CC41-(TH)-P16	Theory	Neuro-Environmental Biology, Animal Biotechnology, Gene therapy and Bioethics	50	4
NS DSEC41-(TH)-P17	Theory	Students will opt subjects offered by the Department	50	4
NS DSEC42-(TH)-P18	Theory	Students will opt subjects offered by the Department	50	4
NS DSEC43-(PR)-P19	Practical	Students will opt subjects offered by the Department	50	4
NS DSEC44-(PSV)-P20	Project	Students will opt subjects offered by the Departments (a) **P**roject work & **S**eminar; (b) **V**iva	50	4
Total			250	20
		Grand Total	**1000**	**80**

"P" stands for paper

DSE Courses: Department will offer following courses for students of Neurosciences.
1. Cellular & Molecular Neuroscience
2. Systems Neuroscience

GE Course: Department will offer following course for students of other Departments.
Neurobiology: Function & Dysfunction

Detailed Syllabus for Two-year M. Sc. Course in Neuroscience
University of Calcutta - 2018

First Semester

NS CC11-(TH)-P01: Biomolecules, Enzymes & Instrumentation

Biomolecules: Chemical basis of life - Chemical bonding, forces involved in biological molecules and building blocks - macromolecules; informational macromolecules. Proteins as informational macromolecules; chemistry of amino acids; primary, secondary and tertiary structure of polypeptides; peptides; peptide subunits and quaternary structure, ∝-helix, β-sheet and collagen structure, metabolism of protein and amino acids. Chemistry of Carbohydrates - mono, di- and polysaccharides. Molecular structure of DNA, alternate DNA structures, circular and superhelical DNA, Denaturation and Renaturation of DNA, the physical and chemical stability of DNA.

Enzymes and Reaction Kinetics: Definition of enzymes; active site, substrate, coenzyme, cofactor and different kinds of enzyme inhibitors; enzyme kinetics, two substrate kinetics, three substrate kinetics, deviation from linear kinetics; ligand binding studies; rapid kinetics; association and dissociation constants; use of isotopes in enzyme kinetics mechanism analysis; effect of pH, temperature and isotopically labeled substrates on enzyme activity; allosteric model of enzyme regulation; substrate induced conformational change in enzyme.

Techniques: Principles and application following spectroscopy in biological systems: Absorption Spectroscopy (UV-visible), Fluorescence and Phosphorescence, Circular Dichroism (CD), Infrared spectroscopy (IR), Resonance Raman spectroscopy; Electron spin resonance (ESR), Liquid Scintillation counter; pH meter; Ultracentrifuges, Optical microscopes, optical microscopy; phase, ultraviolet and interference microscope- their basic principles; optical systems and ray diagrams- their applications in cell biology; fluorescence microscope; microspectrophotometry of cells and tissues, fluorescence activated cell sorter (FACS). Electron microscopy: theory of magnetic and electrostatic lenses and their focal length; construction of electron microscope; limiting resolution and useful magnification; contrast formation; shadowing and staining technique; scanning electron microscopy; specimen preparation techniques; application of electron microscopy in cell and molecular biology; embedding and section cutting.

NS CC12-(TH)-P02: Cell Biology, Molecular Biology, Stem cells & Neurodevelopment Biology

Cell Biology: Evolution of cells (from prokaryotes to eukaryotes; from single cells to multicultural organisms), Cell-structure and function. Internal Organization of the cell: Membrane structure – Lipid Bilayer, membrane protein; Membrane transport of small molecules and the electrical properties of membrane; Principles of membrane transport, carrier protein and active membrane transport, ion channel and the electrical properties of membranes; Roles of ion transport in human genetic disease Intracellular compartments & protein sorting; Intracellular vesicular traffic; Energy conversion and Mitochondria; Cell communication - General principles of cell communication signaling through G-protein linked cell surface receptor. Shape and structure of protein and protein function. Cytoskeleton - Self assembly& dynamic structure of cytoskeletal filaments, regulation of cytoskeletal filaments, Molecular motor, Cytoskeleton and cell behaviour. Cell Cycle and programmed cell death. Components of cell cycle control system, intracellular control of cell cycle events; Apoptosis, extracellular control of cell division, cell growth and apoptosis. Cell Division -

Mitosis and Meiosis, Genetic diversity). Concept of extracellular matrix and adhesion molecules. The cytoskeleton, myofibrils and their function in cell shape. Isolating cells and growing them; fractionation of cell, Methods of studying the cell surface, re-constitutional studies; fluorescence assisted methods e.g. flow cytometry.

Molecular Biology: Gene Concept: Fine structure analysis of the gene, one gene-one enzyme hypothesis; organization of eukaryotic genes: Basic Genetic Mechanisms - DNA & Chromosome – structure and function of DNA, chromosomal DNA & packaging, DNA replication, repair & recombination, transcription, RNA synthesis and processing in eukaryotes, translation, the Genetic Code, deciphering the code, codon usage; protein synthesis: structure of ribosome, role of tRNA and rRNA, translation and its control, control of gene expression, post transcription control; evolution of genome.

Stem cells & Neurodevelopmental Biology: Principles in stem cell biology, pluripotency, totipotency, multipotency; Brain stem cells – Embryonic & adult stem cells. Introduction to brain development – evolution of brain – the principles of use it – Nature vsnurture : role of epigenetics – brain cells and functions, Brain morphogenesis – mechanisms involving neural tube formation, neuronal migration etc. Neuronal differentiation – mechanisms involving axonal growth, dendritic spine formation – Growth cones in axonal path finding – Synaptogenesis, Myelinogenesis – Pruning of brain: apoptotic mechanisms involved, Nerve growth factor: discovery – mode of action – signalling pathway – role in the various stages of brain development, BDNF and other growth factors – importance in brain development Steroid superfamily: mode of action – role of thyroid hormones, glucocorticoids and retinoic acid in brain development, Role of Vitamin D3 in brain development – importance of estrogen in the sexual dimorphism of the brain.

NS CC13-(TH)-P03: Neuroanatomy, Neurophysiology & Neuroimmunology

Neuroanatomy: Gross anatomy of adult brain, organization of the nervous system, subdivision of the nervous system, concept of CNS, ANS & PNS, meninges. The scalp, skull, meninges and cerebrospinal fluid, anatomy of the pituitary (normal & enlarged), vertebral column, cutaneous nerve supply of head and neck limb and trunk. Brain, spinal cord, cranial nerve, spinal nerve, autonomic nervous system.

