## SCHEME OF TEACHING AND EXAMINATION
### MSc. PHYSICS I AND II YEAR (I-IV) SEMESTERS
#### (2016-2018)

### “PHYSICS I SEMESTER”

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Pd/W</th>
<th>Exam</th>
<th>CIA</th>
<th>ESE</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSPH111</td>
<td>CLASSICAL MECHANICS</td>
<td>6</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSPH112</td>
<td>MATHEMATICAL PHYSICS</td>
<td>6</td>
<td>3</td>
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<td>MSPH113</td>
<td>COMPUTATIONAL PHYSICS</td>
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<tr>
<td>MSPH114</td>
<td>SEMICONDUCTOR DEVICES AND CIRCUITS</td>
<td>6</td>
<td>3</td>
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<td>80</td>
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<tr>
<td>MSPH121</td>
<td>GENERAL LAB</td>
<td>8</td>
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<tr>
<td>MSPH122</td>
<td>ELECTRONICS LAB</td>
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**Total**

### “PHYSICS II SEMESTER”

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<thead>
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<th>Code</th>
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<tbody>
<tr>
<td>MSPH211</td>
<td>DIGITAL ELECTRONICS AND MICROPROCESSORS</td>
<td>6</td>
<td>3</td>
<td>20</td>
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<tr>
<td>MSPH212</td>
<td>QUANTUM MECHANICS-I</td>
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<tr>
<td>MSPH213</td>
<td>SOLID STATE PHYSICS</td>
<td>6</td>
<td>3</td>
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<td>MSPH214</td>
<td>STATISTICAL AND PLASMA PHYSICS</td>
<td>6</td>
<td>3</td>
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<tr>
<td>MSPH221</td>
<td>LASER LAB</td>
<td>8</td>
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<tr>
<td>MSPH222</td>
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**Total**

### “PHYSICS III SEMESTER”

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<tbody>
<tr>
<td>MSPH311</td>
<td>ELECTRODYNAMICS</td>
<td>6</td>
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<tr>
<td>MSPH312</td>
<td>QUANTUM MECHANICS-II</td>
<td>6</td>
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<td>MSPH313</td>
<td>NUCLEAR PHYSICS-I</td>
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<tr>
<td>MSPH314</td>
<td>SPECIAL PAPER-I (A/B)</td>
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<td>GENERAL LAB</td>
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<tr>
<td>MSPH322</td>
<td>SPECIAL PAPER LAB(A/B)</td>
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**Total**

### “PHYSICS IV SEMESTER”

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>MSPH411</td>
<td>NUCLEAR PHYSICS-II</td>
<td>6</td>
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<tr>
<td>MSPH412</td>
<td>ATOMIC AND MOLECULAR SPECTROSCOPY</td>
<td>6</td>
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<tr>
<td>MSPH413</td>
<td>NANOMATERIALS</td>
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<td>MSPH414</td>
<td>SPECIAL PAPER-II (A/B)</td>
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<tr>
<td>MSPH421</td>
<td>SPECIAL PAPER LAB</td>
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<tr>
<td>MSPH422</td>
<td>PROJECT</td>
<td>8</td>
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</table>

**Total**

**GRAND TOTAL OF MARKS OF MSc. PHYSICS (I-IV) SEMESTERS:**

2400

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
## SYLLABUS OF MSc. I YEAR (I AND II SEMESTERS)

**SUBJECT: PHYSICS**

### (2016-2017)

#### MSPH111: CLASSICAL MECHANICS

<table>
<thead>
<tr>
<th>Unit</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Langrangian Dynamics: Constraints, Generalized coordinates, Concept of virtual work, D’Alembert principle, Langrange equation from D’Alambert principle, Velocity dependent potential, Expression for kinetic energy of a system in terms of Generalized coordinates, Cyclic coordinates, Symmetry properties and conservation theorems.</td>
</tr>
<tr>
<td>II</td>
<td>Hamiltonian dynamics: Hamiltonian function H and conservation of energy: Jacobi’s integral and its significance, Hamilton’s equation, Routhian. Hamilton’s variation principle, Derivation of Langrange equation, Extension of Hamilton’s Principle, to non-holonomic system. A hoop rolling without slipping on an inclined plane, Modified Hamilton’s Variation principle, Derivation of Hamilton’s equation from variation principle, $\Delta$- variations, Principle of least actions in various forms.</td>
</tr>
<tr>
<td>III</td>
<td>The Two Body Central Force Problem: Central force and motion in a plane, Reduction of a two body central force to equivalent one body problem, Equation of motion and first integral, Differential equation for an orbit, Equivalent one dimensional problem and classification of orbits for some specific potential. Integral power law potential, Virial theorem, Relation between kinetic and potential energy. Kepler’s Problems: Equation of orbit and the kind of the orbit, Motion in time.</td>
</tr>
<tr>
<td>IV</td>
<td>The kinematics of rigid body motion: Independent co-ordinate of a rigid body, Orthogonal transformation, Formal properties of transformation matrix, Euler angles, Euler’s theorem, Finite rotation, Infinitesimal rotations (contact transformation). Angular momentum, Moment of inertia tensor, Product of inertia, Inertia tensor, Principal moment of inertia: Principal axis, Kinetic energy of motion of a rigid body about a point.</td>
</tr>
<tr>
<td>V</td>
<td>Canonical transformation and Hamilton Jacobi theory: Canonical transformation, Legendre transformation, Generating functions, Conditions for canonical transformation, Bilinear invariant condition. Poisson’s brackets, Langrange brackets, Invariance of Poisson bracket under canonical transformation, Angular momentum Poisson bracket relation. Hamilton Jacobi equation for Hamilton’s principal function, Harmonic oscillator problem by Hamilton Jacobi method, Hamilton’s characteristic function</td>
</tr>
</tbody>
</table>

**Suggested Readings:**


#### MSPH112: MATHEMATICAL PHYSICS

<table>
<thead>
<tr>
<th>Unit</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Complex Variables: Analytical functions, Cauchy Riemann conditions, Cauchy’s integral theorem, Cauchy’s integral formula, Taylor and Laurent’s Series expansions, Cauchy’s residue theorem, Simple examples of contour integration.</td>
</tr>
<tr>
<td>II</td>
<td>Fourier and Laplace Transforms: Fourier transform, Convolution theorem, Laplace transforms, Laplace transform of derivatives, Substitution properties of Laplace transform. Properties of gamma function, Error function and Dirac delta functions.</td>
</tr>
<tr>
<td>III</td>
<td>Curvilinear Coordinates: Orthogonal coordinate systems, Gradient, Curl.</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
### Unit-I
- General Concepts of Programming: Algorithm, Flowchart, Programming language, High level and low level language, Compiler, Errors in programs and their removal, Data, Record and file.

### Unit-II
- Programming with FORTRAN: Constants and variables, Arithmetic operations, Built in functions, Input and output statements, FORMAT statement, Assignment statement, Expression, Relational and logical operator, Transfer of control, IF statements, GOTO statements, Do loop, Nested loop, Function and subroutines, COMMON and TYPE statement, Use of files, Writing and executing a FORTRAN program.

### Unit-III
- Solution of Transcendental and Polynomial Equation in one Variable: Newton Raphson, Successive bisection, False position methods, Convergence of these methods.

### Unit-IV
- Solution of Ordinary Differentials Equations: Euler and Runge-Kutta Methods, Predictor-corrector method, Error estimates in these methods.
- Numerical Differentiation: Differentiation of continuous function, Forward difference and central difference methods, Differentiations of tabulated functions.

### Unit-V
- Curve Fitting: Interpolation, Polynomial forms, Linear interpolation, Lagrange interpolation, Newton interpolation, Interpolation with equidistance points, Regression, Fitting linear equation, Least square regression, Fitting transcendental equation and polynomial Function.

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Suggested Reading:
Simulation Methods : Random numbers, Generation of random numbers, Monte Carlo method of numerical Integration, Introduction to simulation and simulation methods, Monte Carlo simulation method, Molecular dynamics method

Suggested Reading:
1. E. Balagurusamy: *Numerical Methods*, TMH, New Delhi, 2006

### MSPH114: SEMICONDUCTOR DEVICES AND CIRCUITS

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Unit-II</td>
<td>Bipolar Junction Devices: Bipolar junction transistor, Factors controlling gain, I-V characteristics, Switching, Thyristors and UJT, Metal semiconductor devices and FETs, Metal semiconductors barrier, Schottky effect, MOS diode, Energy band and I-V characteristics, MOSFET and MESFET.</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Optoelectronics: LED materials, Configurations and efficiency, LASER principle, Semiconductor and He–Ne lasers, Photo diodes and couples, Solar Cells: Solar radiations, Ideal conversion efficiency, PN junction solar cells, Spectral response, Elementary ideas of BSF solar cells, Tandem solar cells, Organic solar cells, Electrolyte junction and photo electrochemical solar cells</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>Waveshaping: Feedback concept, positive and negative feedback, Barkhausen criterion, RC phase shift oscillator, Wein bridge oscillator, Hartley and Colpitt’s oscillators, Nyquist criterion, Multivibrators: astable, monostable and bistable multivibrator, UJT relaxation oscillator, Schmitt Trigger, 555 timer based astable multivibrator</td>
</tr>
<tr>
<td>Unit-V</td>
<td>Differential amplifier: Dual input, Balanced output differential amplifier, DC analysis, CMRR, constant currents bias, Level translator, Block diagram of typical OP-Amp, Characteristic of OP-Amp, Open and closed loop configuration, Inverting and non-inverting amplifiers, Voltage series feedback, Effect of feedback on closed loop gain, Input resistance, Bandwidth, Total output voltage, Applications of OPAMP- sign changer, scale changer, adder, integrator, differentiator, Active Filters: first and second order Butterworth filters- Low pass, High pass, band pass and band reject filters</td>
</tr>
</tbody>
</table>

Suggested Reading:

*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*

<table>
<thead>
<tr>
<th>Lab I</th>
</tr>
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<tbody>
<tr>
<td><strong>MSPH121: GENERAL LAB</strong></td>
</tr>
<tr>
<td>List of Experiments:</td>
</tr>
<tr>
<td>1. To determine Plank’s constant.</td>
</tr>
<tr>
<td>2. To determine paramagnetic susceptibility of given material (solution).</td>
</tr>
<tr>
<td>3. To determine Young’s modulus of glass by Cornu’s method.</td>
</tr>
<tr>
<td>4. To determine critical potentials with the help of Franck Hertz’s experiment.</td>
</tr>
<tr>
<td>5. Study of coupled oscillators and finding the beat frequency.</td>
</tr>
<tr>
<td>6. Verification of Cauchy’s Dispersion relation and calculation of Cauchy’s constant.</td>
</tr>
<tr>
<td>7. To determine electrical resistivity of semiconductor by Four Probe method.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lab II</th>
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<tbody>
<tr>
<td><strong>MSPH122: ELECTRONICS LAB</strong></td>
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<tr>
<td>List of Experiments:</td>
</tr>
<tr>
<td>1. Study of effect of negative feedback on frequency response and input and output impedance of a BJT amplifier.</td>
</tr>
<tr>
<td>2. Study of wave shapes generated by astable multivibrator and determination time constant.</td>
</tr>
<tr>
<td>3. Study of differential amplifier and determination of CMRR.</td>
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<tr>
<td>4. Life time measurement by reverse recovery method.</td>
</tr>
<tr>
<td>5. Life time measurement by open circuit voltage decay (OCVD) method.</td>
</tr>
<tr>
<td>6. Sawtooth wave generation using UJT and determination of time constant.</td>
</tr>
<tr>
<td>7. Study of RC phase shift oscillator and measurement of time period.</td>
</tr>
<tr>
<td>8. First and second order low pass filters.</td>
</tr>
<tr>
<td>9. First and second order high pass filters.</td>
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</tbody>
</table>
MSPH211: DIGITAL ELECTRONICS AND MICROPROCESSOR

Unit-I

Unit-II
Counters and Registers: Counters: Asynchronous counters, Ring counter, Synchronous counter, MOD counters, Registers, Shift registers, Parallel loading, Universal shift registers, Applications of shift registers: Serial to parallel convertor, Parallel to serial convertor, Digital to analog convertor(D/A), Analog to digital convertor(A/D).

Unit-III
Micro- Computer Hardware: Semiconductor memories, RAM, SRAM, DRAM, ROM, CPU: Instruction register and decoder, ALU, Control unit, Buses: Data, Address and control buses, Minimum microcomputer configuration, Interrupts, Concept of I/O mapped and memory mapped I/O.

Unit-IV
8085 Microprocessor: Microprocessor 8085: Organization of 8085 microprocessor, Fetch and execution of instruction, Bus multiplexing, Interrupts: Maskable and non-maskable, Call locations, Interrupt service subroutine, Instruction set of 8085 Microprocessor: Data transfer group, Arithmetic group, Logical group, Branches group, Stack related instructions, Mnemonics and operation codes, Addressing modes: Direct, Indirect, Immediate, Indexed and relative, Assembly language programming.

Unit-V
Data Transfer, Peripheral devices and Interfacing: Types of data transfer, DMA, 8257 DMA controller, LED displays, I/O ports, 8255 programmable peripheral interface, 8253 programmable interval timer, 8279 keyboard-display interface, 8259 Programmable interrupt controller.

Suggested Reading:

MSPH212: QUANTUM MECHANICS-I

Unit-I
General Formalism: Historical background, Stern-Gerlach experiment leading to concept of vector space, Ket and bra notation for vector space, Inner product, Norm of a vector, Orthonormality and linear independence, Basis and dimension, Outer product, Projection operator, Completeness (closure property), Hilbert space, Operator, Hermitian operator, Eigen value and eigen function, Representation theory, Change of basis, Unitary operator, Matrix elements, Unitary transformation, Diagonalisation, Coordinate and momentum representation.

Unit-II

Unit-III
Solution of Schrödinger Equation: One dimensional simple harmonic oscillator: Eigen function and Eigen value by solving Schrödinger equation and also by
### Unit-IV

**Angular Momentum:** Spin angular momentum and total angular momentum, Ladder operators, Matrix representation of Operators $J_x$, $J_y$, and $J_z$, Pauli spin matrices, Addition of two angular momentums, Clebsch- Gorden coefficients, Selection Rules and simple applications.

### Unit-V

**Approximation Methods:** WKB approximation: Principle, WKB wave function, Criterion for the validity of the approximation, Connection formulas, Applications to the one dimensional bound system, Penetration of potential barrier. Variational method: Principle and applications to linear harmonic oscillator, Helium atom. Time independent perturbation theory: Non degenerate case, Application to anharmonic oscillator ($X^4$) and linear harmonic oscillator, Degenerate case: Application to linear Stark effect and Zeeman effect in the Hydrogen atom.

### Suggested Reading:


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### MSPH213: SOLID STATE PHYSICS

#### Unit-I

Crystal Physics: Diffraction of waves by crystals, Reciprocal lattice and its application to diffraction technique, Laue, Powder and rotating crystal method, Crystal structure factor and atomic form factor.

Lattice Vibrations: Quantization of elastic waves, Phonon momentum and inelastic scattering by phonons.

Defects in Crystal: Point defects, Color centres, F-centres, Line defects and planer defects, Role of dislocations in crystal growth.

#### Unit-II

Ferroelectrics: Classification of ferroelectric crystals, Theory of the ferroelectric displacive transitions: Polarization catastrophe, Soft optical phonon, Thermodynamics of ferroelectric transition, Ferroelectric domains, Antiferroelectric, Piezoelectric and pyroelectric material.

Phase Transition: First and second order transition, Long range order, Short range order and Bragg William model.

#### Unit-III

Superconductivity: Basic phenomena, Meissner effect, Critical field, Type- I and Type- II superconductors, Heat capacity, Isope effect, London equations, Coherence length, BCS theory of superconductivity, Flux quantization, Normal tunneling, dc and ac Josephson Effect, SQUID, High temperature superconductors.

#### Unit-IV


#### Unit-V


Optical Properties: Refractive index, Electronic polarization, Optical absorption, Photoconductivity, Relationship between absorption coefficient and band gap recombination.

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*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
Suggested Reading:

**MSPH214: STATISTICAL AND PLASMA PHYSICS**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
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<tbody>
<tr>
<td>Unit-I</td>
<td>Ensembles Theory and Boson gas: Micro canonical, Canonical and grand canonical ensembles, Phase spacing of classical system, Liouville’s theorem and its consequence, Quantum state and phase space, Chemical potential near absolute zero, Thermodynamics behavior of an ideal Boson gas, Bose-Einstein condensation, Liquid $^4$He, Phase relation of Helium, Quasiparticles and superfluidity of $^4$He, Superfluid phases of $^3$He.</td>
</tr>
<tr>
<td>Unit-II</td>
<td>Fermi Gas: Strongly degenerate Fermions gas and its thermodynamics, Ground state of Fermi gas, density of states, heat capacity of electron gas, Fermi gas in metals, Magnetism of free electron gas in weak and strong magnetic field, Landau diamagnetism, Ultra cold Fermi gas, White dwarf stars, Nuclear matter, Statistical model of an atom.</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Basic Properties and Occurrence of Plasma: Definition of plasma, Criteria for plasma behavior, Plasma oscillation, Quasi-neutrality and Debye Shielding, Plasma parameters, Natural occurrence of plasma, Astrophysical plasmas, Plasma in Magnetosphere and Ionsphere, Plasma production and diagnostics, Thermal ionization, Saha equation, Brief discussion of methods of laboratory plasma production, Steady stage glow discharge, Microwave breakdown and induction discharge, Double plasma machine, Elementary ideas about plasma diagnostics, Electrostatic and magnetic probes.</td>
</tr>
<tr>
<td>Unit-V</td>
<td>Equilibrium and Stability: Hydromagnetic equilibria, Concept of magnetic pressure, Equilibrium of a cylindrical pinch, Benner pinch, Diffusion of magnetic field into plasma, Classification instabilities, Two stream instability, Gravitational instability. Resistive drift waves.</td>
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Suggested Reading:

**MSPH221: LASER LAB**

<table>
<thead>
<tr>
<th>List of Experiments:</th>
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</thead>
<tbody>
<tr>
<td>1. To determine and compare slit width from the study of Fraunhoffer Diffraction pattern.</td>
</tr>
<tr>
<td>2. To measure Brewster angle and hence to find the refractive index of given...</td>
</tr>
</tbody>
</table>

*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
material.
3. To determine basic laser beam parameters of a given laser.
4. To study Magneto- Optic effect and hence to determine Verdet constant of a given material.
5. To study Electro- Optic effect and to determine the value of half wave voltage.
6. To study the Special Coherence using laser beam with double slit.

MSPH22: COMPUTATIONAL PHYSICS LAB

List of Experiments:
2. Determination of roots by Bisection method.
3. Determination of roots by False- Position method.
8. Solution of differential equation by Runga- Kutta second order method.
10. Using Monte-Carlo methods integrate numerically the given function of one variable.
11. Curve fitting by least square method.
### SYLLABUS OF MSc. II YEAR (III AND IV SEMESTERS)

**SUBJECT: PHYSICS**

(2017-2018)

### MSPH311: CLASSICAL ELECTRODYNAMICS

<table>
<thead>
<tr>
<th>Unit-I</th>
<th>Electrostatics: Poisson and Laplace equations, Green’s Theorem, Uniqueness of the solution with the Dirichlet or Neumann boundary conditions, Formal solutions of electrostatics boundary value problem with Green’s function, Electrostatics potential energy density. Boundary value problems in Electrostatics: Method of images, Point charge in the presence of grounded conducting sphere, Point charge in the presence of a charge insulated conducting sphere, Point charge near a conducting sphere at fixed potential, Conducting sphere in uniform electric field by method of images.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-II</td>
<td>Maxwell Equations, Vector and scalar potentials, Gauge transformations, Lorentz gauge, Coulomb gauge, Green functions for wave Equation, Derivation of equations of macroscopic electromagnetism, Poynting theorem and conservation of energy and momentum for a system of charged particles, Poynting theorem in linear dispersive media with losses, Poynting theorem for harmonic field.</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>Radiation by Moving Charges: Retarded time and retarded potential, Lienard–Wiechert potentials and fields for a moving point charge, Electromagnetic fields of a uniformly moving point charge. Total power radiated by an accelerated charge: Larmor’s formula and its relativistic generalization, Angular distribution of radiation emitted by an accelerated charge, Radiation emitted by a charge in arbitrary and extremely relativistic motion, Distribution in frequency and angle of energy radiated by accelerated charges.</td>
</tr>
<tr>
<td>Unit-V</td>
<td>Dynamics of Relativistic Charged Particle: Lagrangian and Hamiltonian for a relativistic charged particle in external electromagnetic fields, Covariance of equation of motion, Euler-Lagrange equation, Motion of charged particle in uniform static magnetic field, Combined uniform static electric and magnetic fields, Motion of charged particle in non uniform static magnetic fields. Adiabatic invariance of flux through the orbit of particle, Generalization of the Hamiltonian: Canonical stress tensor.</td>
</tr>
</tbody>
</table>

**Suggested Reading:**

**MSPH312: QUANTUM MECHANICS-II**

<table>
<thead>
<tr>
<th>Unit-I</th>
<th>Theory of Scattering-I: The scattering experiments, Relationship of cross-section and wave function, Scattering amplitude; Partial wave analysis: Expansion of a plane wave in terms of partial waves, Scattering by central potential, Zero energy scattering; Scattering by a square well potential, Effective range, Resonant scattering.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-II</td>
<td>Theory of Scattering-II: Born approximation, Integral equation for scattering, Born’s first approximation, Spherically symmetric potential, Criterion for validity of Born approximation, Scattering of electrons by atoms, Rutherford scattering.</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Identical Particles: Principle of indistinguishability, Symmetry of wave functions, Spin and statistics, Pauli’s exclusion principle, Construction of wave function of two electrons in L-S and j-j coupling, Allowed states, Ortho and para helium; Exchange force; Scattering of identical particles, Cases of spin half and spin zero particles.</td>
</tr>
<tr>
<td>Unit-V</td>
<td>Relativistic Wave Equation: Klein Gordan equation, Dirac equation, Properties of Dirac matrices, Free Dirac particle, Equation of continuity, Non-relativistic limit, Spin-orbit coupling, Hole theory.</td>
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</table>

**Suggested Reading:**


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**MSPH313: NUCLEAR PHYSICS-I**

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<tbody>
<tr>
<td>Unit-II</td>
<td>Nuclear Models: Introduction to nuclear models, Fermi gas model, Shell model of the nucleus: Harmonic potential, Spin-orbit interaction, Existence of shells, Application of shell model. Limitations of the Shell models, Collective model; Rotational and vibration states, Nilson model and explanation of ground states of the nuclei.</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Energy Spectrum of α and β rays: Discrete energy spectrum of α particles, Geiger-Nuttal’s law, Gamow theory of α decay, Continuous spectrum of β particles, Pauli’s neutrino hypothesis, Fermi theory of β decay, Coulomb correction, Screening effect, Kurie’s plot, Selection rules in β decay, Orbital electron capture, Parity violation in β decay.</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>γ-ray spectrum: γ-ray spectra and nuclear energy levels, Irradiative transition in nuclei, Nuclear isomerism, Internal conversion, Internal pair creation, Selection rules of γ-ray transitions. Mössbauer Effect: Nuclear resonance, Recoil energy, Thermal broadening, Doppler</td>
</tr>
</tbody>
</table>

*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
broadening, Heisenberg, Natural line width, Recoil free fraction, Velocity modulation, Isomer shift, Quadrupole splitting, Magnetic Hyperfine splitting.