Neurophysiology: Neurons and glial cells, Resting Potential & Action potential, Propagation of Nerve Impulses, Degeneration & regeneration /repair of nerve fibers, Nerve growth factors. Synaptic & neuro-muscular transmission, Muscle tone, posture, Equilibrium & their regulation. Pain production, pathways and analgesics, head ach & referred pain. Vestibular apparatus & motion sickness. Integrative functions of thalamus, cerebellum, basal ganglia & Cerebral cortex. Blood brain barrier, Blood CSF barrier, Spit Brain, EEG.

***Basic Immunology*:** Immunoglobins, organization and expressions of Ig genes; B cell maturation, activation and differentiation; MHC/ HLA; antigen processing and presentation; T-cells, T-cell receptors, T-cell maturation, activation and differentiation; cytokines; cell mediated and humoral effector responses, auto immunity, immunodeficiency diseases, transplantation immunology, cancer and immune system. Monoclonal and polyclonal antibodies, monoclonal antibody technique. Lymphocytes that respond to individual antigens, Immunogenetics - immunoglobulin genes, diversity of germline information, somatic mutations and diversity; Stem cell differentiation – embryonic/fetal/adult cell transplantation; Immune Diversity

Neuro-immunology: Microglia as immune cells in CNS, role of astrocytes in microglia activation, Neural cell immunology, Immune interaction between Neurons-Microglia-Astrocytes; Interaction between peripheral immunity and central nervous system; Neuro-immunomodulation; neuroendocrine-immune interaction**;** Basic concepts of Psychoneuroimmunology

NS CC14-(PR)-P04: Practical

Biomolecules & Instrumentation: pH meter – buffer preparation, Absorption Spectroscopy (UV-visible), DNA, protein measurement, Optical microscopy; phase, - their applications in cell biology; Circular Dichroism (CD), fluorescence microscope, etc

Cell Biology: Isolating cells and growing them; fractionation of cell, Methods of studying the cell surface, re-constitutional studies; fluorescence assisted methods e.g. flow cytometry.

Enzymology: Protein Estimation,Enzyme kinetics, effects of pH and temperature on enzyme activity, use of inhibitors for active site determination, Michaelis-Menten equation: determination K_M and V_{max}

NS CC15-(PR)-P05: Practical

Neuroanatomy: Gross examination, dissected Brain and its different parts (human & animal), histology of animal brain.

Neurophysiology: Animal preparations, Stereotaxic preparations: Ablation, Lesioning (Surgical, Electrolytic and Chemical); to study the electrical or chemical stimulation of the brain and its different parts. Electrophysiological studies of the brain in animals (EEG), Human studies including B. P., Respiratory, Postural and Vestibular Reflexes.

Second Semester

NS CC21-(TH)-P06: Metabolism, Neuroendocrinology & Neuropharmacology

Metabolism: Chemical component of cell, catalysis and use of energy by cells. Intracellular metabolism of glucose - glycolysis. HMP Shunt. Citric acid cycle; Glycogenolysis. Glycogen synthesis. Carbon cycle, bioenergetics and metabolism, the ATP cycle and glycolysis, the citric acid cycle, electron transport, oxidative phosphorylation and regulation of ATP production, membranes – its structure and role in ATP generation oxidative degradation of fatty acids and amino acids in animal tissues correlation between carbohydrate, amino acids and fatty and degradation, Metabolism of nitrogen compounds protein turnover, metabolic regulation of enzymes, nitrogen fixation - mechanisms and control he nitrogen cycle as the source of cellular biosynthetic intermediates.

Brain metabolism: Brain metabolism of carbohydrate, lipids & amino acids, Brain energy metabolism, Metabolism of neurotransmitters and Brain amines, Neuro-glial interaction on brain metabolism, Calorie restriction and ketogenic diet in brain function, Effect of malnutrition on brain metabolism; Metabolic brain diseases.

Redox Biology*:* Introduction to reactive oxygen and nitrogen species (ROS/RNS)**,** Important cellular redox couples (Glutathione and Thioredoxin couple), Methods of monitoring cellular redox homeostasis, Real-time monitoring of redox homeostasis in live cells by ratiometric imaging, Changes in redox homeostasis as part of normal physiology. Implications in neuronal differentiation, Perturbations of redox homeostasis - relevance to diseases. e.g redox homeostasis changes in neurodegeneration.

Neuroendocrinology: Structure and function of hypothalamus, pituitary, median eminence, circumventricular organs, characteristics of blood brain barrier;Hypophysiotrophic hormones; Posterior Pituitary&Neurohormones; Feedback loops & neuroendocrine control of pituitary hormones; Neuron as target cells for hormone action; pineal gland & neuroendocrine regulation of biological rhythms; Metabolic regulation of hypothalamic function and role of tanycytes; Neuroendocrine regulation of energy metabolism Neuroendocrine disorders;

Neuropharmacology: Chemistry of the brain, chemical architecture, environment, Fundamentals of Organic Chemistry - recent concepts for understanding the drug action.

Cellular foundation of Neuropharmacology - the chemical approach; Molecular foundation of Neuropharmacology, Fundamental molecular interactions, Molecular strategies in neuro-pharmacology, Metabolism in Central Nervous System, Receptors, Modulation of Synaptic transmission, amino acid transmitters – GABA / GABA receptors, Pharmacology of Gabaergic Neurons, excitatory amino acid receptors; Acetylcholine / Cholinergic pathways / Cholinergic receptors, ACTH in disease states, Norepinephrine and Epinephrine, Morphology of Adrenergic Neuron, Life Cycle of the Catecholamines, Pharmacology of Noradrenergic Neuron, CNS Catecholamine Neurons, Systems of Catecholamine pathways in the CNS, Epinephrine Neurons, Biochemical organization, Pharmacology of Central Catecholamine containing neurons, Catecholamine. Theory of Affective Disorder; Dopamine / Dopaminergic systems, Postsynaptic dopamine receptors, Parkinson's disease, Dopamine hypothesis or Schizophrenia; Serotonin and Histamine - biosynthesis and metabolism, Pineal Body, localization of Brain Serotonin to Nerve Cells, 5-HT Receptors, Neuroactive peptides.