<table>
<thead>
<tr>
<th>Unit-V</th>
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</thead>
<tbody>
<tr>
<td>Basic interaction of various particles with matter: Interaction of Charge particles with matter; Bohr-Bethe formula, Interaction of γ-rays with matter: Photo electric, Compton effects and pair production.</td>
</tr>
</tbody>
</table>

Suggested Reading:


**Paper IV: (Special Paper-I)**

**Group A: ELECTRONICS**

**MSPH314(A) : COMMUNICATION TECHNOLOGY**

<table>
<thead>
<tr>
<th>Unit-I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Communication: Modulation: Amplitude modulation-generation of AM waves, Demodulation of AM waves –DSBSC modulation, Generation of DSBSC waves, SSB modulation, Generation of SSB, Vestigial sideband modulation and frequency division multiplexing (FDM), Frequency modulation, Mathematical analysis, Generation of FM. Demodulation: Demodulation of AM signals, Demodulation of FM signals: Foster seeley discriminator, Ratio detector</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Communication: Pulse modulation system, Sampling theorem-low pass and Band pass signals, PAM Channel BW for a PAM signal, Natural sampling. Flat top sampling, Pulse code modulation, Quantization and the binary code, Dynamic range, Coding efficiency, Quantization error, Noise in PCM signals, Companding, Digital modulation techniques: ASK, FSK, BFSK, DPSK, QPSK</td>
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</table>

<table>
<thead>
<tr>
<th>Unit-III</th>
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<tbody>
<tr>
<td>Transmission Lines: Voltage and current equations of transmission lines, Characteristic impedance, Propagation constant, Reflection coefficient, VSWR, Impedance transformation, Smith chart, Impedance matching by single stub and double stub. Optical Fiber : Light propagation in fibers, Total internal reflection, Numerical aperture of a given fiber, Fiber index profiles, step index and graded index fiber, Modes of propagation, Number of propagated modes in step-index fibers,</td>
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<tr>
<th>Unit-IV</th>
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<tbody>
<tr>
<td>Radars and Satellite: Radar System: Radar block diagram and operation, Radar frequencies, Pulse consideration radar range equation, Minimum detectable signal, Receiver noise, Signal to noise ratio, Integration of radar pulses, Radar cross section, Pulse repetition frequency, Pulsed radar system, Doppler’s effect, CW Doppler Radar system, Moving target Indicator principle, FM radar. Satellite Communication: Orbital satellites, Geo- stationery satellite, Orbital patterns, Look angles, Orbital spacing, Satellite systems link modules</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit-V</th>
</tr>
</thead>
</table>
Addressing, Efficiency, Error Detection and Correcting Codes: Types of errors, Redundancy, Detection versus correction, Block coding, Hamming codes, Cyclic codes: Cyclic Redundancy Check, Hardware Implementation, Polynomials, Parity generation and detection

Books Suggested:

**Paper IV: (Special Paper-I)**

**Group B: MATERIAL SCIENCE**

**MSPH314(B): MATERIAL SYNTHESIS AND CHARACTERIZATION**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-I</td>
<td>Introduction to Crystal Growth, Morphology of crystals, Various Crystal Growth Processes: Driving force, Rate-determining process, Vapour Growth: Step velocity, Mechanism of two-dimensional nucleation growth, Mechanism of spiral growth, Growth of a Crystal in a Solution: Solvation effects and growth rates</td>
</tr>
<tr>
<td>Unit-II</td>
<td>Solid States and Solution Routes: Mechanical mixing, Grinding, Solid solution technique, Combustion method, Top seeded solution growth; Sol-gel techniques; Hydrothermal, Melt methods: Czechorliskek methods, Skull melting, Electrochemical, Sono-chemical and Photo-chemical synthesis.</td>
</tr>
<tr>
<td>Unit-V</td>
<td>Spectroscopic Techniques: Mass spectroscopy and X-ray emission spectroscopy (Principle and limitations), Special surface techniques: Electron spectroscopy for chemical analysis (ESCA), Ultraviolet photo electron spectroscopy (UPS), X ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES), Electron energy analysers.</td>
</tr>
</tbody>
</table>

Suggested Reading:

**MSPH321: GENERAL LAB**

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
### List of Experiments:

1. To study the characteristics of a GM tube and determination of its operating voltage, Plateau length and Slope.
2. Verification of inverse square law for gamma rays.
4. Linear and mass attenuation co-efficient using gamma/beta ray source.
5. Estimation of efficiency of G.M. detector for gamma and beta ray source.
6. Study of energy resolution characteristics of a scintillation spectrometer as a function of applied high voltage and to determine the best operating voltage.
7. Study of Cs-137 spectrum and calculation of FWHM and resolution for a given scintillation detector.
8. Study of Co-60 spectrum and calculation of resolution of detector in terms of energy.
10. Calculation of unknown energy of a radioactive isotope.
11. Variation of energy resolution with gamma energy.
12. Study of Hall effect in semiconductor crystals.

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### MSPH322: ELECTRONICS LAB.

<table>
<thead>
<tr>
<th>List of Experiments:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Study of RC phase shift oscillator.</td>
</tr>
<tr>
<td>2. Study of square wave generator.</td>
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<tr>
<td>4. Study of flip flops.</td>
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<tr>
<td>5. Study of half adder and full adder.</td>
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<tr>
<td>6. Study of half and full subtractor.</td>
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<tr>
<td>7. Study of shift registers.</td>
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<tr>
<td>8. Study of counters.</td>
</tr>
<tr>
<td>10. Assembly language programming on 8085 microprocessor: Data transfer using direct and indirect addressing, Addition, Subtraction.</td>
</tr>
<tr>
<td>11. Assembly language programming on 8085 microprocessor: Multiplication, Division, Array Addition, Largest and smallest from a set of numbers.</td>
</tr>
</tbody>
</table>

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### MSPH411: NUCLEAR PHYSICS-II

<table>
<thead>
<tr>
<th>Unit-I</th>
<th>Nuclear Forces: Two body problem, Ground state of deuteron, Magnetic moment, Quadruple moment, Tensor forces, Meson theory of nuclear forces, Yukawa potential, Nucleon-nucleon scattering, Low energy n-p scattering, Effective range theory, Spin dependence, Charge independence and charge symmetry of nuclear forces.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-II</td>
<td>Nuclear Reactions: Energetic of nuclear reactions, Reaction dynamics, Q-value equation, Scattering and reaction cross sections, Compound nucleus, Scattering matrix, Reciprocity theorem, Breit-Wigner one level formula, Resonance Scattering, Continuum theory, Optical model.</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
### MSPH412: ATOMIC AND MOLECULAR SPECTROSCOPY

#### Unit-I

#### Unit-II
Microwave Spectroscopy: Pure rotational spectra of diatomic molecules, Isotopic effect, Non-rigid rotator, Polyatomic molecules, Study of linear molecules and symmetric top molecules, Stark effect, Quadrupole hyperfine interaction, Microwave spectrometer, Information from rotational spectra.

#### Unit-III
Infrared Spectroscopy: Vibrational spectroscopy of diatomic and simple polyatomic molecules, Harmonic Oscillator, Anharmonic Oscillator, Rotational vibrators, Normal modes of vibration of polyatomic molecules, Experimental techniques, FTIR Spectrometer, Applications of infrared spectroscopy: H₂O and N₂O, CO₂ molecules

#### Unit-IV
Raman Spectroscopy and Electronic Spectra: Pure rotational Raman spectra, Linear and symmetric top molecules, Vibrational Raman spectra, Raman activity of vibrations, Mutual exclusion principle, rotational fine structure, Raman spectra, Structure determination from Raman spectroscopy.

#### Unit-V
NMR and ESR Techniques: Theory of NMR, Relaxation effect, Bloch equations, Theory of dipolar interaction and chemical shifts, Indirect spin-spin interactions, Experimental set up of NMR, Applications of NMR to quantitative measurements (Idea only).

ESR: Quantum mechanical treatment of ESR, Nuclear interaction and hyperfine structure, Relaxation effects, Basic principles of spectographs, Applications of ESR method.

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**Suggested Reading:**

MSPH413: NANOMATERIALS

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-I</td>
<td>Introduction: Nano size scale, History of Nanotechnology, Quantum Mechanics and Fluctuation in nanostructure systems, Surface area to volume ratio, Surface energy, chemical potential as a function of surface curvature, Electrostatic stabilization and Steric stabilization. Idea of zero, one and two dimension nanostructures. Changes to the system structures, Vacancies in nanocrystals, Dislocations in nanocrystal. Effect of nanoscale dimensions on various properties: Structural, Thermal, Chemical, Mechanical, Magnetic, Optical and electronic properties.</td>
</tr>
</tbody>
</table>

Suggested Reading:


2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)

<table>
<thead>
<tr>
<th>Paper IV: (Special Paper-II)</th>
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</thead>
<tbody>
<tr>
<td><strong>Group A: ELECTRONICS</strong></td>
</tr>
<tr>
<td><strong>MSPH414(A): NETWORK ANALYSIS AND MICROWAVE ELECTRONICS</strong></td>
</tr>
</tbody>
</table>

**Unit-I**

**Unit-II**
S-Plane Analysis: Transform impedance and admittance functions, Thevinin’s and Norton’s theorems, Two port networks, Driving point impedance, Transfer functions, Poles and zeros of network functions, Restrictions on poles and zeros of driving point impedance and transfer functions, Time domain response from pole zero configuration. Frequency Response Plots: Magnitude and phase plots, Complex loci, Plots from s-plane phasors, Bode plots.

**Unit-III**
Introduction: Microwave frequency bands; Limitations of conventional devices at microwave frequencies. Wave Guides: Wave propagation between parallel planes, Modes of propagation, Rectangular and circular wave guides, Impedance concept in wave guide, Impedance measurement by VSWR, Measurement of dielectric constant at microwave frequency, Cavity resonator, Measurement of frequency.

**Unit-IV**
Microwave Components: Scattering matrix, Phase shifters, Directional couplers; E-plane, H-plane and Hybrid Tees; Ferrite isolators, Circulator. Microwave Tubes: Velocity modulation, Basic principles and characteristics of two cavity klystron and reflex klystron; Magnetrons; Slow wave structure, Helix traveling wave tube, Wave modes, Gain

**Unit-V**
Semiconductor microwave devices: Microwave tunnel diodes; HEMT; Transfer electron devices, Gunn effect, Principle and modes of operation; Read diode, IMPATT and TRAPATT; Varactor, Parametric converters, Manley Rowe relations, Up converter and negative resistance amplifier.

**Suggested Reading:**

<table>
<thead>
<tr>
<th>Paper IV: (Special Paper-II)</th>
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</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
Group B: MATERIAL SCIENCE
MSPH414(B): THIN FILMS

Unit-I

Unit-II
Sputtering: Sputtering mechanisms and yield, DC and RF sputtering, Magnetron sputtering, Bias sputtering, Reactive sputtering, Evaporation versus Sputtering, Hybrid and modified PVD processes- Ion plating, Reactive Evaporation, Ion beam assisted deposition.

Unit-III

Unit-IV

Unit-V
Deposition Monitoring and Control: Microbalance, Crystal oscillator thickness monitor, Thickness measurement: Fringes of equal thickness (FET) method-Multiple beam interferometer, Fringes of equal chromatic order (FECO) method-Ellipsometry. Scope of Devices and Applications: Thin film resistors, Thin film capacitors, Thin film field effect transistors, Thin film solar cells, Antireflection coatings

Books Suggested:

Lab-I : Group B: MATERIAL SCIENCE
MSPH421(B): SPECIAL PAPER LAB

List of Experiments:
1. Experiments with introductory Nano Kit.(Understanding nano scaling and demonstrating atomic arrangement)
2. Experiments based on Nano TiO₂ Solar Cell Trainer Kit.(Four experiments).
3. Experiments based on ferro-fluid demonstrator. (Three experiments).
5. Experiments with lattice dynamics kit.
7. Study of electron spin resonance in a paramagnetic crystal and calculation of Lange-g-factor.
8. Study of Curie temperature in a ferroelectric crystal and determination of dielectric constant.
9. To determine electrical resistivity of a given material by Vader Paw method.

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
10. Measurements of various magnetic parameters using hysteresis loop tracer.

<table>
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<tr>
<th>Lab-II: MSPH422: PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>All the students have to carry out a project. The project work may be experimental or theoretical. Each student has to carry out his individual project. At the end of the semester each student has to submit a report of the work. The assessment of the project work will be done by the presentation of the work by the students.</td>
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</tbody>
</table>
## Teaching and Examination Scheme

### M.Sc. Botany (2016-2018)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Pd/Wk</th>
<th>Exam (hr)</th>
<th>CIA*</th>
<th>ESE</th>
<th>Total</th>
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<tr>
<td>MSBO 111</td>
<td>Biology and Diversity of Microbes</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSBO 112</td>
<td>Diversity and Systematics of Seed Plants: Angiosperms</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSBO 113</td>
<td>Cell Biology</td>
<td>4</td>
<td>3</td>
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<tr>
<td>MSBO 114</td>
<td>Cytology and Genetics</td>
<td>4</td>
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<td>MSBO 115</td>
<td>Plant Physiology</td>
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<tr>
<td>MSBO 121</td>
<td>Practical I</td>
<td>12</td>
<td>6</td>
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<tr>
<td>MSBO 122</td>
<td>Practical II</td>
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<tr>
<td>MSBO 211</td>
<td>Biology and Diversity of Lower Plants</td>
<td>4</td>
<td>3</td>
<td>20</td>
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<td>100</td>
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<tr>
<td>MSBO 212</td>
<td>Diversity and Systematics of Seed Plants - Gymnosperm</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
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<tr>
<td>MSBO 213</td>
<td>Molecular Biology</td>
<td>4</td>
<td>3</td>
<td>20</td>
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<tr>
<td>MSBO 214</td>
<td>Genetics, Plant Breeding and Evolution</td>
<td>4</td>
<td>3</td>
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<tr>
<td>MSBO 215</td>
<td>Plant Biochemistry and Metabolism</td>
<td>4</td>
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<tr>
<td>MSBO 221</td>
<td>Practical I</td>
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<tr>
<td>MSBO 222</td>
<td>Practical II</td>
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<tr>
<td>MSBO 311</td>
<td>Fundamentals of Ecology</td>
<td>4</td>
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<td>MSBO 312</td>
<td>Plant Resource Utilization and Conservation</td>
<td>4</td>
<td>3</td>
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<tr>
<td>MSBO 313</td>
<td>Plant Development</td>
<td>4</td>
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<tr>
<td>MSBO 314</td>
<td>Plant Reproductive Biology</td>
<td>4</td>
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<tr>
<td>MSBO 315</td>
<td>Fundamentals of Plant Tissue Culture</td>
<td>4</td>
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<td>MSBO 321</td>
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<tr>
<td>MSBO 322</td>
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<tr>
<td>MSBO 411</td>
<td>Applied Ecology</td>
<td>4</td>
<td>3</td>
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<tr>
<td>MSBO 412</td>
<td>Biostatistics and Bioinformatics</td>
<td>4</td>
<td>3</td>
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<tr>
<td>MSBO 413</td>
<td>Genetic Engineering</td>
<td>4</td>
<td>3</td>
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<tr>
<td>MSBO 414</td>
<td>Genomics and Proteomics</td>
<td>4</td>
<td>3</td>
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<tr>
<td>MSBO 415</td>
<td>Applied Plant Tissue Culture</td>
<td>4</td>
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<tr>
<td>MSBO 421</td>
<td>Practical I</td>
<td>12</td>
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<tr>
<td>MSBO 422</td>
<td>Practical II</td>
<td>12</td>
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*CIA for practical includes marks for practical record, practical skills, regularity, seminar, viva voce, educational tour, tour report, collection of flora and preparation and submission of permanent slides (as applicable).

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
NOMENCLATURE OF PAPERS IN M.Sc. BOTANY

MSBO111: Biology and Diversity of Microbes
MSBO112: Diversity and Systematics of Seed Plants: Angiosperms
MSBO121: Practical I (Covering MSBO 111 and 112)
MSBO113: Cell Biology
MSBO114: Cytology and Genetics
MSBO115: Plant Physiology
MSBO122: Practical II (Covering MSBO 113, 114 and 115)

MSBO211: Biology and Diversity of Lower Plants
MSBO212: Diversity and Systematics of Seed Plants: Gymnosperms
MSBO221: Practical I (Covering MSBO 211 and 212)
MSBO213: Molecular Biology
MSBO214: Genetics, Plant Breeding and Evolution
MSBO215: Plant Biochemistry and Metabolism
MSBO222: Practical II (Covering MSBO 213, 214 and 215)

MSBO311: Fundamentals of Ecology
MSBO312: Plant Resource Utilization and Conservation
MSBO321: Practical I (Covering MSBO 311 and 312)
MSBO313: Plant Development
MSBO314: Plant Reproductive Biology
MSBO315: Fundamentals of Plant Tissue Culture
MSBO322: Practical II (Covering MSBO 313, 314 and 315)

MSBO411: Applied Ecology
MSBO412: Biostatistics and Bioinformatics
MSBO421: Practical I (Covering MSBO 411 and 412)
MSBO413: Genetic Engineering
MSBO414: Genomics and Proteomics
MSBO415: Applied Plant Tissue Culture
MSBO422: Practical II (Covering MSBO 413, 414 and 415)

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
## MSBO111: BIOLOGY AND DIVERSITY OF MICROBES

### Unit-I

### Unit-II

### Unit-III
- Mycology: General characters and classification of fungi; substrate relationship in fungi; cell ultrastructure, unicellular and multicellular organization; cell wall composition; nutrition (nectrotrophic, biotrophic and symbiotic); reproduction; hetrothallism; heterokaryosis; parasexuality.

### Unit-IV
- Phylogeny of fungi: general account of Mastigomycotina (Synchytrium, Albugo, Peronospora), Zygomycotina (Rhizopus, Mucor, Pilobolus), Ascomycotina (Saccharomyces, Penicillium, Erysiphe, Phyllactinia, Mochella); Basidiomycotina (Polyporus, Puccinia, Uromyces, Melampsora), Deuteromycotina (Curvularia, Dreshlera, Alternaria, Phoma, Fusarium, Colletotrichum); fungi in industry, medicine and as food; Mycorrhiza; fungi as biocontrol agents.

### Unit-V

### Suggested Readings:

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## MSBO112: DIVERSITY AND SYSTEMATICS OF SEED PLANTS - ANGIOSPERMS

### Unit-I
- Fundamentals and importance of Plant Systematics and Taxonomy: Basic concepts and practices of plant taxonomy- Identification, nomenclature, salient features of...
<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
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<tbody>
<tr>
<td>Unit-II</td>
<td>Classification systems: Phenetic versus Phylogenetic systems; Taxometrics and Cladistic methods in taxonomy; Relative merits and demerits of systems of Bentham and Hooker, Cronquist, Takhtajan and Thorne. The Angiosperm Phylogeny Group system of classification of flowering plants.</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Taxonomic tools and evidences: Taxonomic literature, herbarium techniques, Digital and e-herbaria, morphological, anatomical, palynological, cytological, phytochemical, serological, biochemical and molecular techniques - genome analysis, nucleic acid hybridization and DNA bar-coding.</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>Phylogeny of angiosperms: Ancestors of Angiosperms, Time of origin and Habit of Angiosperms, Primitive living Angiosperms, Inter-relationship among the major groups of angiosperms.</td>
</tr>
</tbody>
</table>

**Suggested Readings:**


*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*

### PRACTICAL - I : MSBO121
### PART-A
### MICROBIOLOGY
### SUGGESTED LABORATORY EXERCISES:

| Material A: | Gram Staining of Bacteria |
| Material B: | Study of Cyanobacteria (*Nostoc*, *Oscillatoria*, *Microcystis*, *Lyngbya*, *Scytonema*) |

### SPOTS:

2. Study of Symptoms of the following diseases(Specimens / Photographs):  
   1. Powdery mildew of Pea  
   2. Loose smut of Wheat  
   3. Smut of Bajra  
   4. Grain smut of Sorghum  
   5. Covered Smut of Barley  
   6. White rust of Crucifers  
   7. Head smut of Sorghum  
   8. Little leaf of Brinjal  
   9. Sesame phyllody  
   10. Paddy blast  
   11. Angular leaf spot of Cotton  
   12. Red rot of sugarcane  
   13. Ergot of Pearl Millet  
   14. Citrus canker  
   15. Potato Virus  
   16. Tomato leaf curl  
   17. Groundnut leaf spot  
   18. Downy mildew of Bajra  
   19. Bacterial blight of paddy  
   20. Wilts.  
   21. Sandal Spike
## PART-B

### TAXONOMY

SUGGESTED LABORATORY EXERCISES:

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Description of a species based on various specimens to study intra-specific variation: a collective exercise.</td>
</tr>
<tr>
<td>3.</td>
<td>Description of various species of a genus; location of key characters and preparation of keys at generic level.</td>
</tr>
<tr>
<td>4.</td>
<td>Location of key characters and use of keys at family level.</td>
</tr>
<tr>
<td>5.</td>
<td>Field trips within and around the campus; compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant.</td>
</tr>
<tr>
<td>6.</td>
<td>Training in using floras and herbaria for identification of specimens described in the class.</td>
</tr>
<tr>
<td>7.</td>
<td>Educational Visit*.</td>
</tr>
</tbody>
</table>

* The students are expected to prepare a brief illustrated narrative of the Scientific Visits. After evaluation, the marks would be added to the CIA of the practical examination.