NS CC22-(TH)-P07: Neurogenetics & Molecular Diagnostics, Evolutionary Neurosciences

***Basic genetics*:** Concepts of gene: Allele, multiple alleles, pseudoallele, complementation tests.Mendelian principles - Inheritance, sex linked inheritance, Dominance, segregation, independent assortment. Mutations - Types, causes and detection, germline versus somatic mutations, Mutant types – lethal, conditional, biochemical, loss of function, gain of function, point/deletion/insertional mutations, DNA repair. Chromosomal Variations - Structural and numerical abnormalities: Aneuploidy, Euploidy, Polypoidy, Trisomy, monosomy, nullisomy. Epigenetic mechanisms of inheritance, regulatory RNA molecules (miRNA, siRNA), antisense RNA and their applications, Types of DNA and RNA. DNA as a genetic material.

***Genetic Diseases*:** A brief overview on chromosomal abnormalities, single gene disorder, multifactorial diseases**,** Molecular approaches to characterize genetic diseases -Genome mapping, Functional and positional cloning, Positional-candidate approach to detect the genes responsible for diseases caused by single gene mutation.Gene Expression, Basic Molecular Biology techniques to assess gene expression.

Neurogenetic diseases: Autosomal (recessive and dominant) and X-linked neurological diseases **–**Neurodegenerative diseases, unstable mutation (repeat expansion) causing spinocerebellar ataxias, Huntington's disease, Myotonic dystrophy, Friedreich's ataxia, Fragile-X syndrome, etc., and molecular pathology**.** Metabolic defects causing neurological diseases (Tay-Sach's, Gaucher's diseases, etc). Complex genetic diseases, gene environment interactions,Pathogenetics of migraine, epilepsy, autism and schizophrenia.

Molecular techniques: Manipulating proteins, DNA, RNA – Cell culture, fractionation of cell, DNA-isolation, cloning and sequencing, analysis of protein structure and function, studying gene expression & function, visualizing cells, molecules in cells.

Molecular diagnostics: Gene function evaluation and mutation detections using techniques, such as, DNA microarray, knock out in mice, transgenic mice, Southern blot, northern blots, DNA sequencing, RFLPs, single nucleotide polymorphisms, methods for identification of mutations. PCR based diagnostics, DNA fingerprinting, DNA chip.

NS CC23-(TH)-P08: Biostatistics, Computer application & Neuroinformatics

Biostatistics: Probability and statistics; population, variables, collection, tabulation and graphical representation of data, frequency distribution, central tendency and skewness, binomial, poisson and Gaussian distributions, additive and multiplicative laws of probability, concept and correlation; regression; methods of least squares; chi-square tests, random number generation- testing and use; probability density and cumulative distribution function;

systematic and random sampling. Principles and applications of statistical methods in Genetics.

Computer applications: Basics of Computer applications-introduction to structural organization and types of digital computers, operating systems, word processing, Computer programs in the analysis of statistical methods and preparation of graphs. Application of Programs to solve - Algebric and matrix equations - Differential equations -Dynamical systems Models – Linear Regression, Handling Files - Containing Numerical and /orcharacter data -Files from sequence and structural data banks.

Neuroinformatics: Biophysics & Theoretical Neuroscience with Computational application; Elements of Neural network and computation, complexity and learning. Non-linear elements and networks, linear and polynomial threshold elements, network capacity, learning theory, the sample complexity of learning, perception training, learning complexity, the intractability of learning, model selection. Brain as electrical machine; Neuron & Nervous system Modeling; Essential Bioinformatics related to Neuroinformatics; Application of Neuroinformatics; Neuroinformatics related to Brain Disease/Disorder.

NS CC24-(PR)-P09: Practical

Metabolism: Determination of activity of different metabolically active enzymes. Fatty acid analysis; saponification value, Iodine value, acid value, etc.

Neuroendocrinology & Neuropharmacology: Neurochemical studies: TLC, Silica gel chromatography, DBH analysis. Isolation of neurotransmitters; analysis of neurotransmitters by fluorometry, HPLC.

NS CC25-(PR)-P10: Practical

Neurogenetics & Molecular Diagnostics: DNA isolation, restriction enzyme digestion, gel electrophoresis, etc. Techniques for mutation detection: Polymerase chain reaction (PCR); Analysis of PCR products by polyacrylamide gel electrophoresis; primer designing for PCR; SSCP analysis, Gene dosage analysis by MLPA, Analysis of DNA sequencing data by BLAST.

Bio-informatics: Applications and Prospects, Genome and protein information resources, sequence analysis, multiple sequence alignment, homology and analogy, pattern recognition, analysis package. DNA, RNA, Protein sequence analysis, DNA Translation, identifying ORF, restriction sites, finding SNPs, Primer design, Predicting elements of DNA RNA structure, Using BLAST to compares Protein and DNA sequences, finding protein structures, multiple sequence alignment, internet resources for geneticists, Human genetic variations – database and concepts, *in silico* computational techniques for gene functions.

Neuro-informatics: MRI & other image database (NIH); Digital reconstructions of neuronal morphology (NeuroMorpho.Org.); Metadata, morphometry, and visualization, Perils and potential of data mining, Data conversion, visualization, and editing: NeuronLand, CVapp, and common morphological irregularities in experimental data; Neuronal reconstructions: from image stacks to digital vector trees. NeuTube, Vaa3D, and other tracing tools; Overview of active neuroinformatics initiatives: Allen Brain Atlas, Human Connectome Project, SenseLab, CramTest.Info, NeuroElectro, BigNeuron, EU HBP, HHMI news, etc. Other tools and meta-reviews (Scholarpedia review); Neuron types of the mammalian hippocampus. Anatomical patterns, biophysical properties, and molecular markers: Hippocampome.org.

[Summer Project: At end of the session of 2nd Semester, Student will opt their DSEC and will be assigned for summer projects. *The project performance report based on the summer research training in a reputed laboratory of excellence will have to be submitted in the 4th semester. A presentation of the accomplishments will be required before a panel of experts. Evaluation will be based on both the project report and presentation.]*

Third Semester

NS CC31-(TH)-P11: Psychology, Behaviour & Cognition

Introductory Psychology: Definition of Psychology, application of Psychology, methods in Psychology, Principles of Learning, Behaviour, memory, thinking and language, emotion and stress, social perceptions, influences and relationships, attitudes, Psychological assessment and testing, Abnormal Psychology, Therapy for Psychological distress.

Sensory principles

Sensory processing, Weber-Fechner law & Power law, Muller's specific nerve energy, basic attribute of special senses.

Special Senses:

Vision: Photochemistry of vision, Neural pathways of vision, accommodation, light & accommodation reflexes, modern concept of color vision

Audition: organ of corti, auditory transduction, Pathways of audition, auditory coding, auditory localization.

Olfaction: Olfactory organ, olfactory transduction, pathways, coding.

Gustation: gustatory organ, pathways, transduction, coding.

Pathophysiological conditions related to vision, audition, olfaction &gastation.

Higher brain functions

Neurophysiological basis of sleep, wakefulness. Learning, Memory, Emotion & Speech. Sleep disorders. Memory retrieval, Amnesia, AD, Kluver-Bucy syndrome, Kindling phenomena, Mood Disorders, Schizophrenia, Depression, Aphasia, stress management.

Effect of Ageing on the brain function.

NS CC32-(TH)-P12: Genomics and Proteomics, Clinical Neurology & Molecular Neuropathology

Genomics: Introduction to genomics and first generation sequencing strategies; Overview of new sequencing strategies; Study of variants: SNP in genomics; Study of gene expression: Microarray miRNA in Genomics. Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, chromosome microdisection, molecular markers in genome analysis; RAPD and AFLP analysis, molecular markers linked to disease resistant genes, application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc. Genome sequencing: genome sizes, organelle genomes, genomic libraries, YAC, BAC libraries, strategies for genome sequencing, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes. Pharmacogenetics, genetics of globin triplet repeat disorders, cancer genetics; immunogenetics; mapping of human genome; somatic cell genetics; DNA polymorphism in mapping; structure and function; biochemical genetics; polygenic inheritance.

Pharmacogenomics: Effects of drugs in individual and susceptibility; Acetylation polymorphisms, Succinyl choline sensitivity and G6PD deficiency. Human genome and its impact on medicine-Genome mapping and sequencing, implications of human genome sequence information, molecular medicine, pharmacogenomics and personalized medicine, Databases for disease and mutation information.

History and development of Human genetics- hereditary traits, genetics and disease; Organization of the Human genome; Repetitive DNA in human genome; Methods of' genetic study in man Pedigree analysis, Chromosomal analysis; Biochemical analysis; Somatic cell genetics; Human Genome Project.

Proteomics: Introduction and techniques applicable to macromolecule / proteomics: Standard

technologies to identify and characterize protein-protein interactions, Biophysical approaches, computation and functional approach, Characterization of the proteome by ORF analysis, Gene disruption Knockouts; study of gene interaction by yeast two-hybrid system, Study of developmental regulation by using DNA chips. Physical techniques (absorption and fluorescence spectroscopy, IR, NMR techniques); Chromatography: TLC, GLC, HPLC, FPLC, gel filtration, ion-exchange and affinity chromatography; CD, ORD, X-Ray Diffraction and crystallography and its application in protein structure determination, 2D gel electrophoresis. Mass spectroscopy, basic principle, MALDI-TOF, ESI; 2-D Gel electrophoresis, Nuclear magnetic resonance spectroscopy (NMR), basic principles, chemical shift, spin-spin interaction, NOE, 2D-NMR**,** NOESY, COSEY. X-ray Crystallography: Principle of X-ray diffraction, scattering vector, structure factor, phase problem, reciprocal lattice and Ewald sphere, Miller indices, Zone axes, crystal lattice, Lane Equations, Bragg's law, special properties of protein crystals, model building, refinement and R-factor.
Microscopy: Bright field, fluorescence, phase contrast, electron microscopy; UV, visible, and infra-red absorption spectrophotometer and their working - principles; microspectrophotometry of cells and tissues; Fluorescence activator cell sorter (FACS); Patch Clamp, MRI, Mass spectrometry.
Clinical Neurology: Epidemiology, Anatomical Diagnosis, Pathological diagnosis, Symptoms of neurological diseases, examination of Nervous system, etc.
Neuroimaging – Neuroradiology: CT, MRI, Mylography; Interventional Radiology - PET (Positron Emission Tomography) – CVA, Epilepsy, etc., Single - Photon Emission Computed Tomography, MR Spectroscopy, Magnetic Source imaging.
Molecular Neuropathology: Molecular basis of Neuropathology in Epilepsies and Convulsive diseases, Cerebrovascular diseases, Dementia,Parkinson's Disease, Torsion dystonia, Progressive Supranuclear Palsy (PSP), Motor neuron Diseases[Amyotropic Lateral Sclerosis (ALS)], Lower Motor Neuron Disorder - Kennedy's Disease, others**;** Upper Motor Neuron Disorder - Primary Lateral Sclerosis, Familial Spastic Paraplegia**;** Ataxia:(Frederich's Ataxia, others); Demyelinating Diseases: **(**Multiple Sclerosis, Other Demyelinating Diseases**,** Encephalomyelities); Viral diseases – Encephalitis, etc.**;** Prions (Proteinaceous infectious particles) – Transmissible Neurodegenerative diseases; Nutritional and Metabolic Diseases (Lysosomal storage disease e. g. TaySach's, Gaucher's, etc); Neurocutaneous Syndromes, Developmental Disorders, Neurodegenerative movement disorder: Parkinson's Disease, Wilson & Menkes Disease, Huntington's chorea; Neurological diseases : Schizophrenia, Torsion dystonia, Pyramidal Tract lesion, Motor neuron Diseases [Amyotropic Lateral Sclerosis (ALS)], Lower Motor Neuron Disorder - Kennedy's Disease, Primary Lateral Sclerosis, Familial Spastic Paraplegia; Ataxia: (Frederich's Ataxia, others); Multiple Sclerosis, Spinomuscular atrophy, Encephalomyelities, Encephalitis, Prions Disease, Dementia, Epilepsies (Mitochondrial and others), cerebral infarction, stroke, etc