### SPOTS:

- a. Vasculum
- b. Secateur
- c. Plant Press
- d. Drier
- e. Flora
- f. Types of inflorescence
- g. Types of leaf
- h. Types of placentat
LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - I
M. Sc Botany
SEMESTER I
MSBO 121 (covering MSBO 111 and 112)

Time: 6 Hours \hspace{2cm} \text{Max. Marks: 80}

PART – A

Q.1 Prepare a stained smear of the material A. Identify the nature of gram’s stain. \hspace{2cm} 03

Q.2 Examine the material B. Prepare temporary glycerin mount and identify giving reasons. Draw suitable labeled diagrams. \hspace{2cm} 06

Q.3 Make temporary preparation of material C. Identify and classify giving reasons and place in its systematic position. Draw suitable labeled diagrams. \hspace{2cm} 10

Q.4 Identify and comment upon spots ‘a’ to ‘d’ \hspace{2cm} 4 \times 4 = 16
(a) __________________________
(b) __________________________
(c) __________________________
(d) __________________________

PART-B

Q.5 Describe the given flowering plant (Material D) in semi-technical language and identify it up to the species level giving reasons. (Flora will be given only after identification of the family). \hspace{2cm} 12

Q.6 Solve the given nomenclature exercise. Select the correct name giving reasons. \hspace{2cm} 07

Q.7 Identify and comment upon spots ‘a’ to ‘d’ \hspace{2cm} 4 \times 4 = 16
(a) __________________________
(b) __________________________
(c) __________________________
(d) __________________________

Q.8 Viva-Voce \hspace{2cm} 10

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
**MSBO113: CELL BIOLOGY**

<table>
<thead>
<tr>
<th>Unit-I</th>
<th>The dynamic cell: Structural organization of the plant cell; specialized plant cell types; Chemical foundation: Atoms and Molecules, Covalent and Non-covalent interactions (Van der Waals, electrostatic, hydrogen bonding &amp; hydrophobic interactions) Composition, structure and function of biomolecules: Carbohydrates, lipids, proteins, nucleic acids and Vitamins.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-II</td>
<td>Cell wall: Structure and functions; biogenesis; growth; Plasma membrane: Structure of model membrane and functions; Active and Passive transport, Sites for ATPases, ion carriers, channels and types of pumps; receptors and electrical properties of membranes; Plant vacuole: Tonoplast membrane; ATPases; transporters; as storage organelle; Plasmodesmata: Structure, role in movement of micromolecules and macromolecules; comparison with gap junctions.</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Plastid and Mitochondria: Structure and function; division and biogenesis; Plastome and Chondriome. Hydrogenosome: Ribosome, Endoplasmic reticulum, Golgi Apparatus: Structure and function; Protein sorting and targeting.</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>Cell shape and mobility: The cytoskeleton; organization and role of microtubule and microfilament, motor movements; implication in flagellar and other movements; Other cellular organelles: Structure and function of microbodies, lysosome, Peroxisome; Nucleus: Structure; nuclear pores; chromatin organization, nucleolus; DNA polymorphism: A, B and Z forms and non-canonical forms of DNA; RNA polymorphism- mRNA, rRNA, tRNA and other regulatory RNAs</td>
</tr>
<tr>
<td>Unit-V</td>
<td>Microscopic techniques: Visualization of cells and sub-cellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission Electron Microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy; Flow cytometry and FACS; Centrifugation: Velocity gradient and Buoyant Density centrifugation; Chromatography: Paper, Thin layer and Column Chromatography (Gel permeation, Ion exchange, Affinity and HPLC)</td>
</tr>
</tbody>
</table>

**Suggested Readings:**


*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
<table>
<thead>
<tr>
<th>Unit</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit-I</strong></td>
<td>Cell Division: Mitosis and Meiosis, their regulation, cell cycle and its regulation. Stability and variability of DNA: The amount of DNA in nuclei and the C-value paradox. Unique and Repetitive DNA. The chromosomes in interphase: Euchromatin and Heterochromatin. Chromosome organization: Nucleosome, Solenoid and higher order structure</td>
</tr>
<tr>
<td><strong>Unit-II</strong></td>
<td>Molecular organization of telomere and centromere. Chromosome banding Patterns: G banding, C banding, R banding and Q banding. Molecular basis of chromosome pairing. Specialized types of chromosomes: Polytenic, Lampbrush and β-form chromosomes. Transposable elements in Bacteria and Plants</td>
</tr>
<tr>
<td><strong>Unit-III</strong></td>
<td>Mutation: Types, causes and detection; mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis. Structural alteration in chromosome: Deletion, Duplication, Inversion, Translocation and Robertsonian translocation. Recombination: Homologous and non-homologous recombination, including transposition, site-specific recombination</td>
</tr>
<tr>
<td><strong>Unit-V</strong></td>
<td>Extensions of Mendelian principles: Codominance, incomplete dominance, Gene interactions: Dominant and recessive epistasis, Complementary, Supplementary and duplicate genes. Pleiotropy, Penetrance and expressivity, phenocopy, Sex linkage</td>
</tr>
</tbody>
</table>

**Suggested Readings:**


*MSBO114: CYTOLOGY AND GENETICS*

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
| Unit-I | Transport of Water - Components of water potential, water absorption by roots, pathways of movement of water in the root, mechanism of water transport through the xylem, transpiration and stomatal regulation; Mineral Nutrition - Essential nutrient elements, their functions and deficiency symptoms in plants; Solute Transport - Passive and active transport, root-microbe interactions in facilitating nutrient uptake; Transport of Organic Solutes - Pathway, materials translocated, the pressure-flow model, phloem loading and unloading |
| Unit-II | Phytochrome - Discovery, photochemical and biochemical properties, characteristics of VLF, LF and HI responses, phytochrome-mediated responses including shade-avoidance response, mode of action; Cryptochrome - Discovery, chemistry, cryptochrome-mediated responses, mode of action; a brief account of phototropins; Photoperiodism - Discovery, critical day length, site of signal perception, circadian clock and photoperiodic time measurement, photoreceptors in flowering; photoperiodism in nature; Vernalization - Discovery, site of signal perception, vernalized (induced) and devernalized state |
| Unit-III | Plant growth regulators: Discovery, chemical structure, occurrence, biosynthesis, physiological effects, commercial applications and signal transduction pathways of Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid and Brassinosteroids. A brief account of Strigolactones |
| Unit-IV | Stress: Definition, types & plant responses (susceptibility, avoidance & tolerance): constitutive & induced responses; Biotic Stress: Production of physical barriers (cutin, suberin & wax) and secondary metabolites (terpenes, phenolics & N-containing compounds); induced plant defense against insect herbivores; plant defense against pathogen-elicitors, receptors & signaling, hypersensitive response & systemic acquired resistance; role of Salicylic acid & Jasmonic acid |
| Unit-V | Abiotic Stress: Water deficit stress & drought tolerance, signaling; Salt stress & adaptive strategies by plants, biochemical determinants & signaling; Heat stress & adaptive strategies by plants, SOS signaling; Cold (chilling and freezing) stress & adaptive strategies by plants, role of ABA and antifreeze proteins; Oxidative stress & its causes, enzymatic and non-enzymatic antioxidants; Heavy metal stress & adaptive strategies by plants, role of transporters and chelators. Chaperones and Chaperonins |

**Suggested Readings:**


### PRACTICAL - II: MSBO122

### SUGGESTED LABORATORY EXERCISES

<table>
<thead>
<tr>
<th>Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Determination of stomatal index (quantitative).</td>
</tr>
<tr>
<td>2. Quantitative estimation of SOD activity.</td>
</tr>
<tr>
<td>3. Demonstration of continuity of water column by the use of mercury in <em>Cucurbita/Tinospora</em> stem.</td>
</tr>
<tr>
<td>4. Separation of Turmeric Alkaloids by TLC.</td>
</tr>
<tr>
<td>5. Separation of amino acids by TLC.</td>
</tr>
<tr>
<td>6. Smear preparations in <em>Allium cepa</em> or any other suitable material for mitotic studies.</td>
</tr>
<tr>
<td>7. Meiotic studies in plants by slide preparation and/or photographs.</td>
</tr>
<tr>
<td>9. Study of Mendelian and non-Mendelian inheritance with the help of seed samples.</td>
</tr>
<tr>
<td>10. Separation of biomolecules using gel permeation chromatography.</td>
</tr>
<tr>
<td>15. Study of photoperiodism in <em>Petunia</em>.</td>
</tr>
</tbody>
</table>

### SPOTS:

<table>
<thead>
<tr>
<th>Spot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cell membrane</td>
</tr>
<tr>
<td>2 Plasmodesmata</td>
</tr>
<tr>
<td>3 Secondary structure of protein</td>
</tr>
<tr>
<td>4 Flow cytometry</td>
</tr>
<tr>
<td>5 TEM</td>
</tr>
<tr>
<td>6 C-value paradox</td>
</tr>
<tr>
<td>7 Robertsonian translocation</td>
</tr>
<tr>
<td>8 Transposable elements</td>
</tr>
<tr>
<td>9 Linkage maps</td>
</tr>
<tr>
<td>10 Chromosome organization</td>
</tr>
<tr>
<td>11 Active transport</td>
</tr>
<tr>
<td>12 Phloem loading and unloading</td>
</tr>
<tr>
<td>13 Photomorphogenesis</td>
</tr>
<tr>
<td>14 Effect of auxins on rooting</td>
</tr>
</tbody>
</table>

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2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
1. Perform the given Cell Biology experiment.  
   
2. Perform the given Cytology/Genetics exercise  
   
3. Perform the given Physiology experiment  
   
4. Identify and comment upon spots ‘a’ to ‘f’  
   
   a. ____________________________  
   
   b. ____________________________  
   
   c. ____________________________  
   
   d. ____________________________  
   
   e. ____________________________  
   
   f. ____________________________  

Viva-voce  

Max. Marks: 80  

Total: 80  

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
**SEMESTER-II**

**MSBO211: BIOLOGY AND DIVERSITY OF LOWER PLANTS**

<table>
<thead>
<tr>
<th>Unit-I</th>
<th>Phycology: Algae in diversified habitats (terrestrial, fresh water &amp; marine); thallus organization: cell ultrastructure; reproduction; criteria for classification of algae; Schemes of algal classification, Outline of Fritsch's &amp; Smith's classification.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-II</td>
<td>Salient features of Prochlorophyta, Chlorophyta (Coleochaete, Hydrodictyon, Ulva, Cladophora), Charophyta (Chara), Xanthophyta (Vaucheria), Bacillariophyta, Phaeophyta (Ectocarpus, Sargassum) and Rhodophyta (Batrachospermum, Polyisiphonia); algal blooms, algal biofertilizers; algae as food, feed and uses in industry.</td>
</tr>
<tr>
<td>Unit-III</td>
<td>General characters and classification of bryophytes. General account of morphology, anatomy, reproduction of marchantiales (Marchantia, Plagiochasma, Astrella, Targionia), Jungermanniales (Pellia, Porella), Anthocerotales (Anthoceros), Sphagnales (Sphagnum), Funariales (Funaria) and Polytrichales (Polytrichum, Physcomitrella); economic and ecological importance.</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>General account of morphology, anatomy and reproduction of pteridophytes with special reference to Psilopsida (Psilotum) and Lycopsida (Lycopodium, Selaginella &amp; Isoetes), Heterospory and origin of seed habit.</td>
</tr>
<tr>
<td>Unit-V</td>
<td>General account of morphology, anatomy and reproduction of pteridophytes with special reference to Sphenopsida (Equisetum) and Pteropsida (Ophioglossum, Osmunda, Gleichenia, Pteris), Soral evolution, Alternation of generation, Apospory and apogamy; General account of fossil pteridophyta.</td>
</tr>
</tbody>
</table>

**Suggested Readings:**


**MSBO212: DIVERSITY AND SYSTEMATICS OF SEED PLANTS: GYMNOSPERMS**

<table>
<thead>
<tr>
<th>Unit-I</th>
<th>Introduction: General characters, classification and economic importance of gymnosperms. Evolution of gymnosperms- Trends, origin of secondary wood, primary vasculature and leaf.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-II</td>
<td>Brief account of families of Pteridospermales – Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae. General account of Bennettitales-Williamsoniaceae, Cycadeoidales- Cycadoeoidaceae, Cordaitales- Cordaitaceae.</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Structure and reproduction: Cycadales- Cycadaceae; Ginkgoales-Ginkgoaceae;Coniferales- Taxodiaceae, Araucariaceae, Podocarpaceae, Cephalotaxaceae and Taxales- Taxaceae.</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>Structure and reproduction: Ephedrales - Ephedraceae, Welwitschiales-</td>
</tr>
</tbody>
</table>
Welwitschiaceae and Gnetales - Gnetaceae.

<table>
<thead>
<tr>
<th>Unit-V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paleobotany: Geological Time Scale; Process of fossilization, types and age of fossils, Paleopalynological techniques – Coal and Lignite maceration.</td>
</tr>
</tbody>
</table>

**Suggested readings**


**PRACTICAL - I: MSBO221**

**SUGGESTED LABORATORY EXERCISES:**

<table>
<thead>
<tr>
<th>Material A- Algae-</th>
<th>Coleochaete, Hydrodictyon, Ulva, Cladophora, Chara, Stigeoclonium, Vaucheria, Pithophora, Closterium, Cosmarium, Polysiphonia, Batrachospermum, Ectocarpus, Sargassum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material B- Bryophyta-</td>
<td>Marchantia, Plagiochasma, Targionia, Astrella, Pellia, Porella, Dumortiera, Anthoceros, Sphagnum, Funaria, Polytrichum</td>
</tr>
<tr>
<td>Material C- Pteridophyta-</td>
<td>Lycopodium, Selaginella, Isoetes, Equisetum, Ophioglossum, Osmunda, Gleichenia, Pteris</td>
</tr>
<tr>
<td>Material D- Gymnosperms-</td>
<td>Comparative study of the anatomy of (i) vegetative and (ii) reproductive parts of Cycas, Ginkgo, Pinus, Cedrus, Abies, Picea, Cupressus, Araucaria, Cryptomeria, Taxodium, Podocarpus, Agathis, Taxus, Ephedra and Gnetum</td>
</tr>
</tbody>
</table>

**SPOTS:**

Slides/ Specimens/ Photographs of Material-A, B, C and D

Slide/ Specimens/ Photographs of the following fossil gymnosperms:

1. Williamsonia  
2. Pitlophyllum  
3. Bucklandia  
4. Weltrichia

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)  
2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
JODHPUR, RAJASTHAN  
PRACTICAL EXAMINATION - I  
M. Sc Botany  
SEMESTER II  
MSBO 221 (covering MSBO 211 and 212)  

Time: 6 Hours  
Max. Marks: 80  

PART – A  

Q.1 Examine the material A. Prepare temporary glycerin mount of any two out of the given mixture. Identify the materials and classify giving reasons. Draw suitable labeled diagrams.  

Q.2 Make temporary preparation of material B. Identify and classify giving reasons and place in its systematic position. Draw suitable labeled diagrams.  

Q.3 Cut transverse section (T.S.) of the material C. Make double stained permanent mount for examination. Identify the material giving reasons. Draw suitable labeled diagrams.  

Q.4 Identify and comment upon spots ‘a’ to ‘c’  
(a) _______________________
(b) _______________________
(c) _______________________

Q. 8 Viva-Voce  

PART-B  

Q.5 Cut transverse section (T.S.) of the material D (i). Make double stained permanent mount for examination. Identify the material giving reasons. Draw suitable labeled diagrams.  

Q.6. Make single stained mount of the given reproductive part material D (ii). Identify the material giving reasons. Draw suitable labeled diagrams.  

Q.7 Identify and comment upon spots ‘a’ to ‘d’  
(a) _______________________
(b) _______________________
(c) _______________________
(d) _______________________

Q. 8 Viva-Voce
# MSBO213: MOLECULAR BIOLOGY

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit-I</strong></td>
<td>Nature of genetic material, Central Dogma of life, Forward and Reverse genetics; DNA replication: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication; DNA damage and repair: Direct repair, Excision repair, Recombination repair and other repair mechanisms in plants; Organization of genes: Operons and interrupted genes, gene families, r-RNA, protein coding and t-RNA genes</td>
</tr>
<tr>
<td><strong>Unit-II</strong></td>
<td>Transcription in plants: Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination; RNA processing: 5’capping, splicing, polyadenylation, RNA editing and Alternative processing mechanisms; Structure and function of different types of RNA and RNA transport; Transcription of plastid and mitochondrial genes and post-transcriptional processing</td>
</tr>
<tr>
<td><strong>Unit-III</strong></td>
<td>Ribosome, Genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase; Translation in plants: Formation of initiation complex, initiation factors, elongation and elongation factors, termination; Translational proof-reading, translational inhibitors; Translation in plastids and mitochondria</td>
</tr>
<tr>
<td><strong>Unit-IV</strong></td>
<td>Regulation of gene expression in plastids and mitochondria; Regulation of gene expression in plants at genomic level and genomic imprinting; Regulation of transcription and post-transcriptional events in plants; Regulation of translation and post translational events in plants</td>
</tr>
<tr>
<td><strong>Unit-V</strong></td>
<td>Mechanism of signal transduction in plants: Receptors, effectors, adaptors and secondary messengers: two component regulatory system in bacteria and plants, molecular mechanism of sucrose sensing</td>
</tr>
</tbody>
</table>

**Suggested Readings:**

### MSBO214: GENETICS, PLANT BREEDING AND EVOLUTION

<table>
<thead>
<tr>
<th>Unit</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit-II</strong></td>
<td>Molecular Techniques: Restriction Mapping-concept and technique, <em>In-situ</em> Hybridization-concept and technique, Site Directed Mutagenesis, Microarray, Southern, Northern and Western Hybridization, DNA foot printing, Yeast two hybrid system, Phage Display. Genetic variations in natural populations (Protein variation and variation with RFLP and DNA sequences)</td>
</tr>
<tr>
<td><strong>Unit-III</strong></td>
<td>Introduction to Plant Breeding: History and objectives of plant breeding; Centers of origin of cultivated plants, Genetic variability in crop plants and germplasm conservation, Plant Introduction and acclimatisation. Principles of breeding in self pollinated crops: Selection and Hybridization. Principles of breeding in cross pollinated crops: Genetic composition, Selection, Heterosis and inbreeding depression, Cytoplasmic Male sterility in plants.</td>
</tr>
<tr>
<td><strong>Unit-IV</strong></td>
<td>Methods of breeding in self pollinated crops- mass selection, pureline selection, pedigree selection, Bulk method and back cross method, Methods of breeding in cross pollinated crops- Population improvement, Hybrid and Synthetic varieties. Breeding work done on Wheat and Rice. Molecular plant breeding: Development of mapping population in plants, QTL mapping, Molecular marker systems, Importance of molecular marker assisted breeding</td>
</tr>
<tr>
<td><strong>Unit-V</strong></td>
<td>Evolution: Natural selection and Genetic Drift, concepts of neutral evolution. The Mechanisms of evolution: Population genetics – populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency, Speciation- allopatric, parapatric and sympatric; convergent evolution, Co-evolution</td>
</tr>
</tbody>
</table>

**Suggested Readings:**


*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*

**MSBO 215: PLANT BIOCHEMISTRY AND METABOLISM**

**Unit-I**

**Bioenergetics**: Laws of thermodynamics, Concept of entropy, enthalpy and Free energy.

**Enzymes**: Characteristics, mechanism of action, reversible and irreversible inhibitions, Regulation of enzyme activity; Allosteric enzymes; Isoenzymes and their physiological significance; Steady – state enzyme kinetics for single substrate, Michaelis - Menten Equation ; Line weaver-Burk plot and determination of Km and Vmax; Effects of reversible inhibitors on apparent Km and Vmax

**Unit-II**

**Photosynthesis**: General concepts and historical background; Photosynthetic pigments, Organization of Light – Absorbing antenna systems; Photo-oxidation of water, mechanism of electron and proton transport ; Photophosphorylation; Repair and Regulation of photosynthetic machinery; Carbon Assimilation- Calvin cycle and its regulation; Photorespiration and its significance.

**Unit-III**

**Carbon dioxide- Concentrating Mechanisms**: C4 cycle, Characteristics of C4 plants, C4 Variants -NAD-ME, NADP-ME and PEP-CK type ; C3-C4 intermediates, CAM pathway, Characteristics of CAM plants.

**Allocation of photo assimilates**: Biosynthesis of starch and sucrose;

**Starch degradation**: Hydrolytic and Phosphorolytic.

**Unit-IV**

**Respiration**: Glycolysis and bottom-up regulation, TCA cycle, Pentose phosphate pathway and glyoxylate cycle; Mitochondrial Electron transport and ATP synthesis; Alternative oxidase system and its significance.

**Lipid metabolism**: Biosynthesis of saturated fatty acids–de novo biosynthesis and further modifications; Synthesis of membrane and storage lipids ; β-oxidation of saturated fatty acids, unsaturated fatty acids and fatty acids with odd– number of carbons.

**Unit-V**

**Assimilation of nutrients**: Mechanism of nitrate uptake, transport and assimilation; Ammonium assimilation; Symbiotic Nitrogen fixation: Plant-microbe interactions, nodule formation, nod factors; Nitrogenase enzyme complex and Energetics; Sulphur uptake, transport and assimilation.

**Suggested Readings**:

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)

<table>
<thead>
<tr>
<th>PRACTICAL – II: MSBO222</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUGGESTED LABORATORY EXERCISES:</td>
</tr>
<tr>
<td>1. Extraction of genomic DNA from given plant tissue using CTAB method.</td>
</tr>
<tr>
<td>2. Visualization of isolated genomic DNA from plant sample by Agarose gel electrophoresis.</td>
</tr>
<tr>
<td>3. Extraction of RNA from given plant tissue.</td>
</tr>
<tr>
<td>5. Quantitative estimation of RNA by orcinol method.</td>
</tr>
<tr>
<td>6. Restriction digestion of DNA.</td>
</tr>
<tr>
<td>7. Isolation of plasmid DNA from <em>E. coli</em>.</td>
</tr>
<tr>
<td>8. Genetic problems on gene mapping in higher plants.</td>
</tr>
<tr>
<td>9. Study of Centers of origin of crop plants.</td>
</tr>
<tr>
<td>10. Demonstration of Emasculatin and cross pollination in <em>Datura</em>.</td>
</tr>
<tr>
<td>11. Extraction and Visualization of plant proteins using SDS-PAGE.</td>
</tr>
<tr>
<td>14. Extraction and quantification of lipids by soxhlet method.</td>
</tr>
<tr>
<td>15. Kinetic Studies- Effect of pH, Temperature, enzyme and substrate concentration on peroxidase activity.</td>
</tr>
<tr>
<td>17. Extraction and Visualization of Isoenzymes by Electrophoresis</td>
</tr>
</tbody>
</table>

**SPOTS:**
1. RNA polymerase
2. Lac operon
3. Plastome
4. Chondriome
5. Bacterial two component system
6. Restriction mapping
7. Microarray
8. Selection
9. Molecular marker
10. QTL mapping
11. Allosteric enzymes
12. Photosystems
13. ETC
14. Root nodules
15. CAM pathway
LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - II
M.Sc. BOTANY
SEMESTER- II
(MSBO222: Covering Papers –MSBO213, 214 and 215)

Time: 6 hours

1. Perform the given Molecular Biology experiment 15
2. Perform the given Genetics and Plant Breeding experiment 7+8
3. Perform the given Biochemistry experiment 16

4. Spots (Identify and comment upon the spots ‘a’ to ‘f’) 6x 4= 24
   a. ____________________________
   b. ____________________________
   c. ____________________________
   d. ____________________________
   e. ____________________________
   f. ____________________________

5. Viva-voce 10

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
## SEMESTER - III

### MSBO311: FUNDAMENTALS OF ECOLOGY

<table>
<thead>
<tr>
<th>Unit-I</th>
<th>Climate &amp; Vegetation: Introduction to concept and development of ecology, experiments &amp; models. Atmosphere, Hydrosphere and Biosphere; microclimate.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-II</td>
<td>Vegetation Organization, Soil biology and Fertility: Life zones; Major biomes; Adaptation, Tolerance and Homeostasis; Vegetation types of the world. Major soil types of the world; Biological Management of soil fertility; litter fall and decomposition, litter quality and climatic factors affecting C, N, P and S mineralization, nutrient synchronization.</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>Community Ecology: Concept of community; Analytical and Synthetic characters. Community coefficients. Inter-specific associations; Basic concepts of Ordination, Concept of habitat, Coexistence and Niche.</td>
</tr>
</tbody>
</table>

### Suggested Readings:


### MSBO 312: PLANT RESOURCE UTILIZATION AND CONSERVATION

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-II</td>
<td>Food security; Innovations for meeting World food demands. New dimensions of agricultural policy, Role of science, technology and women education in agriculture. Regimes of WTO, IPR issues and plant genetic resources of India.</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Important fire-wood and timber yielding plants and non-wood forest products</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
(NWFPs). Bamboos, Rattans, Raw materials for paper-making; Gums and resins, tannins and dye from natural plant resources.
Origin, botany, cultivation and uses of Food, forage and fodder crops; Fibre crops; Medicinal and aromatic plants, and Vegetable and oil yielding crops; Plants used as avenue trees for shade, pollution control and aesthetics.

Unit-IV
Strategies for conservation: In situ conservation: International efforts and Indian initiatives, protected areas in India – sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs for conservation of wild biodiversity.

Unit-V
Ex situ conservation: Principles and practices, botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks. General account and activities of Botanical Survey of India (BSI); Indian Council of Agricultural Research (ICAR), National Bureau of Plant Genetic Resources (NBPGR), Council of Scientific & Industrial Research (CSIR), Department of Science and Technology (DST), Department of Biotechnology (DBT), and Ministry of Environment, Forest and Climate Change (MoEFCC)

Suggested Readings:

**PRACTICAL - I: MSBO321**

**ECOLOGY:**

**SUGGESTED LABORATORY EXERCISES**

1. Determination of minimum size and number of quadrates required for reliable estimate of biomass in a natural field.
2. Finding out association between important species using chi- square test.
3. Comparison of protected and gochar land vegetation using similarity indices.
5. Determination of diversity indices (concentration of dominance, Shannon-Wiener, species richness, equitability and diversity) for protected and gochar land vegetation.
6. Estimation IVI of the species in protected and gochar land vegetation
7. Determination of productivity in terrestrial (Harvest method) and aquatic (Light and dark bottle method) systems.

SPOTS:
   a. Light and dark bottle method
   b. Phenothermal index
   c. Ecological Succession
   d. Facilitation model of Succession
   e. Y-shaped energy flow model
   f. Biome
   g. Microclimate
   h. r- and k- selected species
   i. Polar ordination method

SUGGESTED LABORATORY EXERCISES:
1. Quantification of starch in food crops (wheat, rice, maize, potato & sweet potato)
2. Quantification of starch in forage/fodder crops (sorghum, bajra, gram & guar bean)
3. Quantification of acid detergent fibre (ADF) content in fibre crops (cotton, jute, coir & silk Cotton)
4. Morpho-anatomical features of plant fibres (cotton, jute, coir & silk cotton)
5. Quantification of saponification value in vegetable oils (mustard, groundnut, soybean, coconut, sunflower & castor)
6. Quantification of acid value in vegetable oils (mustard, groundnut, soybean, coconut, sunflower & castor)
7. Quantification of iodine value in vegetable oils (mustard, groundnut, soybean, coconut, sunflower & castor)
8. Micro-chemical test for fats & oils
9. Micro-chemical test for gums (guar & kumbhatia)
10. Micro-chemical test for tannins (Acacia, Terminalia, Cassia & tea leaves)
11. Micro-chemical test for dyes (Butea & henna powder)
12. Impurity test for natural products (honey, saffron, katha & mustard oil).

Educational Visit*
* The students are expected to prepare a brief illustrated narrative of the Scientific Visits.
After evaluation, the marks would be added to the CIA of the practical examination.

SPOTS:
   a. Food crops: wheat, maize potato, chickpea, sugarcane & sweet potato
   b. Forage/Fodder crops: sorghum, bajra, gram & guar bean
   c. Fiber crops: cotton, jute, coir & silk cotton
   d. Medicinal plants: Papaver, Catharanthus, Adhatoda, Allium, Rauwolfia, Withania, Phyllanthus & Aloe
   e. Aromatic plants: Mentha, Rosa, Marjorana, Jasminum, Cymbopogon & Pandanus

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
Time: 6 hours                      Max. Marks: 80

1. Perform the given Ecological experiment.
   a. Major                        15
   b. Minor                        08

2. Perform the given Plant Resource Utilization experiment-
   a. Major                        15
   b. Minor                        08

3. Spots (Identify and comment upon the spots from ‘a’ to ‘f’)
   6x 4= 24
   a. ____________________________
   b. ____________________________
   c. ____________________________
   d. ____________________________
   e. ____________________________
   f. ____________________________

4. Viva Voce                      10
MSBO313: PLANT DEVELOPMENT

<table>
<thead>
<tr>
<th>Unit</th>
<th>Introduction/Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-I</td>
<td>Unique features of plant development, differences between animal and plant development. Seed germination and seedling development. Plant body architecture; primary and secondary thickening; Concept of stem cell in plants.</td>
</tr>
<tr>
<td>Unit-II</td>
<td>Shoot development: Organization of the shoot apical meristem (SAM); cytochemical and molecular analysis of SAM; control of cell division and cell to cell communication; control of tissue differentiation, especially xylem and phloem; secretory ducts and laticifers; wood development in relation to environmental factors; cellulose factories</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Nodal and floral anatomy of angiosperms; Leaf growth and differentiation: Determination; phyllotaxy; control of leaf form; differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll.</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>Root development: Organization of root apical meristem (RAM); cell fates and lineages; vascular tissue differentiation; lateral roots; root hairs-development and function; root-microbe interactions.</td>
</tr>
<tr>
<td>Unit-V</td>
<td>Reproduction: Vegetative options and sexual reproduction; flower development; genetics of floral organ differentiation; homeotic mutants in Arabidopsis and Antirrhinum; mechanism of sex determination in plants.</td>
</tr>
</tbody>
</table>

Suggested Readings:
8. Murphy, TM & Thompson, WF 1988, Molecular Plant Development. Prentice Hall, New Jersey.

MSBO314: PLANT REPRODUCTIVE BIOLOGY

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-I</td>
<td>Floral characteristics, Microsporangium &amp; Male gametophyte: Structure of anthers; microsporogenesis, role of tapetum; pollen development and gene expression; sperm dimorphism and hybrid seed production; pollen germination, pollen tube growth and guidance; pollen storage; pollen allergy; pollen embryos.</td>
</tr>
<tr>
<td>Unit-II</td>
<td>Megasporangium &amp; Female gametophyte: Ovule-structure, types and development; megasporogenesis; organization of the embryo sac, structure of the embryo sac cells, Functional role of accessory cells in embryonic sac.</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Pollination mechanisms and pollination vectors; breeding systems; commercial considerations; structure of the pistil; pollen-stigma interactions, sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspects); double fertilization and triple fusion; in vitro fertilization, embryo culture, molecular mechanism of in vitro differentiation.</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
Seed development and fruit growth: Endosperm development during early maturation and desiccation stages; embryogenesis, ultrastructure and nuclear cytology; cell lineages during late embryo development; storage proteins of endosperm and embryo.

Polyembryony; apomixis and apospory; dynamics of fruit growth; biochemistry and molecular biology of fruit maturation.

Dormancy: Importance and types (seed and bud); Metabolic changes associated with senescence and its regulation; influence of hormones and environmental factors on senescence, PCD/apoptosis in plants.

Suggested Readings:
13. The Plant Cell, Special Issue on Reproductive Biology of Plants, Vol. 5(10) 1993, The American Society of Plant Physiologists, Rockville, Maryland, USA

MSBO315: FUNDAMENTALS OF PLANT TISSUE CULTURE

Unit-I
- Plant Tissue Culture: General Introduction; Concept of Totipotency, Historical Background; Concept of asepsis and methods of sterilization, Laboratory planning and design, Basic tools and techniques of in vitro culture, Explant selection and surface sterilisation, Composition and preparation of tissue culture media.

Unit-II
- Micropropagation: Pathways (Axillary bud proliferation, adventitious shoot bud differentiation, callus organogenesis and somatic embryogenesis), meristem tip culture, Applications and limitations.

Unit-III
- Somaclonal Variations: Isolation of somaclonal variants-with and without in vitro selection, molecular basis of somaclonal variations, Applications and limitations. Haploid production through Androgenesis and Gynogenesis; In vitro fertilization and ovary culture, Production of Triploids through endosperm culture - advantages and limitations.

Unit-IV
- Protoplast Culture: Isolation, purification and regeneration of protoplast; Testing of viability of isolated protoplast; Somatic hybridization and methods of protoplast fusion; Selection of hybrids, Practical applications of somatic hybridization (hybrids/cybrids).

Unit-V
- Slow growth and cryopreservation technique – importance of cryopreservation.
pretreatment, freezing methods, cryoprotectants; Application of plant tissue culture in plant pathology; Production of virus-free plants-Thermotherapy, chemotherapy, virus indexing; Culture of obligate parasites

**Suggested Readings:**

<table>
<thead>
<tr>
<th><strong>PRACTICAL - II: MSBO322</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SUGGESTED LABORATORY EXERCISES:</strong></td>
</tr>
</tbody>
</table>

**MSBO313: Plant Development**
1. Dissection of shoot apical meristem (SAM) to observe different zones in shoot apex of *Hydrilla*.
2. Study of root morphology and root apical meristem (RAM) in *Eichhornia*.
3. Study of anatomy of stem to observe the growth due to environmental conditions. (*Bignonia & Salvadora* stem).
5. Study of origin of lateral roots.

**MSBO314: Plant Reproductive Biology**
1. Study of pollen germination under different conditions of solution.
2. Study of Trichomes (*Hibiscus rosa-sinensis* / *Althea rosea*).
3. Testing the viability of given seed sample.
4. Determination of pollen stainability & percentage pollen stainability to test pollen viability.
5. Study of various types of placentation (T.S. of ovary of given flower).
6. Dissection and mounting of translator.
7. Study of T.S. of mature anther.

**MSBO315: Fundamentals of Plant Tissue Culture**
1. Preparation of the stock solutions for MS medium.
2. Preparation of MS medium from stock solutions.
3. Isolation, preparation, surface sterilization and inoculation of different explants.
4. Effect of auxins and cytokinins on callus growth and organogenesis.
5. Effect of auxins and cytokinins on shoot multiplication.
6. Experiments on multiple shoot induction from mature nodal shoot

**2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)**
segments of economically important plant species.
7. Differentiation of tissues through organogenesis/somatic embryogenesis.

SPOTS:

MSBO313: Plant Development
1. T.S. Stem (Bignonia & Salvadora)
2. T.S. Leaves (Nerium, Wheat & Zea mays)
3. Kranz anatomy
4. Types of Stomata
5. Mycorrhiza
6. Root Nodules

MSBO314: Plant Reproductive Biology
1. T.S of mature anther
2. Types of placentation (Axile, Parietal, Marginal, Free central, Basal)
3. Ranslator Ruminate endosperm
4. Types of ovules
5. Fruit ripening
6. Senescence
7. Apomixis
8. Sex determination in plants

MSBO315: Fundamentals of Plant Tissue Culture
1. Multiple shoot
2. Callus Culture
3. Somatic embryogenesis
4. Protoplast
5. Synthetic seed
6. Somatic hybridization
7. Cryopreservation
8. in vitro Rooting
1. Perform the given Plant development exercise. 15

2. Perform the given Reproductive biology exercise. 08

3. Perform the given Plant tissue culture experiment allotted by lots.
   a. Preparation of nutrient medium & reporting the constituents in mg/l 07
   b. Pre-treatment, surface sterilization and inoculation of the explants according to the given experiment. 16

4. Spots (Identify and Comment upon the spot from ‘a’ to ‘f’) 6x 4= 24
   a. ____________________________
   b. ____________________________
   c. ____________________________
   d. ____________________________
   e. ____________________________
   f. ____________________________

5. Viva Voce 10
### SEMESTER-IV
**MSBO411: APPLIED ECOLOGY**

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-II</td>
<td>Biodiversity and Ecological Management: Biodiversity concept and levels, biodiversity role in ecosystem function and stability. Speciation and extinction; IUCN categories of threat; distribution and global patterns. Convention on Biological Diversity (CBD)Terrestrial biodiversity hot spots.</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Sustainable development: Concept of sustainable development; Capitals and currencies, problems and solutions. Concept of sustainable consumption, sustainability indicators; Food security and human population growth.</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>Environmental pollution and industrial ecology: Air, water and land pollution kinds, sources, effects on plants and ecosystem. Bioremediation, environment impact assessment, concepts of industrial ecology.</td>
</tr>
<tr>
<td>Unit-V</td>
<td>Climatic changes and consequences: The greenhouse effect, greenhouse gases; CO₂, CH₄, N₂O, CFCs sources, trends and role; Global warming; Ozone layer and hole; Consequences of climatic changes:CO₂ fertilization, sea level rise and radiation; Concept of carbon credit.</td>
</tr>
</tbody>
</table>

**Suggested Readings:**

### MSBO412: BIOSTATISTICS AND BIOINFORMATICS

<table>
<thead>
<tr>
<th>Unit-I</th>
<th>Introduction to statistics, designing and methodology of an experiment, sample and sampling techniques, collection and representation of data (diagrammatic and graphical). Measures of Central tendency: Mean-Arithmetic, Geometric and Harmonic Mean; Median, Mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-II</td>
<td>Measures of Dispersion: Range-characteristics, coefficient, merits and demerits, Variance and Standard Deviation-calulation, merits and demerits, standard error.</td>
</tr>
</tbody>
</table>

*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
<table>
<thead>
<tr>
<th>Unit-III</th>
<th>Idea of two types of errors and level of significance, Paired Mean Comparison (t-test; Chi-square). Multiple Mean Comparison (DMRT), Analysis of variance- RBD and its application in resource evaluation. Correlation-Types, Methods, Deduction of auto correlation, Correlation Coefficient; Simple Regression analysis and its coefficient, Computer application in data analysis (MS-Excel and SPSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-IV</td>
<td>Introduction to computer: component, generation and types. Introduction to Internet: history, IP address, URL, types of networking and applications. Introduction to bioinformatics: definition, history and principle. Database concept, biological databases (GENBANK, DDBJ, EMBL, SWISSPROT, PROSITE), types of nucleotide sequences, types of databases (primary, secondary, composite databases), information retrieval from databases.</td>
</tr>
<tr>
<td>Unit-V</td>
<td>Sequence analysis: homology search, sequence alignment: types and methods of alignment, alignment score, multiple sequence alignment and ClustalW. Phylogenetic analysis: Dendrogram, Cladogram, Extraction of a phylogenetic data set, Tree building methods (UPGMA, NJ, MP, ML), Tree evaluation (Boot strap and Jack knifing) and use of various software (TREE VIEW, PHYLIP) in phylogeny and genetic diversity analysis</td>
</tr>
</tbody>
</table>

**Suggested Readings:**

**PRACTICAL -I: MSBO421**

**APPLIED ECOLOGY:**

**SUGGESTED LABORATORY EXERCISES:**

1. Water quality assessment for polluted water bodies:
   a. Physical- Color, odor, pH, Electrical conductivity, transparency
   b. Chemical- CO<sub>3</sub> -, HCO<sub>3</sub> -, Cl, Hardness, Dissolved oxygen.
   c. Biological- Pathogenic and non-pathogenic microorganisms.
2. Growth curve / biomass quantification in terms of protein for bio-remediating protists.
3. Comparison of community status in disturbed and undisturbed areas.
5. Estimation of chlorophyll content in SO<sub>2</sub> fumigated and unfumigated plant.
7. Study of environmental impact of a given developmental activity using

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2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
checklist as a EIA method.
8 Calculation of mean, variance, standard deviation, standard error, coefficient of variation and to use t-test for comparing two means related to ecological data.
9 Finding out the relationship between two ecological variables using correlation and regression analysis.
10 Finding the association between important species using chi-square test.

SPOTS:
1. Seed output and reproductive capacity of plants
2. Digital color checker
3. Odour meter
4. pH meter
5. Turbidometer
6. Sulphate estimation
7. Alkali absorption method
8. Litter bag method
9. EIA checklist method

BIOSTATISTICS AND BIOINFORMATICS:
SUGGESTED LABORATORY EXERCISES:
1 Retrieval of required sequence from search engine.
2 Homology search for given unknown sequence using BLAST.
3 Similarity search using FASTA.
4 Primer designing for given nucleotide sequences.
5 Multiple sequence alignment using suitable software.
6 Searching Exon coding regions, Intron and SNPs in the given nucleotide sequence.
7 Preparation of phylogenetic tree
8 Measurement of Central Tendency-Mean, Mode and Median.
9 Measurement of Variance and Standard Deviation
10 Chi Square Test
11 Analysis of variance (RBD)
12 Analysis of Correlation and Regression
13 Phylogenetic study of biological samples through PHYLIP

SPOTS:
1 BLAST
2 NCBI
3 EMBL
4 FASTA
5 MSA (Multiple sequence alignment)
6 Phylogeny tree (cladogram, dendrogram)
7 PHYLIP
8 Clustal W
9 ANOVA
10 t-test
11 Standard deviation
12 Standard error
1. Perform the given Ecological experiment.
   a. Major 15
   b. Minor 08

2. Perform the following:
   a. Bioinformatics Exercise 13
   b. Biostatistics Exercise 10

3. Spots (Identify and Comment upon the spots from ‘a’ to ‘f’) 6x 4= 24
   a. __________________________
   b. __________________________
   c. __________________________
   d. __________________________
   e. __________________________
   f. __________________________

4. Viva Voce 10
### MSBO413: GENETIC ENGINEERING

**Unit I**
- Tools and techniques: Restriction enzyme, DNA ligase, polynucleotide kinase, alkaline phosphatase, DNA polymerase, terminal transferase. RNAse and DNAse; Reverse transcriptase.
- Vector: Characteristics of plasmids (pBR322 and pUC19), phages, phagemids, cosmids, viruses, YAC and BAC as vector.

**Unit II**

**Unit III**
- Genetic engineering of plants: Aims, strategies for development of transgenics; Methods of gene transfer: Physical, Chemical and Biological methods
- *Agrobacterium* - the natural genetic engineer; Mechanism of tumour formation by *A. tumefaciens*; Vectors engineered from Ti Plasmid; Root formation using *Agrobacterium rhizogenes*.

**Unit IV**

**Unit V**
- Biosafety and Bioethics; Containment facilities, Biotechnology risk assessment, Patenting life forms.

**Suggested Readings:**

### MSBO 414: GENOMICS AND PROTEOMICS

**Unit I**
- Introduction to Genomics- Structural, Functional, Comparative and Evolutionary genomics; Plant genomes; Indian initiatives in plant genome sequencing.

**Unit II**
- DNA sequencing methods: Dideoxy chain termination, Pyrophosphate sequencing.

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
High throughput, Ultra high throughput sequencing.

Tools for genome analysis-PCR-Working and types; Molecular markers: RFLP, DNA Fingerprinting and its applications, RAPD, AFLP, SSR, SNP

Unit-III
Proteome: definitions and conceptualization; Protein structure; Post-translational modifications (PTM) - phosphorylation, glycosylation, ubiquitination, additional modifications; Mass spectrometric characterization of PTM – Identification of phosphorylated, glycosylated proteins and other PTM

Unit-IV
Proteomics: Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Peptide fingerprinting; MALDI-TOF; Differential display proteomics, Protein-protein interactions

Unit-V
Functional genomics and proteomics: Microarrays; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics; Concept of Transcriptomics, Metabolomics and Metagenomics

Suggested Readings:

**MSBO415: APPLIED PLANT TISSUE CULTURE**

Unit-I
Planning and design of tissue culture facility for mass propagation of plants: Concept of clean area. Mass media preparation, dispensation and storage. Autoclaving and contamination control. Hatcheries, transfer area, control of physical environment in growth room, air–handling and conditioning, culture room lighting, air exchange, humidity control.

Unit-II
Greenhouse location and design. General nursery practices, maintenance of plants under nursery shade. Available technologies for micropropagation of ornamentals, fruit plants, plantation crops, spices and condiments, oil seeds and legumes, commercialization of plant tissue culture in India

Unit-III
Principal classes of secondary metabolites (alkaloid, terpenes, phenolics), shikimic acid and mevalonate pathways. Production of pharmaceutically important drugs in culture – alkaloids (Catharanthus, Nicotiana, Papaver), anti-tumour agents (taxol, podophyllotoxins, vincristine), saponins and sterols (diosgenin, guggul, ginseng); food additives (sweeteners, flavours and colours) and insecticides. Basic methods of extraction and isolation of secondary metabolites: alkaloids, polyphenolics and terpenes

Unit-IV
Bioreactors: types of bioreactors (stirred tank, air lift, membrane type, immobilized cell bioreactors), process and operation, factors affecting the mass scale production of secondary metabolites (optimization, selection, hairy roots, elicitation).

Unit-V
Bioconversion of molecules by cell free system, and cell cultures, freely suspended and immobilized cells and enzymes. Molecular farming: production of drugs by genetic engineering technology, metabolic engineering for the production of useful metabolites.

Suggested Readings:
10. Purohit, SD 2013, Introduction to Plant cell, Tissue and organ culture, PHI Learning Private Limited, Delhi.

### PRACTICAL -II: MSBO422

**SUGGESTED LABORATORY EXERCISES**

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Isolation of plasmid DNA from bacteria. (minipreparation of plasmid)</td>
</tr>
<tr>
<td>2.</td>
<td>Performing restriction and digestion of lambda phage DNA. (kit based)</td>
</tr>
<tr>
<td>3.</td>
<td>Performing DNA ligation of restricted lambda DNA. (kit based)</td>
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<tr>
<td>4.</td>
<td>Preparation of competent cells of bacteria. (kit based)</td>
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<tr>
<td>5.</td>
<td>Transformation of E. coli cells with standard plasmids. (kit based)</td>
</tr>
<tr>
<td>6.</td>
<td>Calculation of transformation efficiency.</td>
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<tr>
<td>7.</td>
<td>Demonstration of polymerase chain reaction.</td>
</tr>
<tr>
<td>8.</td>
<td>Construction of restriction map of the plasmid pBR322.</td>
</tr>
<tr>
<td>9.</td>
<td>Experiments on multiple shoot induction from mature nodal shoot segments of economically important plant species.</td>
</tr>
<tr>
<td>10.</td>
<td>Demonstration of anther culture in Datura.</td>
</tr>
<tr>
<td>14.</td>
<td>Experiment on ex vitro rooting.</td>
</tr>
<tr>
<td>15.</td>
<td>Establishment of suspension culture.</td>
</tr>
<tr>
<td>16.</td>
<td>Extraction &amp; separation of secondary metabolites using TLC.</td>
</tr>
</tbody>
</table>

*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
<table>
<thead>
<tr>
<th>SPOTS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Southern Hybridization</td>
</tr>
<tr>
<td>2. Western Hybridization</td>
</tr>
<tr>
<td>3. Biochip</td>
</tr>
<tr>
<td>4. Biosensors</td>
</tr>
<tr>
<td>5. Bacterial Artificial Chromosome (BAC)</td>
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<tr>
<td>6. Yeast Artificial Chromosome (YAC)</td>
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<tr>
<td>7. Ti Plasmid</td>
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<tr>
<td>8. SDS-PAGE</td>
</tr>
<tr>
<td>9. Protein-protein interactions</td>
</tr>
<tr>
<td>10. Restriction enzymes</td>
</tr>
<tr>
<td>11. Green House</td>
</tr>
<tr>
<td>12. Growth Room</td>
</tr>
<tr>
<td>13. Bioreactor</td>
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<tr>
<td>14. Thermocycler</td>
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<tr>
<td>15. Transplastomics</td>
</tr>
<tr>
<td>16. Molecular Farming</td>
</tr>
<tr>
<td>17. Reporter and marker genes</td>
</tr>
<tr>
<td>18. MALDI</td>
</tr>
<tr>
<td>19. Expression Vector</td>
</tr>
<tr>
<td>20. Taxol</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
1. Perform the given Genetic Engineering experiment. 15

2. Perform the given Proteomics/Genomics Experiment. 15

3. Perform the given Plant Biotechnology Experiment 16

4. Spots (Identify and comment upon the spots ‘a’ to ‘f’) 6x 4= 24
   a. ____________________________
   b. ____________________________
   c. ____________________________
   d. ____________________________
   e. ____________________________
   f. ____________________________

5. Viva Voce 10
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Pd/Wk</th>
<th>Exam  (hr)</th>
<th>CIA *</th>
<th>ESE</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSBT 111</td>
<td>Principles of Microbiology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 112</td>
<td>Cell and Developmental Biology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 113</td>
<td>Fundamentals of Immunology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 114</td>
<td>Basic Molecular Biology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 115</td>
<td>Principles of Biochemistry</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSBT 121</td>
<td>Practical - I</td>
<td>12</td>
<td>6</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 122</td>
<td>Practical –II</td>
<td>12</td>
<td>6</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 211</td>
<td>Genetics and Evolution</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 212</td>
<td>Computational Biology and Bioinformatics</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSBT 213</td>
<td>Bioanalytical techniques</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSBT 214</td>
<td>Genomics and Proteomics</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 215</td>
<td>Genetic Engineering</td>
<td>4</td>
<td>3</td>
<td>20</td>
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<tr>
<td>MSBT 221</td>
<td>Practical - I</td>
<td>12</td>
<td>6</td>
<td>20</td>
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<td>100</td>
</tr>
<tr>
<td>MSBT 222</td>
<td>Practical - II</td>
<td>12</td>
<td>6</td>
<td>20</td>
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<tr>
<td>MSBT 311</td>
<td>Environmental Biotechnology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSBT 312</td>
<td>IPR, Biosafety and Bioethics</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSBT 313</td>
<td>Bioprocess Engineering and Technology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
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<tr>
<td>MSBT 314</td>
<td>Plant Biotechnology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 315</td>
<td>Animal Cell Culture and Application</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 321</td>
<td>Practical - I</td>
<td>12</td>
<td>6</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 322</td>
<td>Practical - II</td>
<td>12</td>
<td>6</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSBT 411</td>
<td>Dissertation (minimum 3 months )</td>
<td></td>
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<td></td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

*CIA for practical includes marks for practical record, practical skills, regularity, seminar and viva voce (as applicable).
**NOMENCLATURE OF PAPERS IN M.Sc. BIOTECHNOLOGY**

| MSBT111: | Principles of Microbiology |
| MSBT112: | Cell and Developmental Biology |
| MSBT113: | Fundamentals of Immunology |
| MSBT121: | Practical- I (Covering MSBT 111,112 and 113) |
| MSBT114: | Basic Molecular Biology |
| MSBT115: | Principles of Biochemistry |
| MSBT122: | Practical –II (Covering MSBT 114 and 115) |

| MSBT211: | Genetics and Evolution |
| MSBT212: | Computational Biology and Bioinformatics |
| MSBT213: | Bioanalytical techniques |
| MSBT221: | Practical (Covering MSBT 211,212 and 213) |
| MSBT214: | Genomics and Proteomics |
| MSBT215: | Genetic Engineering |
| MSBT222: | Practical (Covering MSBT 214 and 215) |

| MSBT311: | Environmental Biotechnology |
| MSBT312: | IPR, Biosafety and Bioethics |
| MSBT313: | Bioprocess Engineering and Technology |
| MSBT321: | Practical (Covering MSBT 311,312 and 313) |
| MSBT314: | Plant Biotechnology |
| MSBT315: | Animal Cell Culture and Application |
| MSBT322: | Practical (Covering MSBT 314 and 315) |

| MSBT411: | Dissertation (3 Month Duration) |

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*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
<table>
<thead>
<tr>
<th>MSBT 111: PRINCIPLES OF MICROBIOLOGY</th>
</tr>
</thead>
</table>
| **Unit-I**                          | History of Microbiology; A general account on classification, ultrastructure, nutrition, reproduction, biology and economic importance of Archaeabacteria, Eubacteria, Cyanobacteria, Actinomycetes and Fungi.  
Genetic recombination in bacteria: Transduction, Conjugation & Transformation |
| **Unit-II**                          | Micr...ual growth; Batch culture, methods of growth estimation, stringent response, death of a bacterial cell, growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen  
Microbial physiology: Photosynthesis; Chemolithotrophy; Hydrogen and iron oxidizing bacteria; Sulfate reduction |
| **Unit-IV**                          | Ecological impacts of microbes: Symbiosis (Nitrogen fixation, Mycorrhizal Symbiosis and ruminant symbiosis), Microbes and Nutrient cycles (Nitrogen & Sulphur); Antimicrobial agents: Sulfur drugs, Penicillin and cephalosporin and Mode of action |
| **Unit-V**                           | Molecular methods in assessing microbial diversity: Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis(TGGE), Amplified rDNA Restriction Analysis, Terminal Restriction Fragment Length Polymorphism (T-RFLP), 16S rDNA sequencing and Ribosomal Database Project |