NS CC33-(PR)-P13: Practical
Behaviour & Cognition: Behavioural studies using animal model (Zebra Fish, Mouse), Testing motor functions, Grip Strength Test, Testing Cognitive Functions – Learning and memory related test (Any-arm Maze, Water Maze, etc.). Study of the electrical or chemical stimulation of the brain and its different parts.
Genomics & Proteomics: Genomic DNA preparation; Analysis of DNA sequencing data by BLAST and primer designing. Gel Filtration, Protein analysis by 1-D and 2-D GEL and protein expression analysis

NS GEC31-(TH)-P14: ---- Students will opt course offered by Other Department -----
NS GEC32-(TH)-P15: ---- Students will opt course offered by Other Department-----

Fourth Semester

NS CC41-(TH)-P16: Neuro-Environmental Biology, Animal Biotechnology, Gene therapy and Bioethics

Neuro-Environmental Biology: Introductory concepts of Man and Environment, Causes of environmental hazards, Environmental awareness and safety measures, Environmental factors - physical and chemical, microbial and physiological changes. Physical factors - Electromagnetic Radiations, UV, X-rays; Environmental heat, cellular and metabolic changes, heat disorders and stroke;Atmospheric Composition and Physiology; environmental chemical stress, genotoxic agents and physiology, principles of toxicology; mutagenicity, environmental pollutants: Metals and other chemical and their impact on human health, water pollution and its impact on health and remedy, pesticides, food preservatives, Additives and Toxins and their impact on health and health hazards; Infectious agents – Microbes of soil, air and water. Microbial environments on health and disease. Bioremediation & Phytoremediation;Environmental factors affecting neural system,Neurological disturbances due to altered environment - Hypobaric and Hyperbaric Physiology, Neurological Disorder, Neuroendocrine disruptors, Environmental toxins, pathogens causing neurodegenerative diseases.

Animal Biotechnology, Gene therapy and Bioethics: Structure and organization of animal cell. Equipments and materials for animal cell culture technology, Primary and established cell line cultures, Introduction to the balanced salt solution and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide, role of serum and supplements. Serum & protein free defined media and their application. Measurement of viability and cytotoxicity. Biology and characterization of the cultured cells, measuring growth parameters. Basic techniques of mammalian cell culture *in vitro*, disaggregation of tissue and primary culture, maintenance of cell culture; cell separation, Scaling-up of animal cell culture, cell synchronization, cell cloning and micromanipulation, cell transformation. Application of animal cell culture. Stem cell culture, embryonic stem cells and their applications. Cell culture based vaccine, somatic cell genetics, Organ and histotypic cultures, measurement of cell death, Apoptosis of three dimensional culture. General idea on animal growth and development, Mammalian (including human) reproduction, endocrine control and hormone-cascade. Comparison with Birds (Chicken) and Fish reproduction. General differentiation: Genesis and spermatogenesis, Genes and markers associated with gametogenesis. *In vitro*gamet maturation. *In vitro* sterilization (IVF) and embryo transfer (ET), Sex determination or sex specific makers, sexing of sperm and embryos, Assistedreproductive technology (ART). Animal genes and their regulation, some specific promoters for tissue specific expression. Improvements of animal/fish by biotechnology by transgenic approach with specific examples, embryo splitting and animal cloning. Genetically engineered animals for pharmacological research. Animals as bioreactors: production of IFN/TNF in milk/egg white.

Focusing on emerging infections, viral classifications, transmissions and preventions, viral pathogenesis, mechanisms of viral induced cancer and viral evolution, developmental biology of virally induced birth defects, factors in pathogenesis and transmission of prions. Cell mediated and Gene therapy as a novel form of drug delivery, vectors, cell types. Responses to viral infections; slow and persistent infections, anti viral agents, interferons, equipments and materials for animal cell culture technology. Primary and established cell line cultures. Introduction to the balanced salt solution and the simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Serum and protein free defined media and their applications. Measurements of viability and cytotoxicity. Biology and characterization of the culture cells, measuring parameters of

growth. Basic techniques of mammalian cell culture *in vitro*; desegregation of tissue and primary culture, maintenance of cell culture, cell separation. Scaling up of animal cell culture. Cell synchronization. Cell cloning and micromanipulation. Cell transformation. Application of animal cell culture. Stem cell culture, embryonic stem cells and their applications. Cell culture based vaccines, somatic cell genetics, organ and histotypic cultures.
Gene therapy : Introduction, Understanding vectors used in Gene therapy, Genome Editing by CRISPR cas-9 approach, Methodologies for successful RNAi and expression of non-coding RNAs to regulate genes and treat disease - discussion of concepts, current advances (MolTher.2016 Jan 14.doi: 10.1038/mt.2016.5. [Epub ahead of print]), Current progress in therapeutic gene editing for monogenic diseases.(Prakash V1, Moore M1, Yáñez-Muñoz RJ1.), Gene therapy in the treatment of diseases
Bioethics, Biosafety, Intellectual property right: patents, Biohazards, human safety, environmental and ecological hazards.

NS DSEC41-(TH)-P17: (Theory) Students will opt Discipline Specific Elective course offered by the Parent Department

NS DSEC42-(TH)-P18: (Theory) Students will opt Discipline Specific Elective course offered by the Parent Department

NS DSEC43-(PR)-P19: (Practical) Based on DSEC opted by the students

NS DSEC44-(PSV)-P20: (**P**roject work & **S**eminar, **V**iva) –Based on DSEC opted by the students

(Detailed syllabus of DSEC are in page 13-14)
[Project work (Summer Project) & Seminar: *Students will submit and present performance report of their summer project opted at end of the session of 2nd Semester,for their specific DSE course assigned during 4th Semester curriculum. A project will be performed during the summer research training in a reputed laboratory of excellence. A presentation of the accomplishments will be required before a panel of experts. Evaluation will be based on both the project report and presentation.]*
[Viva: *Students will be evaluated on all the topics discussed in the two years programme by a panel of experts.]*

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSEC)

Offered by the Parent Department
for the Students of Neurosciences

Assigned for 4th Semester Curriculum

Detailed Syllabus for theory and practical classes under DSEC curriculum during 4th Semester.

Students will opt any one of the following subjects offered by the Centre. Selection will be made on merit basis during 2nd Semester curriculum. Each paper carry 50 marks equivalent to 4 credits.