**Suggested Readings:**


<table>
<thead>
<tr>
<th>MSBT 112: CELL AND DEVELOPMENTAL BIOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit-I</strong></td>
</tr>
<tr>
<td><strong>Unit-II</strong></td>
</tr>
<tr>
<td><strong>Unit-III</strong></td>
</tr>
</tbody>
</table>

*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
filaments; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata. extra-cellular matrix in plants and animals

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants;
Gametogenesis, fertilization and early development in Animals: Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals; embryogenesis

Unit-IV

Gametogenesis, fertilization and early development in Angiosperms: Production of gamete, Pollination and Self-incompatibility and molecular interactions, fertilization, embryo sac development and double fertilization in plants; seed formation and germination.
Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila; post embryonic development-larval formation, metamorphosis; environmental regulation of normal development

Suggested Readings:
2. Gilbert, SF 2013, Developmental Biology, 10th edn, Sinauer Associates, Sunderland, MA, USA

MSBT 113: FUNDAMENTALS OF IMMUNOLOGY

Components of innate and acquired/adaptive immunity. Haematopoiesis; Organization and structure of organs and cells of the immune system- primary and secondary lymphoid organs, lymphoid cells- B and T cells, Blood cells- granular and agranular cells, Natural killer cells; Nature and biology of antigens – immunogen and hapten

Basics of self –non-self recognition and discrimination; B-cell maturation, activation and differentiation; Immunoglobulins-basic structure, classes and subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; Generation of antibody diversity; Major Histocompatibility Complex - MHC types, Immune responsiveness and disease susceptibility, HLA typing

T-cell maturation,activation and differentiation and T-cell receptors, Cell-mediated immune responses. Cytokines-properties and therapeutic uses; Antigen processing
and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Antigen-antibody interactions- Precipitation, agglutination and complement mediated immune reactions

Unit-IV

Active and passive immunization; Live, killed, attenuated, sub unit vaccines.; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines; Antibody engineering- Hybridoma Technology, chimeric and humanized monoclonal antibodies. Catalytic antibody-Abzyme; Immunotechniques: Chromatin immunoprecipitation, ELISA, RIA, immunofluorescence, FACS and ELISPOT assay

Unit-V

Hypersensitivity – Type I-IV, mechanisms and diseases; Autoimmune disorders-Types and causes; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology –Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy

Suggested Readings:

3. Decker, J & Reischl, U 2004, Molecular Diagnosis of Infectious Diseases, Humana Press.
6. Paul 1999, Fundamental of Immunology, 4th edn, Lippencott Raven, USA.

**PRACTICAL 1: MSBT 121**
**SUGGESTED LABORATORY EXERCISES:**

1. Preparation of culture media for the growth of bacteria and fungi (Nutrient Agar, LB agar, EMB agar, MacConkey agar and PDA)
2. Separation and identification of microorganisms by streaking and spread plate method.
3. Separation of microorganisms from water and soil by serial dilution method.
6. Staining (Gram’s staining and acid fast staining) and enumeration (by Haemocytometer) of microorganisms.
7. Determination of thermal death point and thermal death time of microorganisms.
8. Studying various stages of Mitosis from onion root tip.
9. Studying various stages of Meiosis from Phlox/Aloe vera flower bud.
12. Performing Immunodiagnostic test to detect diseases- typhoid and malaria.
13. Performing antibody titre by ELISA method.
15. Analysis of antigen-antibody interaction by Immuno-electrophoresis.

SPOTS:

1. Compound Microscope

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>2.</td>
<td>Centrifuge</td>
</tr>
<tr>
<td>3.</td>
<td>Conjugation</td>
</tr>
<tr>
<td>4.</td>
<td>Aids Virus</td>
</tr>
<tr>
<td>5.</td>
<td>Prions</td>
</tr>
<tr>
<td>6.</td>
<td>HR &amp; SAR</td>
</tr>
<tr>
<td>7.</td>
<td>N₂ Fixation</td>
</tr>
<tr>
<td>8.</td>
<td>Louis Pasteur</td>
</tr>
<tr>
<td>9.</td>
<td>Thymus- As Organ Of Immune System</td>
</tr>
<tr>
<td>10.</td>
<td>MHC-T Cell Interaction</td>
</tr>
<tr>
<td>11.</td>
<td>Superantigen</td>
</tr>
<tr>
<td>12.</td>
<td>Monoclonal Antibody</td>
</tr>
<tr>
<td>13.</td>
<td>FACs</td>
</tr>
<tr>
<td>14.</td>
<td>Plant Based Vaccine</td>
</tr>
<tr>
<td>15.</td>
<td>Autoimmune Disorder</td>
</tr>
<tr>
<td>16.</td>
<td>Fluid Mosaic Model Of Plasma Membrane</td>
</tr>
<tr>
<td>17.</td>
<td>Receptor Mediated Endocytosis</td>
</tr>
<tr>
<td>18.</td>
<td>Microtubule</td>
</tr>
<tr>
<td>19.</td>
<td>C. elegans As Experimental Organism</td>
</tr>
<tr>
<td>20.</td>
<td>Cell Cycle And Its Regulation</td>
</tr>
</tbody>
</table>

Double Fertilization

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - I
M.Sc. BIOTECHNOLOGY
SEMESTER- I
MSBT: 121 (Covering Papers MSBT 111,112,113)

Time: 6 hours 
Max. Marks: 80

5. Perform the given Cell biology / Developmental iology experiment 15

6. Perform the given Microbiology experiment 15

7. Perform the given Immunology experiment. 15

8. Spots (Identify and comment upon spots from ‘a’ to ‘e’) :
   a. ________________________________  
   b. ________________________________  
   c. ________________________________  
   d. ________________________________  
   e. ________________________________  
      5x 5= 25

9. Viva-voce 10

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
MSBT 114: BASIC MOLECULAR BIOLOGY

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Prokaryotic and Eukaryotic genome structure and organization, Levels of eukaryotic chromatin organization – Nucleosome, Solenoid &amp; higher-order chromatin structure; Regulation of chromatin structure- nucleosome remodeling</td>
</tr>
<tr>
<td>II</td>
<td>DNA Replication; Repair &amp; Recombination: DNA Replication- initiation, elongation and termination in prokaryotes and eukaryotes, Enzymes and accessory proteins; DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Non-homologous end joining; Recombination: Homologous</td>
</tr>
<tr>
<td>III</td>
<td>Prokaryotic &amp; Eukaryotic Transcription: Prokaryotic Transcription; Prokaryotic Promoters; Mechanism- Initiation, Elongation and Termination-Rho-dependent and independent; Prokaryotic gene expression with reference to inducible and repressible operons</td>
</tr>
<tr>
<td>IV</td>
<td>Eukaryotic transcription and regulation-Initiation, Elongation and Termination;RNA polymerase structure; RNA polymerase I, II, III and IV / V (Plant specific); Eukaryotic promoters ; Transcription factors; Transcriptional and post-transcriptional gene silencing- RNA interference and CRISPR</td>
</tr>
<tr>
<td>V</td>
<td>Post Transcriptional Modifications: Processing of mRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability. Long non-coding RNA and Circular RNA. Translation &amp; Transport: Translation machinery; Ribosomes; Features of genetic code; Prokaryotic and eukaryotic translation, Mechanism of initiation, elongation and termination</td>
</tr>
<tr>
<td>V</td>
<td>Oncogenes and Tumor suppressor genes: Viral and cellular oncogenes; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes</td>
</tr>
</tbody>
</table>

Suggested Readings:

MSBT 115: PRINCIPLES OF BIOCHEMISTRY

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Chemical basis of life, Water – properties, pH, buffers, covalent and non covalent interactions; Laws of Thermodynamics, Concept of free energy, standard free energy, determination of ΔG for a reaction. Redox potentials. High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates. Structure and function of Saccharides, Lipids , Amino acids, Nucleic acids and Vitamins; Emergent properties of biomolecules in water, Macromolecules; Molecular assemblies</td>
</tr>
</tbody>
</table>
| II   | Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Conformations of proteins (Ramachandran plot, secondary structure,
domains, motif and folds). Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin, ATPase and cytochromes

Unit-III Enzyme: Historical perspective, general characteristics and structure, nomenclature, IUB enzyme classification, Concept of ES complex, active site, specificity, Michaelis-Menten equation. Different plots for the determination of Km & Vmax and their physiological significances. Collision & transition state theories. Enzyme inhibition, reversible inhibitions and their kinetics. Allosteric enzymes

Unit-IV Primary Metabolic pathways: Glycolysis, Gluconeogenesis, Pentose Phosphate Pathway, Metabolism of Glycogen, Cori cycle, Citric acid cycle, Fatty acid oxidation, Amino acid oxidation, Urea cycle and its regulation

Unit-V Substrate-level phosphorylation, Oxidative Phosphorylation and Photophosphorylation (cyclic and noncyclic), Photorespiration, Carbohydrate biosynthesis in plants, Lipid biosynthesis, Biosynthesis of amino acids, Integration and hormonal regulation of metabolism. Inborn Errors of Metabolism

SUGGESTED READINGS:
2 Buchanan, B, Gruissem, BW & Jones, RL 2002, Biochemistry and Molecular Biology of Plants. ASPB, Maryland, USA.
3 Cooper, TG 1977, Tools of Biochemistry, John Wiley and Sons, New York. USA.
7 Segel IH 1976, Biochemical Calculations, John Wiley and sons Inc. New York, USA.
8 Voet D, Pratt CW & Voet JG 2013, Principles of Biochemistry, John Wiley and Sons, New York. USA.
9 Zubay, G 2014, Biochemistry, Addison Wesley, Menlo Park, USA

PRACTICAL II: MSBT 122

SUGGESTED LABORATORY EXERCISES
1. Extraction and visualization of genomic DNA from plants by CTAB method.
2. Extraction and visualization of DNA from blood cells.
3. Extraction and visualization of RNA from plants.
5. Quantitative estimation of reducing sugar & total soluble sugar.
9. Separation of amino acids, sugars & plant pigments by TLC.
10. Separation of biomolecules by gel permeation chromatography.
11. Study of the effect of various parameters (substrate concentration, enzyme concentration, temperature and pH) on enzyme (peroxidase/ alkaline phosphatase) activity.
12. Quantitative estimation of Vitamin C from lemon fruits.

SPOTS:
1. Structure of DNA
2. DNA Replication
3. Eukaryotic Transcription
4. Eukaryotic Promoter
5. Structure of Eukaryotic Chromosome
6. Lac Operon

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
<p>| | |</p>
<table>
<thead>
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<tbody>
<tr>
<td>7.</td>
<td>Ribosome</td>
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<td>8.</td>
<td>Ramachandran Plot</td>
</tr>
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<td>9.</td>
<td>ATPase Pump</td>
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<td>10.</td>
<td>Non Competitive Inhibition</td>
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<td>11.</td>
<td>Cori Cycle</td>
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<td>12.</td>
<td>Feedback Inhibition</td>
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<tr>
<td>13.</td>
<td>Photorespiration</td>
</tr>
<tr>
<td>14.</td>
<td>Phenylketonuria</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - II
M.Sc. BIOTECHNOLOGY
SEMESTER- I
MSBT: 122 (Covering paper MSBT 114 and 115)

Time: 6 hours            Max. Marks: 80

1. Perform the given Biochemistry experiment. 25

2. Perform the given Molecular Biology experiment. 25

3. Spots (Identify and comment upon spots from ‘a’ to ‘d’) : 4x 5= 20

   a. ____________________________
   b. ____________________________
   c. ____________________________
   d. ____________________________

Viva-voce 10

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2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
**MSBT211: GENETICS AND EVOLUTION**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit-I</td>
<td>Mendelian Genetics: Introduction to genetics; Background and history; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance. Role of genetics in medicine; Human pedigrees; Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co-dominance; Sex influenced expression</td>
</tr>
<tr>
<td>Unit-II</td>
<td>Non-Mendelian inheritance patterns: Mitochondrial inheritance; Polygenic inheritance - genetic and environmental variation; Heritability; Analysis of quantitative and qualitative traits. Developmental genetics: Genes in early development; maternal effect genes; Pattern formation genes; Homeotic genes; Signaling and adhesion molecules</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Cytogenetics: Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Genetic recombination; Disorders of sex chromosomes and autosomes. Molecular cytogenetics - Fluorescence In-situ Hybridization (FISH); Comparative Genomic Hybridization (CGH)</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>Emergence of evolutionary thoughts: Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection. Origin of cells and unicellular evolution: Origin of basic biological molecules and polymers; Concept of Oparin and Haldane; Experiment of Miller; The first cell; Evolution of prokaryotes; Origin of eukaryotic cells. Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; Origin of new genes and proteins; Gene duplication and divergence</td>
</tr>
<tr>
<td>Unit-V</td>
<td>Genetic variation: Agents of genetic polymorphism; genome polymorphism; uses of polymorphism and molecular markers. Population genetics and evolution: Phenotype; Genotype; Gene frequency; Hardy-Weinberg law; Factors distinguishing Hardy-Weinberg equilibrium; Mutation selection; Migration; Gene flow; Gene drive, Genetic drift</td>
</tr>
</tbody>
</table>

**Suggested Readings:**


*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
MSBT 212: COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

**Unit-I**

**Unit-II**

**Unit-III**
Principles of bioinformatics, Databases introduction, Biological databases: EMBL, GenBank, DDBJ, TrEMBL, SWISS-PROT, PIR; primary and secondary composite databases; SCOP, CATH, Overview of web servers: NCBI, EBI, PDRB; Search engines: Pub Med, ENTREZ, Expasy and SRS. Biological softwares

**Unit-IV**
Computation Biology: Analysis of nucleic acid and protein sequences, sequence comparison algorithms, sequence scoring schemes. Sequence and Genome analysis: Local alignment, global alignment, FASTA, BLAST (Blast P, Blast N, Blast X) and similarity searching scores and their statistical interpretation.

**Unit-V**
Sequence analysis, Genome annotation, Computational evolutionary biology, Analysis of gene expression, Analysis of regulation, Analysis of protein expression, Analysis of mutations, Comparative genomics, Modeling biological systems, High-throughput image analysis, Prediction of protein structure, Molecular Interaction and Docking algorithms. Role of bioinformatics in genome analysis with reference to E. coli, Arabidopsis and Human.

Cloud computing

Suggested Readings:
12. Sward law, AC 1985, Practical Statistics for Exponents Biologists, John Wiley and Sons, New York, USA
### MSBT 213: BIOANALYTICAL TECHNIQUES

<table>
<thead>
<tr>
<th>Unit</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit-I</strong></td>
<td>Chromatography techniques: TLC, gel permeation, ion exchange and affinity chromatography, HPLC. Spectroscopy technique: UV-visible spectroscopy. Theory and application of circular dichroism, fluorescence, NMR, ESR, integrated plasma emission spectroscopy(IPES) and plasma emission spectroscopy.</td>
</tr>
<tr>
<td><strong>Unit-II</strong></td>
<td>Electrophoretic techniques: theory and application of polyacrylamide and agarose gel electrophoresis, capillary electrophoresis, 2-D electrophoresis, pulsed field gel electrophoresis.</td>
</tr>
<tr>
<td><strong>Unit-III</strong></td>
<td>Radioactivity: radioactive and stable isotopes, pattern and rate of radioactive decay, measurement of radioactivity- Geiger-Muller counter, solid and liquid scintillation counters (Basic principle, instrumentation and technique). Autoradiography and radioimmunoassay.</td>
</tr>
<tr>
<td><strong>Unit-IV</strong></td>
<td>Centrifugation: basic principles, types of centrifuge - microcentrifuge, ultracentrifuge and density gradient centrifugation, applications (isolation of cell components), determination of molecular weight by sedimentation velocity and sedimentation equilibrium methods.</td>
</tr>
</tbody>
</table>

**Suggested Readings:**

**PRACTICALS I: MSBT 221**

**SUGGESTED LABORATORY EXERCISES**

1. Introduction to NCBI, NCBI data bases, BLAST, BLASTn, BLASTp, PSI-BLAST.
2. Biological databases: EMBL, GenBank, DDBJ, TrEMBL, SWISS-PROT, PIR; primary and secondary composite databases; SCOP, CATH.
3. Sequence manipulation Suite, Sequence alignment.
4. Primer designing through bioinformatics tools- Primer3.
5. Phylogenetic Analysis through PHYLIP/CLUSTAL- W.
6. Protein structure Analysis, Docking, Ligplot interactions.
7. Protein Modeling.
8. Electrophoresis for native and denatured proteins (SDS PAGE).
9. HPLC- Handling and basic exercise.
10. Identification of bio molecules on the basis of maximum absorption spectrum.
11. Statistical analysis-Mean, mode, Median, Standard Deviation and Chi-Square Test.

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
<table>
<thead>
<tr>
<th>No.</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.</td>
<td>Assessment of mode of inheritance on the basis of pedigree chart.</td>
</tr>
<tr>
<td>15.</td>
<td>Preparation of genetic map in bacteria using data obtained from interrupted mating.</td>
</tr>
</tbody>
</table>

**SPOTS:**

1. Co-Dominance
2. Translocation
3. Miller’s Experiment
4. RFLP
5. NMR Spectroscopy
6. X-Ray Crystallography
7. Electron Microscope
8. Sequence Alignment
9. Comparative Genomics
10. Swiss-Prot
11. Phylogenetic Tree
12. SCOP
13. Chi-Square Test
14. Histogram
15. Phase Contrast Microscope
16. Density Gradient Centrifugation
17. RIA
18. HPLC
19. Darwin
20. FISH
21. Genomic Imprinting
<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Time:</strong> 6 hours</td>
<td><strong>Max. Marks:</strong> 80</td>
</tr>
<tr>
<td>1</td>
<td>Perform the given Genetics Exercise</td>
</tr>
<tr>
<td>2</td>
<td>Perform the given Computational Biology/ Bioinformatics Exercise</td>
</tr>
<tr>
<td>3</td>
<td>Perform/ Demonstrate the given Bio-analytical technique</td>
</tr>
<tr>
<td>4</td>
<td>Spots (Identify and comment upon spots from ‘a’ to ‘e’)</td>
</tr>
<tr>
<td>a.</td>
<td>________________________________</td>
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<tr>
<td>b.</td>
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<td>c.</td>
<td>________________________________</td>
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<tr>
<td>d.</td>
<td>________________________________</td>
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<tr>
<td>e.</td>
<td>________________________________</td>
</tr>
<tr>
<td>5</td>
<td>Viva-voce</td>
</tr>
</tbody>
</table>
MSBT 214: GENOMICS AND PROTEOMICS

Unit-I
Introduction to Genomics- Structural, Functional, Comparative and evolutionary genomics. DNA sequencing-principles and translation to large scale projects; Deep sequencing, High throughput Sequencing;Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR

Unit-II
Nature of genome in prokaryotes and eukaryotes; Importance of genome projects-human genome project; *Haemophilus influenzae* genome; *Caenorhabditis elegans* genome; genomics of cattle; Plant genomes; Indian initiatives in genome sequencing with special reference to *Mycobacterium*, Rice, Neem, Chickpea & Tomato

Unit-III
Proteome: definitions and conceptualization; Protein structure; Post-translational modifications (PTM) -phosphorylation, glycosylation, ubiquitination, additional modifications; Mass spectrometric characterization of PTM –Identification of phosphorylated , glycosylated proteins and other PTM

Unit-IV
Proteomics: Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Peptide fingerprinting; MALDI-TOF; Differential display proteomics; Protein-protein interactions

Unit-V
Functional genomics and proteomics: Microarrays ; Protein and peptide microarray-based technology; PCR-directed protein *in situ* arrays; Concept of Transcriptomics, Metabolomics, Epigenomics and Metagenomics

Suggested Readings:

MSBT 215: GENETIC ENGINEERING

Unit-I
General introduction and tools of genetic engineering: restriction enzyme, homing enzyme, DNA ligase, polynucleotide kinase, alkaline phosphatase, DNA polymerase, terminal transferase, Reverse transcriptase. Cohesive and blunt end ligation: Linkers, Adaptors, Homopolymer tailing; Genome editing and Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes

Unit-II
Cloning vector- Plasmid (pBR322 and pUC19), cosmid, lambda phage, shuttle vector, gateway vector, BACs and YAC. Animal virus derived vectors- SV40, vaccinia and retroviral vectors. *Agrobacterium* as vector- binary and co-integrative vector. Expression vectors- pMal, GST, pET-based vectors. Choice of hosts, Methods for transferring recombinant DNA to host cells (Transformation and Transfection)

Unit-III
Screening and selection for transformants- Hybridization techniques (Northern, Southern and Colony hybridization, Fluorescence *in situ* hybridization). Construction of libraries- Isolation of mRNA and total RNA, cDNA and genomic libraries. Analysis of DNA-Protein Interactions- Yeast- two hybrid system, S1 Mapping, DNaSel footprinting, DNA methylation and Methyl interference assay

Unit-IV
Expression of foreign gene in *E.coli*, Baculovirus, mammalian cell and plant. Principles in maximizing gene expression: Codon optimization, codon biasing, phase
display.
Gene Therapy- gene augmentation, gene editing, gene knockout technology. Somatic
and germ-line therapy- in vivo and ex vivo therapy.
Mutagenesis: PCR based mutagenesis, site - directed mutagenesis and cassette
mutagenesis

| Unit-V | PCR- Primer design, fidelity of thermo-stable enzymes, proof reading enzymes.
 | Types of PCR- LA- PCR, nested, RT - PCR, real time PCR.
 | PCR in gene recombination: Deletion, recombination, addition. PCR in molecular
diagnostics and detection of diseases; Handling biohazardous materials |

**Suggested Readings:**

Blackwell publishing, UK.
of DNA Technology*, 3rd edn, Wiley-Blackwell publishing, UK
DC.
Blackwell Science, USA.
New Delhi.

**PRACTICALS II: MSBT 222**

**SUGGESTED LABORATORY EXERCISES:**

1. Plasmid DNA isolation from bacteria.
2. Quantitative estimation of plasmid isolated from bacteria.
3. Restriction and digestion of lambda phage DNA (kit based)
4. DNA ligation of restricted lambda DNA (kit based)
5. Purification of DNA from electrophoresed gel.
6. Preparation of competent cells of bacteria (kit based)
7. Transformation of *E. coli* cells with standard plasmids (kit based)
9. Amplification of nucleic acid through polymerase chain reaction (demonstration).
10. Construction of restriction map of the plasmid pBR322.
11. Isolation of the gene (neomycin phosphotransferase) from the plasmid pUC7
KAPA (kit based)
12. Cloning of the Bam HI fragment containing the neomycin phosphotransferase
gene into the Bam HI site of pUC19 B/W screening (kit based)
13. DNA sequencing from the given data / photograph by Sanger’s / Maxam
Gilbert’s method.
14. Determination of the effect of different concentrations of agarose on banding
pattern of DNA

**SPOTS:**

1. DNA Fingerprinting
2. Human Genome Project
3. Central Dogma of Life
4. α- Helix

*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
<table>
<thead>
<tr>
<th>5.</th>
<th>2-D PAGE</th>
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<tbody>
<tr>
<td>6.</td>
<td>Microarray</td>
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<td>7.</td>
<td>DNA Ligation</td>
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<td>8.</td>
<td>A. Kornberg</td>
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<td>9.</td>
<td>Cosmid</td>
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<td>10.</td>
<td>Southern Blotting</td>
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<td>11.</td>
<td>c-DNA Library</td>
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<td>12.</td>
<td>Gene Knockout Technology</td>
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<td>13.</td>
<td>PCR</td>
</tr>
<tr>
<td>14.</td>
<td>Microinjection</td>
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</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - II
M.Sc. BIOTECHNOLOGY
SEMESTER- II
MSBT: 222 (Covering paper MSBT 214 and 215)

Time: 6 hours

Max. Marks: 80

1. Perform the given Genomics and Proteomics Experiment 25

2. Perform the given Genetic Engineering Experiment 25

3. Spots (Identify and comment upon the spots from ‘a’ to ‘e’) 5x 4= 20
   a. _______________________________
   b. _______________________________
   c. _______________________________
   d. _______________________________
   e. _______________________________

Viva-voce 10
### MSBT 311: ENVIRONMENTAL BIOTECHNOLOGY

**Unit-I**
Environmental pollutions: Basic concepts and types (air, water, soil). Types of pollutants (inorganic and organic); impact of pollutants on ecosystem. Methods to measure the pollutants. Global warming and Climate change: introduction and current perspectives. Concept of anthropocene. Xenobiotics: Persistence and biomagnification of xenobiotic molecules.

**Unit-II**
Concept of clean and green technology. Bioremediation: *in situ* and *ex situ* bioremediation; Evaluating Bioremediation: Bioremediation of volatile organic compounds (VOCs). Biodegradation of agricultural chemicals; Factors affecting process of biodegradation; Methods in determining biodegradability. Contaminant availability for biodegradation

**Unit-III**
Basic aspects of solid waste management, Aerobic and anaerobic treatments of solid wastes; Comparison of aerobic and anaerobic methods; Composting; Vermiculture; Biogas generation; Treatment of hazardous wastes and effluent treatment

**Unit-IV**
GM microorganisms and their impact on environment. Oil recovery bacteria; hydrocarbon transforming bacteria; Phosphate solubilization; Biofertilizers; Biological control of insect pests; Role of biopesticides/ insecticides; Biocontrol of plant pathogens

**Unit-V**
Need for management of resources; Role of biotechnology in the management of bioresources. Reclamation of wasteland, integrated waste management. Organic farming: Basic concepts and utilities in dry land farming

**Suggested Readings:**

### MSBT 312: IPR, BIOSAFETY AND BIOETHICS

**Unit-I**

**Unit-II**
Agreements and Treaties: History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act. ; TIFAC and its role in India

**Unit-III**
Biosafety: Introduction; biosafety issues in biotechnology-historical background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels, Biomedical waste management. Biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations of Government of India

**Unit-IV**
Roles of Institutional Biosafety Committee : RCGM, GEAC, Definition of GMOs; applications of GMO in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol, Biopiracy

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*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
### Suggested Readings:


### MSBT 313: BIOPROCESS ENGINEERING AND TECHNOLOGY

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Unit-I</td>
<td>Introduction to bioprocess engineering and technology, Material balance in biological systems, energy balance in biological system, kinetics of cell growth and death. Batch, fed-batch and continuous cultures (definition and kinetics). Product formation kinetics, heat transfer and mass transfer. Measurement and control of bioprocess parameter: Feedback control, controller characteristics. Cell as a factory, Cell cytotoxicity</td>
</tr>
<tr>
<td>Unit-II</td>
<td>Concepts of basic mode of fermentation processes; Bioreactor designs; Types of fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media. Upstream processing: Media formulation; Sterilization. Measurement and control of bioprocess parameters</td>
</tr>
<tr>
<td>Unit-III</td>
<td>Downstream processing: Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging</td>
</tr>
<tr>
<td>Unit-IV</td>
<td>Applications of enzymes in food processing: Mechanism of enzyme function and reactions in process techniques; Enzymatic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. and their downstream processing</td>
</tr>
<tr>
<td>Unit-V</td>
<td>Applications of Microbes in food processing and Pharmaceutical products; Food</td>
</tr>
</tbody>
</table>

*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
ingredients and additives prepared by fermentation and their purification; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Biofuels. Bacteriocins from lactic acid bacteria – Microbial products - Antibiotics (penicillin, streptomycin, tetracycline), vitamins, pre- and probiotics; Biotech industries in India

Suggested Readings:

<table>
<thead>
<tr>
<th>SUGGESTED LABORATORY EXERCISES:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quantification of filterable solid wastes.</td>
</tr>
<tr>
<td>2. Water quality assessment for polluted waterbodies:</td>
</tr>
<tr>
<td>a. Physical- colour, pH and conductivity.</td>
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<tr>
<td>b. Chemical- nitrate, chloride, Dissolved oxygen, Chemical oxygen demand and alkalinity.</td>
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<tr>
<td>3. Quantification of inorganic ions (sodium, potassium and calcium) in water sample using flame photometer.</td>
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<td>4. Designing of bioreactor prototype.</td>
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<td>5. Studying cell death and cytotoxicity by staining methods</td>
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<td>6. Studying the synthesis of alcohol by molasses.</td>
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<td>7. Studying cell immobilization and the growth of immobilized cell.</td>
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<td>8. Simple staining, differential staining.</td>
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<td>9. Differentiation of the viable and nonviable cell by staining methods.</td>
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<tr>
<td>10. Studying the pure and mixed cell culture of plant/animal/microbial cell by staining method.</td>
</tr>
<tr>
<td>12. Process of patenting in India; Filing of patent.</td>
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<table>
<thead>
<tr>
<th>SPOTS:</th>
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</thead>
<tbody>
<tr>
<td>1. Trickling Filter</td>
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<tr>
<td>2. Fermenter</td>
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<td>3. Effluenet Treatment</td>
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<tr>
<td>4. Flocculation</td>
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<tr>
<td>5. Reverse Osmosis</td>
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<td>6. Ultrafiltration</td>
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<tr>
<td>7. Vermiculture</td>
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<tr>
<td>8. Bio- Leaching</td>
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<tr>
<td>9. Biofertilizer</td>
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<tr>
<td>10. GATT</td>
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<tr>
<td>11. Patent</td>
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<tr>
<td>12. Biosafety Levels</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>13.</td>
<td>Genetically Modified Organism</td>
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<td>14.</td>
<td>Bioweapons</td>
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<td>15.</td>
<td>Probiotics</td>
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<td>16.</td>
<td>Bacteriocins</td>
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<td>17.</td>
<td>Alcoholic Beverages</td>
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<td>18.</td>
<td>Downstream Processing</td>
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<tr>
<td>19.</td>
<td>High Fructose Corn Syrup</td>
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<td>20.</td>
<td>VAM</td>
</tr>
<tr>
<td>21.</td>
<td>Gene Therapy</td>
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</table>
LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN

PRACTICAL EXAMINATION - I

M.Sc. BIOTECHNOLOGY
SEMESTER- III
MSBT: 321 (Covering Papers MSBT 311,312,313)

Time: 6 hours
Max. Marks: 80

1 Perform the given Environmental Biotechnology Exercise 15

2 Perform/Demonstrate /Comment on IPR related Exercise 15

3 Perform/ Demonstrate the given Industrial Biotechnology Exercise 15

4 Spots (Identify and comment upon spots ‘a’ to ‘e’)
   a. __________________________
   b. __________________________
   c. __________________________
   d. __________________________
   e. __________________________
   5x 5= 25

5 Viva-voce 10
| Unit-III | Germplasm conservation and cryopreservation: Importance, methods of conservation; \textit{In situ} and \textit{ex situ} conservation; \textit{In vitro} conservation, cryopreservation technique – importance of cryopreservation, pretreatment, freezing methods, cryoprotectants, vitrification. Protoplast Culture: Isolation, purification and regeneration of protoplast; Testing of viability of isolated protoplast; Somatic hybridization and methods of protoplast fusion; Selection of hybrids, Practical applications of somatic hybridization (hybrids/cybrids) |
| Unit-IV | Plant Transformation Technology: Features of Ti and Ri plasmid; The basis of tumour formation, mechanisms of DNA transfer, role of virulence genes; Vectors engineered from Ti plasmid; Use of 35S and other promoters; Methods of nuclear transformation Direct DNA transfer: particle bombardment, electroporation, microinjection; Transgene stability and gene silencing |
| Unit-V | Application of plant transformation for productivity and performance: herbicide resistance, insect resistance with special reference to Bt genes, virus resistance, Use of antisense technology to prevent post-harvest losses and prolonging shelf-life of fruits and flowers, Production of vaccines/plantibodies in GM plants, Terminator gene technology, Transplastomics, cis-genics, Application of genome editing |

\textit{Suggested Readings:}


\textit{2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)}
### MSBT 315: ANIMAL CELL CULTURE AND APPLICATIONS

#### Unit-I
- Concept of stem cell, totipotency, pluripotency and induced pluripotency. Epigenetics and stem cell

#### Unit-II
- Biology of cultured cells: the culture environment, cell adhesion, cell proliferation.
- Primary culture: primary explant, isolation of the tissue. Cell line: nomenclature, subculture and propagation, immortalization of cell lines, cell line designations.
- Maintenance of cell culture: cell morphology, replacement of medium, surface area, holding medium and use of antibiotics.
- Methods for measurement of growth: cell quantification, biochemical determinations, viability assay

#### Unit-III
- Organotypic culture: introduction, types- organ and histotypic culture, applications.
- Scaling-up of animal cell culture: scale-up in suspension and scale-up in monolayer

#### Unit-IV
- Cell transformation: introduction, properties and causative factors-genetic instability, immortalization, aberrant growth control and tumorigenicity.
- Three dimensional culture: introduction, multicellular tumour spheroids (MCTS) monoculture.
- Tissue engineering: introduction and examples (skin, urothelium and peripheral nerve implants).
- Safety measures, hazards and ethics of animal cell culture

#### Unit-V
- Applications of animal cell culture: Cell culture based vaccines, Production of special secondary metabolites/ products (insulin, somatotropin, interferon, tPA, factor VIII etc.), Growth factors for promoting proliferation of animal cells (EGF, FGF, PDGF, IL-1, IL-2, NGF, erythropoietin), Transgenic animals: importance and applications

### Suggested Readings:

### MSBT 322: PRACTICALS

#### SUGGESTED LABORATORY EXERCISES:
1. Preparation of stock solutions of MS medium.
2. Preparation of MS medium from stock solutions.
3. Harvesting, preparation, surface sterilization and inoculation of different explants.
4. Effect of auxins and cytokinins on callus growth and organogenesis.
5. Effect of auxins and cytokinins on shoot multiplication.
7. Differentiation of tissues through organogenesis/somatic embryogenesis.
8. Experiments on *in vitro* and *ex vitro* rooting.

*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
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<tbody>
<tr>
<td>11.</td>
<td>Demonstration of anther culture of <em>Datura</em>.</td>
</tr>
<tr>
<td>12.</td>
<td>Preparation of tissue culture media and concept of sterilization in animal cell culture.</td>
</tr>
</tbody>
</table>

**SPOTS:**
1. Gottlieb Haberlandt
2. Multiple Shoot Proliferation
3. Somatic Embryogenesis
4. Cryopreservation
5. *Agrobacterium tumefaciens*
6. Electroporation
7. Gene Silencing
8. Primary Culture
9. Cell Cytotoxicity
10. Batch Culture
11. Continuous Culture
12. Serum Free Media
13. Growth Kinetics
14. Vaccine
LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - II
M.Sc. BIOTECHNOLOGY
SEMESTER- III
MSBT: 322 (Covering paper MSBT 314 and 315)

Time: 6 hours

Max. Marks: 80

1. Perform the given Experiment (Plant Biotechnology) 25

2. Perform the given Experiment (Animal Cell Culture) 25

3. Spots (Identify and comment upon the spots from ‘a’ to ‘e’)
   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________
   e. ______________________________

   5x 4 = 20

Viva-voce 10

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
ACADEMIC REGULATIONS FOR MSBT411: DISSERTATION

1. For the MSBT 411 paper, the student shall carry out a **minimum of three months** of research work in a research laboratory of any Institute/Organisation/University.

2. After the completion of the work, the student shall **submit 2 copies** of the Dissertation report (type written and hard bound) on or before the prescribed date.

3. The Dissertation report shall bear a certificate from the supervisor certifying that:
   
   (i) **The work has been undertaken and completed under his/her supervision and guidance and meets the requirements of the course**;
   
   (ii) **The Dissertation is a bonafide record of the original work carried out by the candidate and the Dissertation work has not formed the basis of award of any other degree of this or any other University**;

4. **Marks (out of 100)** for the Dissertation report shall be awarded on the basis of Dissertation report, presentation and viva-voce by a board consisting of internal examiner(Mentor), external examiner and the HOD. The HOD shall also be the chairperson of the board.

5. No student will be eligible for submitting the Dissertation report unless he/she has passed in all the papers of SEM-I, SEM-II and SEM-III.

6. A student who fails in M.Sc. IV – SEM end examination, shall be furnished by the Board with a clear statement of reasons for failure and suggestions for improvement. The candidate shall revise and resubmit the Dissertation report after incorporating suggestions made by the board. Such a student will have to reappear for the subsequent semester end examination of M.Sc. IV- SEM.
# M.SC. (PREVIOUS) I SEMESTER
## CHEMISTRY
### 2016-17

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
<th>PD/W</th>
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<th>EXAM</th>
<th>CIA</th>
<th>ESE</th>
<th>TOTAL</th>
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<tbody>
<tr>
<td>MSCH111</td>
<td>GROUP THEORY &amp; CHEMICAL BONDING</td>
<td>6</td>
<td>90</td>
<td>3 hrs.</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSCH112</td>
<td>ORGANIC CHEMISTRY-I</td>
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<td>100</td>
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<tr>
<td>MSCH113</td>
<td>PHYSICAL CHEMISTRY-I</td>
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<td>100</td>
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<tr>
<td>MSCH114</td>
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<td>MSCH121</td>
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<td>15</td>
<td>60</td>
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<td>75</td>
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<tr>
<td>MSCH122</td>
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<td>MSCH123</td>
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<td>60</td>
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(CIA I & II in each lab course will be of 7.5 Marks & II CIA will be a Seminar)

## Grand Total
625

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**MSCH111- GROUP THEORY & CHEMICAL BONDING**

**Unit 1: Molecular Symmetry and Symmetry Groups:**
- **Definition and Theorems of Group Theory:** Defining properties of Group, subgroup and classes; group multiplication tables.
- **Molecular Point Groups:** Identification of molecular point groups, molecules of low, high & special symmetry, molecules containing multiple higher order axes, Schonflies symbols, systematic assignment of point groups. Descent in symmetry with substitution.

18 Periods

**Unit 2: Matrix Methods in Symmetry**
- Introduction to matrices, types of matrices, equal matrices, matrix mathematics, block factorization of large matrices, transformation matrices.
- Representations of groups by matrices (representation for the $C_{nv}, C_{nv}, C_{nh}, D_{nh}$ etc. groups to be worked out explicitly). Reducible and irreducible representations, Character of a representation. Great Orthogonality Theorem (without Proof) and its Importance. Construction of character tables, character tables of $C_{2v}, C_{3v}$ and $C_{4v}$ point groups, Mulliken symbols for IRs and structure of character table. Standard reduction formula for reduction of reducible representation, direct products.

18 Periods

**Unit 3: Symmetry and Chemical bonding:**
- Orbital symmetries & overlap, hybridisation scheme in Linear, trigonalplanar, tetrahedral, squarepyramidal & trigonal pyramidal; molecules with $\pi$ bonding as in trigonal planar, tetrahedral, octahedral& benzene

18 Periods

**Unit 4: Stereochemistry and bonding in main group compounds**
- VSEPR, Walsh Diagrams of tri, tetra and penta atomic molecules, $d\pi-p\pi$ bonds, Bent’s rule and energetics of hybridization, some simple reactions of covalently bonded molecules: atomic inversion, berry pseudorotation, substitution reactions and free radical reactions.

18 Periods

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2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
### Unit 5: Metal Ligand Bonding

- Limitations of crystal field theory, molecular orbital theory: octahedral, tetrahedral and square planar complexes, π-bonding and molecular orbital theory, explanation of position of the ligands in spectrochemical series using MOT, comparison with CFT.

#### Suggested Readings:
3. Inorganic Chemistry, Shriver and Atkins, Oxford University Press.

### MSCH112: ORGANIC CHEMISTRY

<table>
<thead>
<tr>
<th>Unit</th>
<th>Nature of bonding in Organic Molecules:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Delocalized chemical bonding:</strong> Conjugation, cross conjugation, resonance hyperconjugation, bonding in fullerenes, tautomerism. <strong>Aromaticity in benzenoid and non-benzenoid compounds:</strong> Alternant and non-alternant hydrocarbons, Huckel's rule, energy level of π-molecular orbitals, annulenes, aromaticity, homoaromaticity, (PMO approach). Bonds weaker than covalent bonds: addition compounds, crown ether complexes and cryptand, inclusion compounds, cyclodextrins and rotaxanes.</td>
</tr>
<tr>
<td>2</td>
<td><strong>Stereohemistry I:</strong> Conformational analysis: Cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, and steric strain due to unavoidable crowding. Stereohemistry of the compounds containing nitrogen, sulphur and phosphorus.</td>
</tr>
<tr>
<td>3</td>
<td><strong>Stereohemistry II:</strong> Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, sterospecific and stereoselective synthesis, Asymmetric synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape.</td>
</tr>
<tr>
<td>4</td>
<td><strong>Reaction Mechanism:</strong> Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, Kinetic and thermodynamic control. Hammond's postulate, Curtin-Hammett principal, Potential energy diagrams, transition states and intermediates, methods of determining mechanism, isotope effects, Hard and soft acids and bases, Generation, structure, stability and reactivity of carbocations, carbonions, free radicals, carbenes and nitrenes, Effects of structure on reactivity resonance and field effects, steric effect, quantitative treatment, The hammett equation and linear free energy relationship, substituent and reaction constants: Taft equation.</td>
</tr>
<tr>
<td>5</td>
<td><strong>Pericyclic Reactions:</strong> Molecular orbital symmetry, frontier orbitals of ethylene, 1, 3-butadiene, 1, 3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward Hoffman correlation diagrams, FMO and PMO approach.</td>
</tr>
</tbody>
</table>

*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
**Electrocyclic Reactions:** Conrotatory and disrotatory motions, 4n, 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions.

**Sigmatropic Rearrangements:** Suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 3, 3 and 5, 5 sigmatropic shifts. Rearrangements, Claisen, Cope and aza-cope rearrangements. Fluxional tautomerism, ene reaction.

**Suggested Readings:**


**MSCH113-PHYSICAL CHEMISTRY**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Chemical Dynamics:</th>
<th>18 Periods</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Unit 2</th>
<th>Catalysis:</th>
<th>18 Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Homogeneous and heterogeneous catalysis, kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by flow method, relaxation method and flash photolysis method, NMR method. Dynamics of molecular motions, probing the transition state, dynamics of barrier less chemical reactions in solution, dynamics of unimolecular reaction, Lindemann, Hinshelwood, RRK and RRKM theories of unimolecular reactions.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 3</th>
<th>Adsorption:</th>
<th>18 Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation) Gibbs adsorption isotherm. Estimation of surface area (BET equation), surface films on liquids, Electro- Kinetic phenomenon and quantitative treatment of Zeta potential.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Micelles:</strong> Surface active agents, Classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentrations (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, pseudophase model of micelles catalysis(proximity effect).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 4</th>
<th>Macromolecules:</th>
<th>18 Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Polymer: Definition types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetic of polymerization, mechanism of polymerization. Molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry, diffusion and light scattering methods)</td>
<td></td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
sedimentation, chain configuration of macromolecules, calculation of average dimensions of various chain structures.

<table>
<thead>
<tr>
<th>Unit 5</th>
<th>Electrochemistry:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18 Periods</td>
</tr>
</tbody>
</table>

Suggested Readings:

1. Physical chemistry, P.W. Atkins, ELBS.
2. Chemical Kinetics, K.J. Laidler, Megraw-Hill.

<table>
<thead>
<tr>
<th>MSCH114: ANALYTICAL CHEMISTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit 1</strong> Fundamentals of Chemical Analysis:</td>
</tr>
<tr>
<td>Classification of analytical method, significance, Sensitivity and Selectivity of Analytical methods, Sampling, Accuracy &amp; precision, Errors: types of errors, error distribution curve, avoid, standard Deviation; Calibration curve and Correlation Coefficient; linear regression; student ‘t’ test, Analysis of Variance (ANOVA). good lab practices.</td>
</tr>
<tr>
<td>18 Periods</td>
</tr>
<tr>
<td><strong>Unit 2</strong> IPR, QA and QC</td>
</tr>
<tr>
<td>Intellectual property rights need and economic importance of IPR, introduction to various IP Properties (Patents, Trademarks, Copyrights, Geographical Indications,) R and D and technology transfer, quality control, quality assurance. International standards, government standards.</td>
</tr>
<tr>
<td>18 Periods</td>
</tr>
<tr>
<td><strong>Unit 3</strong> Chromatography-I</td>
</tr>
<tr>
<td>Chromatography: General introduction, principles and types of chromatography, mechanism of separation and techniques involved. Paper Chromatography: Principle, types, choice of paper and solvent, location of spot, development, visualization, measurement of Rf values, applications.</td>
</tr>
<tr>
<td>18 Periods</td>
</tr>
<tr>
<td>Ion exchange chromatography: principle, experimental methodology, classification of ion exchange resin, features, action of ion exchange reactions, factors affecting the selectivity of ion exchange resin, ion exchange capacity and its applications. Super critical fluid chromatography, gel filtration and gel permeation techniques</td>
</tr>
<tr>
<td><strong>Unit 4</strong> Chromatography-II</td>
</tr>
<tr>
<td>18 Periods</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
<table>
<thead>
<tr>
<th>Unit 5</th>
<th>Spectroscopic Techniques:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HPLC: Theory, General layout of equipment, detectors and applications.</td>
</tr>
<tr>
<td></td>
<td>HPTLC principle advantage over TLC, mobile and stationary Phase</td>
</tr>
<tr>
<td></td>
<td>Gas chromatography: Theory, General layout of equipment, detectors and applications.</td>
</tr>
<tr>
<td></td>
<td>Spectrophotometer- Principle, instrumentation</td>
</tr>
<tr>
<td></td>
<td>Flame Photometry, Atomic Absorption Spectroscopy (AAS) -Principal, General layout of instrument and applications.</td>
</tr>
<tr>
<td></td>
<td>Fluorescence Spectroscopy: Principle, Fluorescence, Phosphorescence basic Instrumentation and their applications.</td>
</tr>
<tr>
<td></td>
<td>Chemiluminiscence</td>
</tr>
<tr>
<td></td>
<td>Nephelometry and Turbidometry: Principle, instrumentation and applications.</td>
</tr>
<tr>
<td></td>
<td>18 Periods</td>
</tr>
</tbody>
</table>

**Suggested Readings:**


**MSCH114-ANALYTICAL CHEMISTRY - I**

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Fundamentals of Chemical Analysis:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>History, basic, classification of analytical method, significance, Sensitivity and Selectivity of Analytical methods, Sampling, Accuracy &amp; precision, Errors: types of errors, error distribution curve, avoid, standard Deviation; Calibration curve and Correlation Coefficient; linear regression; student ‘t’ test, Analysis of Variance (ANOVA).</td>
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<tr>
<td></td>
<td>18 Periods</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 2</th>
<th>Separation technique:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solvent extraction- Principle, methodology and applications, Synergistic extraction: determination of nickel, crown ether for ion association complex. Organic regents like dithiol, diketones, oxinedithizone, cuproin, cupferron, dimethylglyoxime and dithiocarbamates in solvent extraction and electrophoresis</td>
</tr>
<tr>
<td></td>
<td>18 Periods</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 3</th>
<th>Chromatography:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Classification of the basis of phenomenon and solid and liquid phase, ion exchange</td>
</tr>
<tr>
<td></td>
<td>18 Periods</td>
</tr>
</tbody>
</table>

*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
chromatography: principle, experimental methodology, classification of ion exchange resin, features, action of ion exchange reactions, factors affecting the selectivity of ion exchange resin, ion exchange capacity and its applications. Super critical fluid chromatography, gel filtration and gel permeation techniques

<table>
<thead>
<tr>
<th>Unit 4</th>
<th>Thermal analysis:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TGA, DSC (differential scanning calorimetry), DTA (differential thermal analysis): principle, methodology and application</td>
<td></td>
</tr>
<tr>
<td>Inductively Coupled Plasma Emission Spectroscopy (ICPES): Theory, instrumentation and applications</td>
<td></td>
</tr>
<tr>
<td>Photoacoustic Spectroscopy (PAS): Theory, instrumentation and applications</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 5</th>
<th>Spectroscopic Techniques:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal, General layout of instrument and applications of Flame Photometry, Atomic Absorption Spectroscopy (AAS)</td>
<td></td>
</tr>
<tr>
<td>Fluorescence Spectroscopy: Principle, Fluorescence, Phosphorescence and Chemiluminescence, basic Instrumentation and their applications.</td>
<td></td>
</tr>
<tr>
<td>Nephelometry and Turbidometry: Principle, instrumentation and applications.</td>
<td></td>
</tr>
</tbody>
</table>

### Suggested Readings:


### MSCH121-LABORATORY COURSE-I: INORGANIC CHEMISTRY

#### Qualitative Analysis

Qualitative estimation of the inorganic mixture for six radicals including interfering acid radicals, their combinations and insoluble oxides, sulphates and halides.