1. Cellular & Molecular Neuroscience
2. Systems Neuroscience

Cellular & Molecular Neuroscience

NS DSEC41-(TH)-P17: Advance studies of cellular and molecular basis of Neurosciences

Regulation of Neuronal Gene Expression
Energy Metabolism in the Brain
Molecular Properties of Ion Channels & receptors
Release of Neurotransmitter: Stimulus/ Secretion Coupling (direct & indirect)
Neurotransmitter Receptors: Ionotropic vs. metabotropic
Intracellular Signaling Pathways (pre & post synaptic signaling)
Synaptic plasticity
Neuro-glia molecular interaction

NS DSEC42-(TH)-P18: Techniques in Cellular & Molecular Neurosciences for health and diseases

Application of Qualitative and Quantitative approach in Neurosciences for health and diseases;
Functional genomics, proteomics, transcriptomics, metabolomic in clinical neurosciencs;
In vitro Cell, tissue& organ culture in Neurosciences, cell & tissue specific therapy;
Invivo therapeutic approach for Neuro-diseases;
In silico methods for biomarker based evaluation of drug therapy for Neurodiseases.

NS DSEC43-(PR)-P19: Practical

Molecular Genetic tools for neurodegenerative diseases: Investigation of Single Nucleotide Polymorphisms (SNP) using PCR amplification and RFLP. Analysis of Genotype and allele frequency and assessment of risk towards disease predisposition using statistical analysis.
Cell Culture: Culturing, maintenance and differentiation into neurons, analysis of differentiation by investigating differentiation marker usingRealtime PCR and confocal microscopy. Isolation and maintenance of primary cortical neurons.

NS DSEC44-(PSV)-P20: Project work & **S**eminar, **V**iva

Systems Neuroscience

NS DSEC41-(TH)-P17: Brian maps and loops for health & Diseases

Concepts of Micro-structure of brain circuits and their interconnections during health and diseases.
Active & Passive sensing.
Involvement of different brain regions for Sleep-awaking systems, Motor systems, Somato-Sensory systems.
Learning-memory systems.
Disinhibition Circuits & Planning for voluntary movements, motor learning and cognition,
Closing motor-sensory loops.
Spatial navigation and memory consolidation
Emotion-motivation
Eating & Drinking
Language & Sex
Artificial Intelligence, Man-Machine interaction.

NS DSEC42-(TH)-P18: Methodologies used to study brain systems for health and diseases

Basic assumptions and approaches.
Measuring neural activity (electrophysiology and imaging);
Shutting down neural activity (lesions, pharmacological inactivation, optogenetics)
Perturbing of neural activity (microstimulation and opto-stimulation)
Opening the loop at the behavioral and neural levels.

NS DSEC43-(TH)-P19: Practical

Development of paradigm for cognitive task,
EEG recording of single, dual and multi functional aspects of cognition & data analysis,
Artificial Intelligence

NS DSEC44-(PSV)-P20: Project work & **S**eminar, **V**iva

GENERIC ELECTIVE COURSE (GEC)

Offered by S. N. Pradhan Centre for Neurosciences

For Students of Other Departments

Assigned for 3rd Semester Curriculum

Detailed Syllabus for classes (Theory) under GEC curriculum during 3rd Semester.

The students will have to choose two courses offered by the University. No student is allowed to choose the course offered by his/her parent Department. Each course is of 50 marks and carries 4 credits.

GEC syllabus offered by S N Pradhan Centre for Neurosciences

(The course was mentioned in previous syllabus as CBCC-A1)

Topic- Neurobiology: Function & Dysfunction

1. Brain Anatomy

Different Lobes/ Cortex
Brain Organisation – CNS, PNS, ANS
Structure of Cerebellum and Basal Ganglia
Histology of Brain Sections (Coronal/sagittal) – Normal vs. Diseased
Neuro-developmental Biology (Briefly)
Blood Brain Barrier

2. Cell Biology

Neurons and Glial Cells
Detection of different neuronal cells (by IHC/ICC)
Neuronal Transmission

i. Electrical Impulse – Action Potential, Excitatory and Inhibitory Postsynaptic Potentials (EPSP and IPSP)
ii. Chemical Impulse
iii. Synapse
iv. Neurotransmitters and their metabolism
v. Different Pathways (Dopaminergic, Adrenergic, Serotonergic, etc.)
vi. Examples of malfunctions of pathways

Neuronal study in Cell/Organ

a. Isolation and culturing of primary neurons and means of manipulation
b. Culturing and methods of differentiation of cultured neuronal cells
c. Organotypic brain cultures

3. Sensation and Sensory Processing

i. The Somatic Sensory System: Touch and Proprioception
ii. Pain
iii. Vision – The Eye and Central Visual Pathways
iv. The Auditory System
v. Olfactory System
vi. Gustatory System

4. Neuropathology

Clinical, Cellular and Molecular Mechanisms of the Neurological Diseases:
Alzheimer's Disease, Parkinson's Disease, Huntington Disease, Dystonia, Wilson Disease, Epilepsy, Autism, Multiple Sclerosis, Amyotrophic Lateral Sclerosis (ALS), Attention Deficit Hyperactivity Disorder (ADHD), Schizophrenia, Depression, Dementia, Cerebro-vascular Disease (Stroke)
Techniques and tools applicable in neuroscience: MRI, PET, Fluorescence microscopy, FACS, Electron Microscopy, Patch Clamp, etc., Database sequence information and mutation information on specific neurodegenerative diseases

5. Behavioral Studies

Animal behavior*: Behavioural studies by using animal model of C. elegans*, Fruit fly, Zebra Fish, Mouse (Rodents)
Testing motor functions – Rotarod Test, Force Swimming Test, Beam Walking Test, Grip Strength Test
Testing Cognitive Functions – Learning and memory related test (Any-arm Maze, Water Maze, etc.)
Human behavior: Approaches of studies human behavior, Psychological & Physiological tools, Clinical investigation.