#### Chromatography

Separation of cations and anions by circular Paper Chromatography.

#### Preparations

a. Potassium Nitrate
b. Ammonium copper sulphate
c. Potassium Copper Sulphate
d. Copper oxide

Cupric sulphate

### MSCH122: LABORATORY COURSE II: ORGANIC CHEMISTRY

#### Quantitative Analysis

a. Determination of the percentage or number of hydroxyl group in an organic compound by acetylation method.
b. Estimation of amines/phenols using bromate bromide solution/or acetylation method.
c. Determination of Iodine and Saponification values of an oil sample.
d. Estimation of Vitamin C by iodometry.
e. Estimation of glucose by Benedict’s solution titration.
f. Estimation of formaldehyde by iodometry.

#### Chromatographic Separation

Separation and identification of the sugars and amino acids present in the given mixture by paper chromatography and determination of their Rf values.
Suggested Readings:

<table>
<thead>
<tr>
<th>MSCH123: LABORATORY COURSE III: PHYSICAL CHEMISTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Chemical Kinetics</strong></td>
</tr>
<tr>
<td>a. To compare the strengths of HCl and H₂SO₄ by studying the kinetics of hydrolysis of an ester.</td>
</tr>
<tr>
<td>b. Determination of the effect of (a) Change of temperature (b) Change of concentration of reactant and catalyst and (c) Ionic strength of the media on the velocity constant of an acid hydrolysis of an ester.</td>
</tr>
<tr>
<td>c. Determination of the velocity constant of hydrolysis of an ester/ionic reaction in micellar media.</td>
</tr>
<tr>
<td>d. Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide by studying the kinetics as an iodine clock reaction.</td>
</tr>
<tr>
<td>e. To study the effect of acid strength on the reaction of acetone and iodine.</td>
</tr>
<tr>
<td><strong>II. Colorimeter</strong></td>
</tr>
<tr>
<td>a. To test the validity of Beer-Lambert law using colorimeter/ spectrophotometer and determination of the unknown concentration of a solution.</td>
</tr>
<tr>
<td>b. Spectrophotometric estimation of concentration of each component in binary mixture (KMnO₄ (K₂Cr₂O₇))</td>
</tr>
<tr>
<td><strong>III. Surface Tension</strong></td>
</tr>
<tr>
<td>c. To determine the parachor of carbon and hydrogen atoms by drop weight method.</td>
</tr>
<tr>
<td>d. To determine the relative efficiencies of different detergents by surface tension measurements.</td>
</tr>
</tbody>
</table>

Book Suggested:
1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Levitt, Longman.
M.S.C. (PREVIOUS) II SEMESTER
CHEMISTRY
2016-17

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
<th>PD/W</th>
<th>PD/W</th>
<th>EXAM</th>
<th>CIA</th>
<th>ESE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSCH211</td>
<td>COORDINATION CHEMISTRY</td>
<td>6</td>
<td>90</td>
<td>3 hrs.</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSCH212</td>
<td>ORGANIC CHEMISTRY-II</td>
<td>6</td>
<td>90</td>
<td>3 hrs.</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSCH213</td>
<td>PHYSICAL CHEMISTRY-II</td>
<td>6</td>
<td>90</td>
<td>3 hrs.</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSCH214</td>
<td>PRINCIPLES OF SPECTROSCOPY</td>
<td>6</td>
<td>90</td>
<td>3 hrs.</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSCH221</td>
<td>LABORATORY COURSE IV: INORGANIC CHEMISTRY</td>
<td>08</td>
<td></td>
<td>15</td>
<td>60</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>MSCH222</td>
<td>LABORATORY COURSE V: ORGANIC CHEMISTRY</td>
<td>08</td>
<td>18 hrs</td>
<td>15</td>
<td>60</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>MSCH223</td>
<td>LABORATORY COURSE VI: PHYSICAL CHEMISTRY</td>
<td>08</td>
<td></td>
<td>15</td>
<td>60</td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>

(CIA I & II in each lab course will be of 7.5 Marks & II CIA will be a Seminar)

Grand Total 625

**MSCH211-COORDINATION CHEMISTRY**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
<th>Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td><strong>Reaction mechanism of Transitions metal complexes</strong>&lt;br&gt;Energy profile of a reaction (transition state or activated complex) nucleophilic and electrophilic substitution, factors responsible for types of substitution reaction. Introductory classical reaction of Henry-Taube in octahedral complexes (inert and labile complexes), classification of mechanism of. Acid hydrolysis, factor affecting acid hydrolysis, base hydrolysis, conjugate base mechanism (S_N1CB) Evidences in favour of conjugate base mechanism, anation reactions, Substitution reaction without metal-ligand bond cleavage (Special reference to Co(III) complexes).</td>
<td>18 Periods</td>
</tr>
<tr>
<td>Unit 2</td>
<td><strong>Substitution in square planer complexes:</strong>&lt;br&gt;Trans effect, mechanism of substitution reaction, polarization theory and π bonding theory.&lt;br&gt;<strong>Redox reaction:</strong> Classification of mechanism of octahedral complexes (inner and outer sphere reaction; adjacent attack, remote attack. and bridged outer sphere reaction). Electron transfer reaction, mechanism of one electron transfer reaction: outer sphere reaction, Inner sphere reaction, bridge intermediate mechanism.</td>
<td>18 Periods</td>
</tr>
<tr>
<td>Unit 3</td>
<td><strong>Isomerisation and RacemisationReactions:</strong>&lt;br&gt;Linkage isomerization, geometrical isomerization in square planar and octahedral complexes, racemisation: inter and intramolecular mechanism, isomerisation and racemisation of tris chelates of unsymmetrical chelating ligands, structural changes in complexes containing terdentate ligands, optical isomerisation on tetrahedral complexes and configurational changes in some planar complexes</td>
<td>18 Periods</td>
</tr>
<tr>
<td>Unit 4</td>
<td><strong>Electronic spectra of Transition Metal Complexes</strong>&lt;br&gt;Spectroscopic ground states term, correlation, Orgel and Tanabe sugano diagrams for transition metal complexes (d^1 to d^9 states) and calculation of Dq, B and β parameters</td>
<td>18 Periods</td>
</tr>
<tr>
<td>Unit 5</td>
<td><strong>Charge Transfer Spectra</strong>&lt;br&gt;General Introduction to charge transfer spectra and types of spectra. Ligand to metal and metal to ligand charge transfer spectra of transition metal complexes.</td>
<td>18 Periods</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
| Magnetic Properties of Transition Metal Complexes: | Anomalous magnetic moments, magnetic exchange coupling and spin crossover. | ORD and CD: | Introduction, assignment of absolute configuration in optically active metal chelates and their configuration |

Suggested Readings:

**MSCH212-ORGANIC CHEMISTRY**

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Aliphatic Nucleophilic Substitution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The S_N2, S_N1, mixed S_N1 and S_N2 and SET mechanisms.</td>
</tr>
<tr>
<td></td>
<td>The neighbouring group mechanism, neighbouring group participation by π and σ bonds, anichimeric assistance.</td>
</tr>
<tr>
<td></td>
<td>Classical and nonclassical carbocations, phenonium ions, norbornyl system.</td>
</tr>
<tr>
<td></td>
<td>The SNi mechanism.</td>
</tr>
<tr>
<td></td>
<td>Nucleophilic substitution at an allylic, aliphatic trigonal and a vinlyic carbon.</td>
</tr>
<tr>
<td></td>
<td>Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioelectivity.</td>
</tr>
<tr>
<td></td>
<td><strong>Aliphatic Electrophilic Substitution</strong></td>
</tr>
<tr>
<td></td>
<td>Bimolecular mechanisms- S_E2. The S_E1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 2</th>
<th>Aromatic Electrophilic Substitution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The arenium ion mechanism, orientation and reactivity, energy profile diagrams.</td>
</tr>
<tr>
<td></td>
<td>The ortho/para ratio, ipso attack, orientation in mono and substituted ring systems. Quantitative treatment of reactivity in substrates and electrophiles.</td>
</tr>
<tr>
<td></td>
<td>Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction.</td>
</tr>
<tr>
<td></td>
<td><strong>Aromatic Nucleophilic Substitution</strong>: The SNAr SN1 benzylene and SRN1 mechanisms. Reactivity effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 3</th>
<th>Free Radical, Reactions:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance.</td>
</tr>
<tr>
<td></td>
<td>Reactivity for aliphatic and aromatic substrates. Reactivity in the attacking radicals. The effect of solvents on reactivity.</td>
</tr>
<tr>
<td></td>
<td>Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkenes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction and Hunsdiecker reaction.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 4</th>
<th>Addition to Carbon-Carbon Multiple Bonds:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Addition to Carbon-Hetero Multiple Bonds</td>
</tr>
</tbody>
</table>
Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitrites. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction.
Mechanism of condensation reactions involving enolates Aldol, Knoevenagel, Claisen, Mannish, Benzoin, Perkin and Stobbe reactions.
Hydrolysis of esters and amides, ammonolysis of esters

**Unit 5**

Elimination Reactions:
The E1, E2 and E1cB mechanisms and their spectrum, stereochemistry of E1 and E2 reactions and elimination from cyclic compounds, Orientation of the double bond. Reactivity effects of substrate structures, attacking base, the leaving group and the medium.
Mechanism and orientation in pyrolytic elimination.

**Suggested Readings:**

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Quantum Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction to Exact Quantum Mechanical Results:</strong> The Schrodinger equation and the postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz., particle in 1 and 3-dimensional box, the harmonic oscillator, the hydrogen atom.</td>
<td></td>
</tr>
<tr>
<td>18 Periods</td>
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</table>

<table>
<thead>
<tr>
<th>Unit 2</th>
<th>Quantum Chemistry</th>
</tr>
</thead>
</table>
| **Electronic Structure of Atoms:** Russell-Saunders terms and coupling schemes, spectral terms for p^n configurations and d^n configurations.
**Magnetic effects:** Perturbation theory Normal and anomalous Zeeman effects and Stark effect.
**Molecular Orbital Theory:** Huckel molecular orbital (HMO) theory of linear conjugated systems, bond order and charge density calculations. Applications of HMO to ethylene, allyl, butadiene and cyclobutadiene system. |
| 18 Periods |

<table>
<thead>
<tr>
<th>Unit 3</th>
<th>Classical Thermodynamics</th>
</tr>
</thead>
</table>
| **Partial molal properties:** Partial molar free energy - chemical potential, partial molal volume and partial molal heat content. Gibbs Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for ideal gas. 
Thermodynamic derivation of law of mass action. Concept of fugacity and determination of fugacity. Thermodynamic derivation of phase rule, application of phase rule to three component systems |
| 18 Periods |

<table>
<thead>
<tr>
<th>Unit 4</th>
<th>Statistical Thermodynamics</th>
</tr>
</thead>
</table>
| **Concepts of phase space, microstate and macrostate, Ensemble averaging, Canonical, grand canonical and microcanonical ensembles, Maxwell-Boltzman distribution law (using Lagrange's method of undetermined multipliers). 
Partition functions translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition |
| 18 Periods |

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
functions- Energy, specific heat at constant volume and constant pressure, entropy, work function, pressure Gibb's free energy and chemical potential. Chemical equilibria and equilibrium constant in terms of partition functions, Fermi-Dirac statistics distribution law and Bose-Einstein statistics distribution law.

### Unit 5

**Non Equilibrium Thermodynamics**

Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (e.g. heat flow, chemical reaction etc.) transformations of the generalized fluxes and forces, non-equilibrium stationary states, phenomenological equations, microscopic reversibility and Onsager's reciprocity relations, electrokinetic phenomena, diffusion, electric conduction

<table>
<thead>
<tr>
<th>Suggested Readings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical Chemistry, P.W. Atkins, ELBS.</td>
</tr>
<tr>
<td>4. Coulson's Valence, R. McWeeny, ELBS.</td>
</tr>
<tr>
<td>7. Fundamentals of Chemical Thermodynamics, E.N. Yeremin, Mir Publishers</td>
</tr>
</tbody>
</table>

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**MSCH214-PRINCIPLES AND APPLICATIONS OF SPECTROSCOPY**

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Fundamental of Spectroscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Electromagnetic radiation, Born-Oppenheimer approximation, types of spectra, intensity of spectral lines, transition probability, transition moment, natural line width and natural line broadening and selection rules.</td>
</tr>
<tr>
<td></td>
<td><strong>Microwave Spectroscopy:</strong> Classification of molecules, rigid and non-rigid rotator model, effect of isotopic substitution on the transition frequencies and intensities, stark effect, nuclear and electron spin interaction and effect of external field and applications.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 2</th>
<th>Infrared Spectroscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Review of harmonic oscillator, vibrational energies of diatomic molecules, zero-point energy, force constant and bond strengths, normal modes of vibration, anharmonicity, overtones, hot bands, selection rules, group frequencies, Hook's law and calculation of frequencies for different types of bonds, factors affecting bond position and intensities and applications.</td>
</tr>
<tr>
<td></td>
<td><strong>Raman spectroscopy:</strong> Classical and quantum theories of Raman Effect, pure rotational, vibrational and vibrational rotational Raman spectra, selection rules, mutual exclusion principle and applications.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 3</th>
<th>Vibrational Spectroscopy of Polyatomic molecules</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Symmetry of normal modes of molecules, infra-red and Raman activity of: Bent AB₂ type molecules and comparision with other C₂v molecule like ZAB₂, ClF₃, cis-N₂F₂, cis-PtCl₂L₂, CH₂Cl₂, cis-ML₂X₄ and mer-ML₃X₃. AB₄ type molecules having tetrahedral, square planar, square pyramidal and see saw shape &amp; octahedral molecules.</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
Unit 4
Electron Spin Resonance Spectroscopy (ESR)
Basic Principle, ESR Instrumentation, hyperfine splitting, factors affecting the ‘g’ Value, Zero Field Splitting, Isotropic and Anisotropic Hyperfine Coupling Constants, Spin Hamiltonian, Spin Densities and applications.

Nuclear Quadrupole Resonance Spectroscopy (NQR)
Basic principle, effect of magnetic field on spectra, electric field gradient and molecular structure and applications.

Unit 5
Mossbauer Spectroscopy
Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structure of Fe$^{2+}$ and Fe$^{3+}$ compounds including those of intermediate spin (2) Sn$^{2+}$ and Sn$^{4+}$ compounds, nature of metal ligand bonding, coordination number, structure and (3) detection of oxidation state and inequivalent MB atoms.

Photoelectron Spectroscopy:

Auger electron spectroscopy: Auger electron ejection and its examples.

Suggested Readings:
5. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill Basic
8. Introduction to Photoelectron Spectroscopy, P.K. Ghosh, John Wiley
10. Fundamentals of Molecular spectroscopy, Collin and Benwell, Tata McGraw Hill.

MSCH221: LABORATORY COURSE IV: INORGANIC CHEMISTRY

I. Quantitative Analysis:
   a. Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Ag etc, involving volumetric and gravimetric methods.
   b. Estimation of three constituent in the given mixture (one gravimetrically and one volumetrically and one colorimeter).

II. Preparations
   a. Na$_3$[Fe(C$_2$O$_4$)$_3$]
   b. Prussian Blue( Fe$_4$[Fe(CN)$_6$])
   c. [Ni(NH$_3$)$_6$] Cl$_2$
   d. [Ni(dmg)$_2$]
   e. Potassium Chlorochromate
   f. Na$_3$[Co(NO$_2$_)$_2$]
   g. K$_3$[Cr(C$_2$O$_4$)$_3$].3H$_2$O
   h. Cis& Trans potassium diaquodioxalatochromate(III)
   i. Potassium trioxalatocromate(III).
   j. Cuprous tetraiodomercurate(II).
   k. Tetraamminecarbonatocobalt(III) nitrate.
   l. Pentaamminechloridocobalt(III) chloride.
   m. Tris(acetylacetonato)manganese(III) ion

III. Determination of stability constant and composition of complex by Job’s method. and mole method.
### MSCH222: LABORATORY COURSE V: ORGANIC CHEMISTRY

**Qualitative Analysis**
Separation, purification and identification of compounds in given binary mixture (one liquid and one solid and solid-solid mixture) separation using chemical methods as well.

**Organic Synthesis**
- Acetylation: Acetylation of glucose.
- Cannizzaro reaction: benzaldehyde as substrate.
- Aromatic electrophilic substitutions: Synthesis of p-nitroacetanilide and p-bromoacetamide.

**Suggested Readings:**
1. Practical Organic Chemistry, SP Bhutani & Aruna Chhikara, Ane Books India
2. Elementary Practical organic chemistry Part I & II, Arthur I Vogel, CBS
3. Advanced Practical Organic Chemistry, NK Vishnoi, Vikash Publication

### MSCH223: LABORATORY COURSE VI: PHYSICAL CHEMISTRY

**A. Adsorption**
1. To study surface tension concentration relationship for solutions (Gibbs equation) and hence determine the limiting cross-sectional area of molecule.
2. To study the adsorption of acetic acid/oxalic acid by activated charcoal and verification of Freundlich and Langmuir’s isotherms.

**B. Phase Equilibria**
1. Determination of congruent composition and temperature of a binary system (e.g. diphenylamine-benzophenone system).
2. Determination of glass transition temperature of a given salt (e.g. CaCl₂) by solubility method.
3. To construct the phase diagram for three component system (e.g. Chloroform-acetic acid-water)

**C. Electrochemistry/Conductometry**
1. To determine the strength of weak acid using NaOH conductometrically.
2. To determine the strength of strong and weak acids in a given mixture conductometrically.
3. To find out basicity of given acid (mono-di- and tribasic) conductometrically.

**D. Polarimetry/Refractometry**
1. To determine the specific rotation of a given optically active compound.
2. To verify the law of refraction of mixture (e.g. glycerol and water) using Abbe's refractometer

**Suggested Readings:**
1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman
2. Findley's Practical Physical Chemistry, BP Levitt, Longman
3. Experimental Physical Chemistry, RC Das and B Behera, Tata McGraw Hill
4. Experimental physical Chemistry by F. Daniel and others (International Student Edition)

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2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
## M.Sc. (Previous) III Semester
### Chemistry
2017-18

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<th>CIA</th>
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<tbody>
<tr>
<td>MSCH311</td>
<td>ORGANIC SPECTROSCOPY</td>
<td>6</td>
<td>90</td>
<td>3 hrs.</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSCH312</td>
<td>PHOTOCHEMISTRY (ORGANIC &amp; INORGANIC)</td>
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<td>90</td>
<td>3 hrs.</td>
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<tr>
<td>MSCH313</td>
<td>SOLID STATE, SURFACE CHEMISTRY &amp; CATALYSIS</td>
<td>6</td>
<td>90</td>
<td>3 hrs.</td>
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<td>100</td>
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<td>MSCH314</td>
<td>ORGANO TRANSITION METAL CHEMISTRY</td>
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<td>75</td>
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<tr>
<td>MSCH322</td>
<td>LABORATORY COURSE VIII: ORGANIC CHEMISTRY</td>
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<tr>
<td>MSCH323</td>
<td>LABORATORY COURSE IX: PHYSICAL CHEMISTRY</td>
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(CIA I & II in each lab course will be of 7.5 Marks & II CIA will be a Seminar)

Grand Total | 625

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### MSCH311: ORGANIC SPECTROSCOPY

#### Unit 1: Ultraviolet and Visible Spectroscopy
Various electronic transitions (185-800 nm), Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes Woodward- Fieser rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic, heterocyclic compounds and steric effect in biphenyl.

18 Periods

#### Unit 2: Mass Spectrometry
Introduction, ion production EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Molecular ion peak, metastable peak, Mc Lafferty rearrangement and Nitrogen rule. High resolution mass spectrometry .Mass spectral fragmentation of organic compounds containing common functional groups.

18 Periods

#### Unit 3: Infrared Spectroscopy
Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. FTIR.IR of gaseous, solids and polymeric materials.

Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD):
Definition, deduction of absolute configuration, axial halo- ketone and octant rule for ketones.

18 Periods

#### Unit 4: Nuclear Magnetic Resonance Spectroscopy
General introduction and definition, chemical shift, spin- spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), chemical exchange, effect of deuteriation, complex spin-
spin interaction between two, three, four and five nuclei (first order spectra), virtual coupling. Stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with dihedral angle. Simplification of complex spectra-nuclear magnetic double resonance, contact shift reagents, solvent effects.

Unit 5

**Carbon-13 NMR Spectroscopy**
General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, hetero-aromatic and carbonyl carbon), coupling constants
Fourier transform technique, nuclear Overhauser effect (NOE).

**Two dimension NMR spectroscopy**
COSY, NOESY, DEPT, INEPT, APT and INADEQUATE techniques.
Problems of the structure elucidation using above mentioned spectroscopic techniques.

**Suggested Readings:**

**MSCH312: PHOTOCHEMISTRY (ORGANIC AND INORGANIC)**

**Unit 1**

**Basics of Photochemistry**
Effect of visible light intensity on the rate of photochemical reactions. Types of photochemical reactions-photo- dissociation, gas-phase photolysis.

**Properties of Excited States**
Structure, dipole moment, acid-base strength, redox potential of electronically excited states, life time measurement of the excited states- Flash photolysis, stopped flow technique.

**Alkenes:** Intramolecular reactions of the olefinic bond geometrical isomerism, cyclisation reactions, rearrangement of 1, 4- and 1, 5- dienes

**Unit 2**

**Organic Photochemistry**

**Carbonyl Compounds:** Intramolecular reactions of carbonyl compounds saturated, cyclic and acyclic, α,β unsaturated compounds. Cyclohexadienones.
Intermolecular cyloaddition reactions, dimerisations and oxetane formation.
**Aromatic Compounds:** Isomerisation, addition and substitution reaction, miscellaneous photochemical reactions: Photo-Fries reactions of anilides, photo-Fries rearrangement and Barton reaction.
Singlet molecular oxygen reaction, photodegradation of polymer and photochemistry of vision.