Recommended Readings:

1. Biochemistry 4th Ed., Voet and Voet;
2. Lehninger Principles of Biochemistry 5th Ed., Nelson and Cox;
3. Biochemistry 7th Ed., Stryer
4. Principles & Techniques of Biochemistry & Molecular Biology, Wilson and Walker;
5. Physical Biochemistry, Freifelder;
6. Fundamental Enzymology 3rd Ed. Nicholas C. Price, Lenis Steven;
7. Biochemical Calculations 2nd Ed. I. H. Segel
8. Molecular Cell Biology 6th Ed. Lodish;
9. Molecular Biology of the Cell 6th Ed., Alberts;
10. Cell Biology, Karp; The Cell – A molecular Approach, Cooper
11. Molecular Biology 4th Ed. R. F. Weaver; Molecular Biology, Clark;
12. Molecular Biology of the Gene, 7th Watson;
13. Principles of Molecular Biology, Burton E. Tropp
14. Gray's Anatomy; Gray's Anatomy for Students, Drake, Vogl, Mitchell;
15. Text Book of Medical Physiology, Guyton and Hall;
16. Ganong's Reviews of Medical Physiology, Barrett, Barman;
17. Principles of Anatomy and Physiology, G. J. Tortotora, B. Derrickson;
18. Principles of Neural Science, Eric R. Kandel;
19. Neuroscience, Dale Purves;
20. The Human Nervous System, Mai Paxinos
21. Handbook of Neuroendocrinology, George Fink;
22. William's Textbook of Endocrinology, Krorenberg, Meaund;
23. Basic and Clinical Pharmacology, Katzung;
24. Essentials of Medical Pharmacology, K. D. Tripathi
25. Introduction to Genetic Analysis, J. F. Griffiths;
26. Human Molecular Genetics, Strachan and Read;
27. Principles of Genetics, Snustad and Simmons;
28. Gene Cloning and DNA Analysis: An Introduction, T. A. Brown;
29. Immunology, Kuby ;
30. Neuroimmunology in Clinical Practice, Kindt, Goldsby, Osborne;
31. Neuroimmune Biology, Vol:6, Richard M. Ransohoff;
32. Cytokines and the Brain, IstvanBerczi, AndorSzentivanyi
33. Fundamentals of Statistics, A.M. Goon, M.K. Gupta, B. Dasgupta;
34. Statistical Method, N. G. Das;
35. Biostatistics, A Foundation for Analysis in the Health Sciences, Daniel & Cross
36. Strickberger's evolution, Brian K. Hall;
37. Evolutionary Biology, Futuyma
38. Principle of Cognitive Neuroscience, Dale Purves;
39. Cognitive Neuroscience-The Biology of the Mind, Gazzaniga, Ivry, Mangun;
40. Cognitive Neuroscience, Marie T. Banich, Rebecca J. Compton;
41. Principles of Behavioural& Cognitive Neurology, M. MarselMesulam
42. Principles of Gene Manipulation and Genomics, Primrose & R. M. Twyman;
43. Genomes 3, T. A. Brown;
44. Introduction to Genomics - Arthur M. Lesk,
45. From Genes to Genomes: Concepts and Applications of DNA Technology, Jeremy W. Dale and Malcolm von Schantz;
46. Next Generation DNA Sequencing Informatics, Stuart M. Brown;
47. Proteins Biochemistry & Biotechnology, Gary Walsh;

48. Principles of Protein X-ray Crystallography, Jan Drenth;
49. Organic Spectroscopy, William Kemp
50. Developmental Biology, Scott F. Gilbert;
51. Development of the Nervous System, Dan Sanes, Thomas *Reh*, William *Harris*;
52. Developmental Neurobiology, Greg Lemke
53. Introduction to Psychology, Hilgard, Atkinson, Atkinson;
54. Introduction to Psychology, C. T. Morgan & R. K. King;
55. Brain & Behavior: An Introduction to Biological Psychology, Bob Garrett
56. Neuromuscular Disorders, Amato & Russell;
57. Clinical Neurology, Simon, Greenberg, Aminoff;
58. Neuroanatomy through Clinical Cases, Hal Blumenfeld
59. Environmental Science 7th Ed., Botkin, Keller;
60. Environmental Science, Richard T. Wright
61. Animal Biotechnology, M. M. Ranga;
62. Animal Cell Culture-A Practical Approach, John R. W. Masters
63. Bioinformatics Sequence & Genome Analysis, David W. Mount;
64. Discovering Genomics, Proteomics and Bioinformatics, Campbell;
65. Bioinformatics & Functional Genomics 3rd Edition, Jonathan Pevsner
66. Theoretical Neuroscience – Computational and Mathematical Modeling of Neural System by Dayan and Abbot, 1st Edition, The MIT Press, 2001.
67. Neuroinformatics for Neuropsychology by VinothJagaroo, Springer, 2009.
68. Neuroinformatics by ChiquitoJoaquimCrasto, Humana Press, 2007.
69. Neuroinformatics: an overview of the Human Brain Project by Stephen H. Koslow, Michael F. Huerta, Routledge, 1997.
70. Further reading: Conventional Mathematics, Statistics, Computer Science, Database Management System (DBMS), Network Theory, Bioinformatics Books.
71. Principles of Neural Science, Eric R. Kendel;

The regulations for Two-year M. Sc. Course in Neuroscience, University of Calcutta

ADMISSION CRITERIA

1. The University of Calcutta shall provide instructions leading towards two year M.Sc. degree.
2. **Eligibility for admission in M.Sc. Neuroscience:** B.Sc. Hons. in any Life Science Subjects / Chemistry / Biochemistry / Anthropology / Environmental Science / Physics / Mathematics / Computer Science / Informatics. All the above candidates should have Chemistry as one of the General Subjects except the candidates with Hons. in Chemistry/Biochemistry. M.B.B.S, Graduates from Pharmacy / Pharmacology are also eligible. All the candidates should have At least 55% marks in B.Sc. (Hons.) and at least 60% marks on average in best three subjects in Science Group at -(10+2) level. Reservation of seats will be governed by the rules of Govt. of West Bengal at present.
3. Applicants from University of Calcutta will get admission to the sixty percent of seats (Category-A). Forty percent of the seats (Category-B) will be filled up from candidates from both CU and non CU from a common merit list prepared on the basis of a Common Entrance Test. The criteria for the preparation of the merit list will be determined by individual departments. Non-CU students, however, will have to satisfy the same eligibility criteria applicable to the students of the University of Calcutta. A **Common Entrance Test** will be conducted for the 7 (seven) courses including i) Biophysics & Molecular Biology (BMB), ii) Genetics (GN), iii) Biochemistry (BC), iv) Biotechnology (BT), v) Environmental Science (ENV1, ENV2), vi) Marine Science (MS) and vii) Neuroscience (NS). The Common Entrance Test will be MCQ type covering the fields of Physics, Chemistry, Mathematics, and Biology of (10+2) level.
4. The duration of the course shall be two academic years and the examination for the M.Sc. degree shall be held over four semesters over a total of 1000 marks and 80 credits. The duration of the semesters shall be as follows:

1st Semester	**July - December**
2nd Semester	**January - June**
3rd Semester	**July – December**
4th Semester	**January - June**

5. The course curriculum includes **Core courses** (offered by the Department), **Discipline Specific Elective Courses** (offered by the Department) and **Generic Elective Courses** (offered by the other Department).
6. A student will have to take **two courses** from **Generic Elective Courses (GEC) offered by the other Departments in 3rd Semester curriculum** in addition to courses offered by the Parent Department. Each course will carry credits according to the number of theoretical classes required, study hours and laboratory hours.
7. A student will have to take **one course** from **Discipline Specific Elective Courses (DESC)** offered by the **Parent Department in 4th Semester curriculum** in addition to **Core Courses** offered by the Parent Department. The course will carry credits according to the number of theoretical classes required, study hours and laboratory hours.

8. A candidate shall be eligible for appearing at the examination provided he/she prosecutes a regular course of studies maintaining percentage of attendance as specified by the University.

9. Examinations would be held after the completion of curriculum at the end of each semester. However, evaluation of the practical will be based on continuous assessment as well as on the final Viva-Voce examination of the students on the experiments. The examination time allotted for each paper carrying 50 marks is 2 hours.

PASSING CRITERIA

10. A candidate is required to appear at the examination in each and every paper/course/module/part/group of the respective syllabus. A candidate in order to be declared to have passed an examination, must obtain at least 40% marks in each paper/course/module/part/group. In case of a paper/course/module/part/group containing both theoretical and practical portions, a candidate is required to secure at least 35% marks separately in the theoretical and practical portions and at least 40% marks in aggregate in that paper.

11. If a student gets 'F' in a particular course, he/she shall be deemed to have failed in that course only and shall be required to write a supplementary examination to be offered within six months.

12. The students will get a maximum of three academic years to complete the M.Sc. course.

CRITERIA FOR RE-APPEARING AT SUPPLEMENTARY EXAMINATION

13. All supplementary examinations shall be held after six months of the original examination. Having **failed** or **absent** in maximum two papers/courses a candidate shall be eligible to appear at the supplementary examination. A candidate who has **failed** in more than two papers will have to appear at the same semester without appearing at the higher semester and without attending the classes. Candidate who fails in one or two papers can clear the paper/s in two more consecutive chances **(excluding the main examination)** along with higher semester examination. If the candidate is unable to clear the same within two consecutive chances, he shall be dropped from the concerned course. A failed candidate, intending to re-appear in a subsequent semester has to take permission from the concerned Faculty Secretary through the Head of the Department immediately after publication of result.

ABSENT CRITERIA

14. Failure to fill up the examination form shall be considered as missing a chance and such candidates who have not filed up the examination form shall have to appear at the same semester examination. A candidate who has filled up the examination form but remains absent in the entire examination or more than two courses will be considered to have lost a chance and shall be required to re-appear at the same semester examination. A candidate remaining absent in one or two papers/courses but clearing the other papers/courses shall be considered to have failed in those papers/courses in which he remains absent and shall be eligible to clear those as stated above.

15. If all the chances of a candidate (Main + 2) has been exhausted, he has to drop or leave the course. He may apply for re-admission in the same course of study in the 1st Semester of the next academic session along with the fresh applicants.

Results Determination criteria

CALCULATION OF GRADE POINTS, SGPA AND CGPA

Credit-weighted grade point system will be followed and therefore only the grade points but not the overall percentage of marks either in individual paper or in aggregate marks will be provided. The grade points will be given according to the following computation.

Grading of students' performance:
Grade scores will be calculated in a scale of 6 (six) as per the following table:

Marks (%)	Grade Score Brackets	Grade Score added per each additional mark to minimum grade score in the bracket
80-100	5.00 - 6.00	0.05
70-79	4.50 – 4.99	0.05
60-69	4.00 – 4.49	0.05
55-59	3.75 – 3.99	0.05
50-54	3.50 – 3.74	0.05
40-49	3.00 – 3.49	0.05
00-39	Below 3.00	0.075

Award of Grade Points:
For example, if a student scores 53% in theory and 68% in practical in a 3-credit course (2+1), his/her grade point for the course will be as follows:

$$\text{Grade point} = \frac{2x(3.5+0.05x3)+1x(4.0+0.05x8)}{2+1} = 3.90$$

For a credit course with no practical component, for example a 2-credit course, if a student scores say, 56%, then the grade point will be:

$$\text{Grade point} = \frac{2x(3.75+0.05x1)}{2} = 3.80$$

Semester Grade Point Average (SGPA):
The computation of average grade point of a student in a semester will be worked out as follows:

N^{th} Semester

Course	Credits	Grade Scored
1	3+1	5.65
2	3+1	5.33
3	2+0	3.99
4	2+0	5.05
5	3+1	4.22
6	3+1	4.46

Semester Grade Point Average (SGPA) = 4.836

$$\text{SGPA} = \frac{(5.65x4)+(5.33x4)+(3.99x2)+(5.05x2)+(4.22x4)+(4.46x4)}{20} = 4.836$$

Cumulative Grade Point Average (CGPA) over four semesters:
Working out simple average of SGPA obtained over four semesters, cumulative grade point average will be given after four semesters.

Significance of grades:
On the basis of the cumulative results of the student's performance, the following grades will be given in each semester as well as over four semesters.

Grade points	**Grades**	**Class**
5.00 - 6.00	Outstanding (O)	First (I)
4.50 – 4.99	Excellent (A+)	First (I)
4.00 – 4.49	Very good (A)	First (I)
3.75 – 3.99	Good (B+)	Second (II)
3.50 – 3.74	Fair (B)	Second (II)
3.00 – 3.49	Satisfactory(C)	Second (II)
Below 3.00	Fail (F)	Fail