**Unit 3**

**Photochemistry of coordination compounds**
Excited states of metal complexes: Energy, structure, life, electron distribution and chemical reactivity.
Ligand field charge transfer and intra Ligand excited states.
Reactivity of charge transfer and ligand field excited states, photo reactive excited states of Cr (III) complex.
Photo substitution: Photo dissociation, Photo Solvation and photo anation

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
<table>
<thead>
<tr>
<th>Unit 5</th>
<th>Important photochemical Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Photo isomerization Reaction: Geometrical, optical and linkage photo isomerization. Photo chemistry of Fe-dipyridyl, and phenanthroline complexes. Photo chemical behavior of hexahalideplatinate (IV) complexes Photo sensitized reactions. Applications: Chemiluminescence, metal complex sensitizer, metal colloid system, formation of smog</td>
</tr>
</tbody>
</table>

**Suggested Readings:**


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**MSCH313: SOLID STATE, SURFACE CHEMISTRY & CATALYSIS**

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Solid state chemistry-I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General principles, experimental procedures. Crystal Defects, Perfect and imperfect crystals, intrinsic and extrinsic defects point defects, line and plane defects. Thermodynamics of Schottky and Frenkel defect formation, colour centers.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 2</th>
<th>Solid State Chemistry-II</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Unit 3</th>
<th>Surface Chemistry-I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General structural features and behaviour of Surfactants: general use of charge types, effect of hydrophobic group, anionic, cationic, nonionic and zwitter ionic surfactants Solubilization of surfactants: Solubilization in aqueous media; locus of solubilization, factors determining the extent of solubilization, effects of solubilization.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 4</th>
<th>Surface Chemistry-II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Detergency and surfactants: Mechanism of cleaning process, removal of soil from substrate, suspension of soil in bath and prevention of redeposition, dry cleaning, skin irritation, effect of water hardness and chemical structure of surfactants and its detergency.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 5</th>
<th>Catalysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Types of catalysis: Heterogeneous and Homogeneous catalysis, advantages and disadvantages. Catalytic cycles.</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
**Heterogeneous catalysis:** Preparation methods, characterization and quantification of surface active sites, kinetics of heterogeneous catalytic reactions. Structure of adsorbed species. Supported catalysts and metal-support interaction. Catalyst deactivation and regeneration.

**Phase Transfer catalysis & ultrasound:** Definition and importance of phase transfer catalysis, quaternary ammonium and phosphonium salts, crown ethers and other cryptants. Use of ultrasound.

**Suggested Readings:**

2. Principles of solid state, Keer H.V., Wiley Eastern
3. Solid state chemistry, Chakrabarty D.K., New Wiley Eastern

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**MSCH314: ORGANOTRANSITION METAL CHEMISTRY**

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Organotransition Metal Complex</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Definition, Classification and nomenclature</td>
</tr>
<tr>
<td></td>
<td>Types of ligands and M-L bonding: lone pair donor, pi bonding electron pair donor, Hapticity, ambidentate ligands, 18 Electron rule: electron counting, ionic vs covalent model, compliance and violation of the rule oxidation state of the metal.</td>
</tr>
<tr>
<td></td>
<td>18 Periods</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 2</th>
<th>Basic reaction in organometallic chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oxidative addition, reductive elimination, insertion elimination, ligand substitution nucleophilic and electrophilic addition and abstraction</td>
</tr>
<tr>
<td></td>
<td>Fluxional organometallic compound: Rate of rearrangement and study technique, fluxional molecules of C. No. 4, 5, 6</td>
</tr>
<tr>
<td></td>
<td>18 Periods</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 3</th>
<th>Complex of sigma-bonded ligands</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preparation, structure bonding and reaction of alkyl and aryl transition metal</td>
</tr>
<tr>
<td></td>
<td>Complexes of pi-bonded ligands: - Preparation, structure and reaction of alkenes cyclopentadienyl complexes, arenas, carbonyl complexes</td>
</tr>
<tr>
<td></td>
<td>18 Periods</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit 4</th>
<th>Metal cluster and metal-metal bond</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Structures, Isolable analogy, synthesis</td>
</tr>
<tr>
<td></td>
<td>Catalysis: Basic terminology turn over, turnover number, turn over frequency, Dehydrogenation of alkene, Hydroformylation, Monsanto process, Wacker process, Alkene isomerization, Olefin metathesis</td>
</tr>
<tr>
<td></td>
<td>18 Periods</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Unit 5</th>
<th>Applications of organometallic chemistry in organic synthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heck reaction, Suzuki – miyaura reaction, Sonagashira reaction, Stille coupling, Kumada coupling, Pauson – khand reaction, Ullmann reaction, Organo copper compounds</td>
</tr>
<tr>
<td></td>
<td>Application in medicine, agriculture, industries</td>
</tr>
<tr>
<td></td>
<td>18 Periods</td>
</tr>
</tbody>
</table>

**Suggested Readings**


*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
### MSCH321: LABORATORY COURSE VII: INORGANIC & ANALYTICAL CHEMISTRY

#### I. Analyze the given mixture for four rare elements.

#### II. Fluorometry
To determine the concentration of quinine sulphate, Vitamin B (Riboflavin) and Aluminium.

#### III. Nephelometry
1. To determine the concentration of sulphate content in water sample.

#### IV. Flame photometry
1. Estimation of Na and K.
2. Estimation in a mixture (Na and K).

#### V. Water and Waste Water examination
1. To determine the concentration of Fluoride and nitrite spectrophotometrically.
2. To determine the concentration of phosphate content in water sample.
3. Determination of dissolve oxygen in water sample.
4. Determination of chemical oxygen demand (COD) in water sample.

#### VI. Soil Analysis
1. To determine the Na and K content in the given soil sample.
2. To determine the trace metal (Pb, Cu, Zn) using AAS.

**Suggested Readings:**

### MSCH322: LABORATORY COURSE VII: ORGANIC CHEMISTRY

#### I. Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid, two solids and one liquid).

#### II. Extraction of Organic Compounds from Natural Sources (purity of isolated compound may be checked by chemical test TLC or Paper chromatography):
- Isolation of cafeine from tea leaves.
- Isolation of casein from milk.
- Isolation of lactose from milk.
- Isolation of piperine from black pepper.
- Isolation of lycopene from tomatoes.
- Isolation of cartoene from carrots.

**Suggested Readings:**
1. Systematic Qualitative Organic analysis by H. Middleton.
2. Qualitative and Quantitative hand book of Organic analysis by H. Clark
4. Practical Organic Chemistry by N.K. Vishnoi

### MSCH323: LABORATORY COURSE VII: PHYSICAL CHEMISTRY

#### I. Chemical Kinetics
   a. To investigate the kinetics of the reaction between I- and persulphate ion
      i. Order of the reaction
      ii. Energy of activation of the reaction.
      iii. Effect of ionic strength on rate.

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
b. To find out the order of the reaction of saponification of ester using unequal concentrations of reactants.

c. To study the reaction between ceric ammonium nitrate and primary alcohol.

II. Conductometry:

a. To find out the equivalent conductance of strong electrolytes at different dilutions and to verify Debye Huckel Onsagar equation.

b. To determine the equivalent conductance of a weak electrolyte at infinite dilution.

c. To determine the dissociation constant of acetic acid/Oxalic acid and verify the Ostwald's dilution law.

d. Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by NaOH conductometrically.

e. To determine the solubility and solubility product of sparingly soluble salt (PbSO₄, BaSO₄)

f. To determine the degree of hydrolysis and hydrolysis constant of ammonium chloride at room temperature.

III. Phase Equilibrium:

a. To find out the equilibrium constant for the triiodide formation.

b. To find the formula of complex cuprmonium ion by distribution method

IV. Spectrophotometric

a. To determine the pKa of indicator (Methyle Red) in aqueous medium.

b. To determine the order of reaction between acetone & iodine with respect to acetone & iodine.

Suggested Readings:

1. Practical Physical Chemistry, A.M. James and F. E. Prichard, Longman.


### M.Sc. (Previous) IV Semester
**Chemistry**

2017-18

<table>
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<tr>
<td>MSCH411</td>
<td>BIOINORGANIC AND SUPRAMOLECULAR CHEMISTRY</td>
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**OR**

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<td>MSCH421</td>
<td>LABORATORY COURSE X: PROJECT **</td>
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(CIA I & II in each lab course will be of 7.5 Marks & II CIA will be a Seminar)

**Grand Total**

625 Marks

**PROJECT:** The distribution of the marks will be as follows

1. CIA I (Synopsis) 15 Marks
2. CIA II (Regularity & Performance) 30 Marks
3. Project Report 100 Marks
4. Presentation (Max 15 minutes) 50 Marks
5. Viva voce 30 Marks

Total 225 Marks

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**MSCH411: BIOINORGANIC AND SUPRAMOLECULAR CHEMISTRY**

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<td><strong>Metal storage Transport and Bio-mineralization</strong></td>
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</tr>
<tr>
<td></td>
<td>Oxygen carrier (Hb &amp; Mb), ferritin, transferrin and siderophores.</td>
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</tr>
<tr>
<td></td>
<td><strong>Calcium in Biology:</strong> Calcium in living cells, transport and regulation, molecular aspects of intramolecular process, extracellular binding protein, Ca²⁺ ATPase, Ca²⁺ ATPase structure, Ca²⁺ ATPase reaction cycle, intracellular Ca²⁺ transport.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Metalloenzyme</strong></td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Zinc enzymes: Carboxy peptidase and carbonic anhydrase.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Iron enzymes: Reactivity and structure of catalase, peroxidase and cytochrome P450, copper enzymes their Reactivity and structure of superoxide dismutase (SOD).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Co enzyme vitamin B-12 Type, absorption, transport, metabolic function and structure.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>Metal nucleic acid interaction</strong></td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Metal ions and metal complex interaction, Metal complexes nucleic acid.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Metal in medicine:</strong> Metal deficiency and disease, toxic effect of metals, metal used for diagnosis and chemotherapy with particular reference to anticancer drugs.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><strong>Supramolecular chemistry I</strong></td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Introduction, concepts and language molecular recognition: molecular receptors for different types of molecules including anionic substrates, design and synthesis of receptor molecules and multiple recognition.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td><strong>Supramolecular chemistry II</strong></td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Supramolecular reactivity and catalysis, supramolecular assemblies, supramolecular devices, supramolecular photochemistry, molecular and supra</td>
<td></td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
<table>
<thead>
<tr>
<th>MSCH412: HETEROCYCLIC CHEMISTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit 1</strong></td>
</tr>
<tr>
<td><strong>Nomenclature of heterocycles:</strong> <strong>Systemic nomenclature of monocyclic, fused &amp; bridge heterocycles.</strong></td>
</tr>
<tr>
<td><strong>Three Membered Heterocyclic Compounds with One Hetero Atom:</strong> Aziridines, Oxiranes and Thiranes</td>
</tr>
<tr>
<td><strong>Three Membered Heterocyclic Compounds with Two Hetero Atoms:</strong> Diaziridines, Diazirines and Oxaziridines</td>
</tr>
<tr>
<td><strong>Unit 2</strong></td>
</tr>
<tr>
<td><strong>Four Membered Heterocyclic Compounds with One Hetero Atom:</strong> Azitines &amp; Azitidines, Oxitanes, Thietanes and Carbonyl Derivatives: 2-Azitidinones and Oxetanone.</td>
</tr>
<tr>
<td><strong>Five Membered Heterocyclic Compounds with One Hetero Atom:</strong> Tautomerism, Pyrroles, Furans and Thiophenes</td>
</tr>
<tr>
<td><strong>Unit 3</strong></td>
</tr>
<tr>
<td><strong>Five Membered Heterocyclic Compounds with Two Hetero Atoms:</strong> Pyrazoles, Imidazoles, Oxazoles and Thiiazoles.</td>
</tr>
<tr>
<td><strong>Bicyclic Ring Systems Derived from Pyrrole, Furans and Thiophenes:</strong> Benzopyrroles, benzofurans and benzothiophenes.</td>
</tr>
<tr>
<td><strong>Unit 4</strong></td>
</tr>
<tr>
<td><strong>Six Membered Heterocyclic Compounds with One Hetero Atom:</strong> Pyridines, Pyrylium salts and Pyrones</td>
</tr>
<tr>
<td><strong>Six Membered Heterocyclic Compounds with Two Hetero Atoms:</strong> Pyrazines, Pyridazines and Pyrimidines, Quinazolines and Quinoxalines</td>
</tr>
<tr>
<td><strong>Unit 5</strong></td>
</tr>
<tr>
<td><strong>Seven Membered Heterocyclic Compounds with Two Hetero Atoms:</strong> Azepines, Oxepins and Thiiepins</td>
</tr>
<tr>
<td><strong>Bicyclic Ring Systems Derived from Pyridine:</strong> Quinoline and Isoquinoline, Acridines and Phenanthridines</td>
</tr>
</tbody>
</table>

**Suggested Readings:**
2. The Chemistry of Hetrocyles, T Eicher and S Hauptmann, Thieme.

<table>
<thead>
<tr>
<th>MSCH413: ANALYTICAL CHEMISTRY-II</th>
</tr>
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<tbody>
<tr>
<td><strong>Unit 1</strong></td>
</tr>
<tr>
<td><strong>Thermal analysis</strong></td>
</tr>
<tr>
<td>TGA, DSC (differential scanning calorimetry), DTA (differential thermal analysis): principle, methodology and application</td>
</tr>
<tr>
<td>Inductively Coupled Plasma Emission Spectroscopy (ICPES): Theory, instrumentation and applications.</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
### Unit 2
**Radio analytical Techniques**
- Neutron Activation Method: Theory, instrumentation, destructive and nondestructive methods, applications.
- Isotopic Dilution Method: Principle, methods, and applications.

### Unit 3
**Polarography**
- **Polarography:** Principles, classification of polarographic techniques, types of polarographic currents, instrumentation, factors affecting polarographic wave, pulse polarography, and differential pulse polarography.
- **Voltammetry:** Voltammetric principles, hydrodynamic voltammetry, stripping voltammetry, cyclic voltammetry, criteria of reversibility of electrochemical reactions, quasi-reversible and irreversible processes, qualitative and quantitative analysis.
- **Amperometry:** Principle, instrumentation, typical applications, amperometric titrations, chronoamperometry, and chronopotentiometry.
- Ion selective electrode: Basic principle, working, and applications, biosensors.

### Unit 4
**Separation Technique**
- Solvent extraction: Principle, methodology, and applications. Synergistic extraction: determination of nickel, crown ether for ion association complex. Organic reagents like dithiol, diketones, oxinedithizone, cuproin, cupferron, dimethylglyoxime and dithiocarbamates in solvent extraction and electrophoresis.

### Unit 5
**Applied Chemistry**
- Sample treatment, separation of constituents, and analysis method technique. petroleum and petroleum products, drugs, soil agrochemicals, mineral, alloys, cosmetics, food adulterants.
- Photoacoustic Spectroscopy (PAS): Theory, instrumentation, and applications.

### Suggested Readings:
5. Laboratory Technique in Electronanalytical Chemistry, PT Kissinger and HR Heinaman, Marcel decker.

### MSCH414 (A): SYNTHETIC CHEMISTRY

#### Unit 1
**Oxidation and reduction**
- Oxidation: Introduction, Different oxidative processes, oxidation of hydrocarbons: alkenes, aromatic rings, saturated C-H groups (activated and unactivated), Alcohols, diols, aldehydes, ketones, ketals, carboxylic acids, amines, hydrazines, and sulphides.
- Oxidations with ruthenium tetraoxide, iodobenzenediacetate and thallium (III) nitrate.
- Reduction: Introduction. Different reductive processes, reductions of epoxides, nitro, nitroso, azo and oxime groups.

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*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
### Hydrogenolysis

General mechanistic considerations – nature of migration, migratory aptitude.

**A detailed study of the following rearrangements:** Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorkii, Arndt-Eistert synthesis, Neber, Beckmann, Hofmann, Curtius, Lossen Schmidt, Baeyer-Villiger, Shapiro reaction

### Disconnection Approach

An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions.

**Protecting Groups:** Principle of protection of alcohol, amine, carbonyl and carboxyl groups.

### One Group C-C Disconnections

Alcohols and carbonyl compounds, regioselectivity, Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

### Two Group C-C Disconnections

Diels-Alder reaction, 1, 3-difunctionalised compounds, α, β-unsaturated carbonyl compounds, control in carbonyl condensations, 1, 5-difunctionalised compounds, Micheal addition and Robinson annelation.

### Ring Synthesis (Disconnection Approach)

Saturated heterocycles, synthesis of 3-, 4-, 5- and 6-membered rings, aromatic heterocycles in organic synthesis.

**Green Synthesis**

Introduction, Basic principles of Green Chemistry and their illustrations with examples.

Green synthesis of adipic acid, catechol, 3- dehydroshikimic acid, methyl methacrylate, urethane, acetaldehyde, ibuprofen, paracetamol and marine antifoulant.

### Suggested Readings:


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### MSCH414 (B): CHEMISTRY OF MATERIALS

#### Unit 1: Multiphase Materials

Classification and properties of materials, Types of phase diagrams, Isomorphous, Eutectic, Peritectic, Monotectic and Eutectiod systems, Calculation of phase amounts from a phase diagram, Phase rule, Ferrous alloys Fe-C phase diagram, Non Ferro alloys, Phase diagrams of brass and tin bronze.

#### Unit 2: Composite Materials

Traditional composites, concrete, Asphalt and Wood, Synthetic composites, dispersion reinforced, Particle reinforced, Laminated and fiber reinforced composites, applications of composites.

#### Unit 3: Polymeric and advanced materials

Brief idea of following: Insulating material, Semiconductors, Superconductors, Fullerenes, Optical fibers, Organic electronic material.

#### Unit 4: Nano Materials

Introduction, and definition of nanoparticles and nanomaterials, emergence of

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*2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)*
<table>
<thead>
<tr>
<th>Unit 5</th>
<th>Characterization and applications</th>
</tr>
</thead>
</table>

**Suggested Readings:**

1. Solid State Physics, NW Ashcroft and ND Mermin, Saunders College.
3. Handbook of Liquid Crystals, Kelker and Hatz, ChemieVerlag
7. Nanotechnology Fundamentals and applications, M. Karkare, I. K. interna
MSO 111: BIOSYSTEMATICS & EVOLUTION

Unit 1

- Biosystematics
  - Definition
  - Importance of Biosystematics
  - Applications of Biosystematics in Biology
- Neotaxonomy – Consequences of New Systematic
  - Chemotaxonomy -
    - Kinds
      - Immunological Approach
      - Chromatographic Approach
      - Histo-chemical Approach
- Cytotaxonomy –
  - Chromosomal behaviour
    - Karyotype test
    - Chromosome number
    - Chromosome morphology
    - Linkage, recombination , frequency analysis
  - Banding pattern – G,C,R,Q Banding
- Molecular Taxonomy
  - Source of variation, satellite DNA (Mini and micro DNA)
  - Molecular markers –RFLP, RAPD, and AFLP
  - Ribotyping and DNA sequencing

Unit 2

- Taxonomic Procedure -
  - Collection -
    - Value of Collection
    - Purpose of Scientific Collection
    - Collecting & Research
    - Scope of Collection
    - Where & How to Collect
    - Content of Collection
  - Preservation -
    - Introduction
    - Process of Preservation
    - Preservation of invertebrates and vertebrates (Basic Idea)
  - Curating -
    - Preparation of Material for Study
    - Housing
    - Cataloging
    - Arrangement of Collection
    - Curating of types
    - Exchange of Material
### Expendable Material

- Taxonomic Keys - Types
  - Indented Key
  - Bracket Key
  - Ground Types
  - Pictorial Type
  - Branching Type
  - Circular Type
- Box Type

### International code of Zoological nomenclature

#### Principles -
- Principle of Binominal Nomenclature
- Principle of Priority
- Principle of Coordination
- Principle of the First Reviser
- Principle of Homonymy
- Principle of Typification

#### Structure
- Gender agreement
- Commission
- Species Indices -
  - Shannon – Weiner Index
  - Dominance Index
  - Similarity & Dissimilarity
  - Association Index

### Modern Theory of Evolution

- Lamarcks Theory and Neo Lamarckism
- Theory of Catastrophism
- Theory of Darwin and Neo Darwinism
- Weismann’s Theory
- Modern Synthetic Theory
- Isolation & Isolating Mechanism
- Definition
- Pre-mating Mechanism -
  - Geographic isolation
  - Isolation due to distance
  - Climatic isolation
  - Seasonal isolation
  - Habitat isolation
  - Ethological isolation
  - Mechanical isolation
  - Physiological isolation
- Post-mating Isolation –
- Gametic Mortality
- Zygotic Mortality
- Hybrid Inviability
- Hybrid Sterility
- Origin of Reproductive Isolation-
- Muller’s view
- Dobzhansky’s View
- Speciation -
<table>
<thead>
<tr>
<th><strong>Modes of Speciation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Phyletic Speciation</td>
</tr>
<tr>
<td>▪ Quantum Speciation</td>
</tr>
<tr>
<td>▪ Gradual Speciation</td>
</tr>
<tr>
<td><strong>Evolution of Man</strong></td>
</tr>
<tr>
<td>▪ Pre human ancestors</td>
</tr>
<tr>
<td>▪ Evolution of man in Pleistocene</td>
</tr>
</tbody>
</table>

**Unit 5**

<table>
<thead>
<tr>
<th><strong>Variation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Kinds of Variation</td>
</tr>
<tr>
<td>▪ Meristic &amp; substantive</td>
</tr>
<tr>
<td>▪ Continuous &amp; Discontinuous</td>
</tr>
<tr>
<td>▪ Determinate &amp; Indeterminate</td>
</tr>
<tr>
<td>▪ Somatic &amp; Germinal</td>
</tr>
<tr>
<td>▪ Sources of Variation</td>
</tr>
<tr>
<td>▪ Basis of Variation</td>
</tr>
<tr>
<td>▪ Chromosomal Aberration</td>
</tr>
<tr>
<td>▪ Variations in chromosome number</td>
</tr>
<tr>
<td>▪ Natural Selection</td>
</tr>
<tr>
<td>▪ Types</td>
</tr>
<tr>
<td>▪ Stabilizing selection</td>
</tr>
<tr>
<td>▪ Directional Selection</td>
</tr>
<tr>
<td>▪ Disruptive Selection</td>
</tr>
<tr>
<td>▪ Selection Pressure</td>
</tr>
<tr>
<td>▪ Genetic Drift -</td>
</tr>
<tr>
<td>▪ Theory of genetic Drift</td>
</tr>
<tr>
<td>▪ Salient Features of Genetic Drift</td>
</tr>
<tr>
<td>▪ Genetic basis of Random Genetic Drift</td>
</tr>
<tr>
<td>▪ Hardy-Weinberg equilibrium &amp; Genetic Drift</td>
</tr>
<tr>
<td>▪ Mimicry -</td>
</tr>
<tr>
<td>▪ Kinds -</td>
</tr>
<tr>
<td>▪ Protective</td>
</tr>
<tr>
<td>▪ Aggressive</td>
</tr>
<tr>
<td>▪ Conscient</td>
</tr>
<tr>
<td><strong>Significance of Mimicry</strong></td>
</tr>
</tbody>
</table>

**MSZO112 STRUCTURE & FUNCTION OF INVERTEBRATES**

**Unit 1**

<table>
<thead>
<tr>
<th><strong>Organization of Coelom</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evolution of Coelom (Various Theories)</strong></td>
</tr>
<tr>
<td><strong>Modification of Coelom</strong></td>
</tr>
<tr>
<td><strong>Significance of Coelom</strong></td>
</tr>
<tr>
<td><strong>Acoelomate</strong></td>
</tr>
<tr>
<td><strong>Pseudocoelomate</strong></td>
</tr>
<tr>
<td><strong>True Coelomate</strong></td>
</tr>
<tr>
<td><strong>Metamerism – Types, Origin and Evolution</strong></td>
</tr>
<tr>
<td><strong>Difference between Protostomia and Deuterostomia</strong></td>
</tr>
</tbody>
</table>

**Unit 2**

<table>
<thead>
<tr>
<th><strong>Nutrition, Feeding, Structure and physiology of Digestion</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Protozoa</td>
</tr>
<tr>
<td>▪ Platyhelminthes (Class Turbellaria)</td>
</tr>
<tr>
<td>▪ Annelida (Class Polychaeta)</td>
</tr>
<tr>
<td>▪ Arthropoda (Class Insecta)</td>
</tr>
</tbody>
</table>
### Unit 3
- Different types of Respiratory organs in Invertebrates - their structure and functions
  - Gills
  - Lungs
  - Trachea
- Respiratory Pigments (Specific to invertebrates only)

### Unit 4
- Different types of Excretory organs in Invertebrates - their structure and functions
  - Nephridia
  - Malphigian Tubules
  - Brief idea about accessory excretory organs
  - Coaxial Glands
  - Kebers Organ
  - Bojanus Organ
- Mechanism of Excretion

### Unit 5
- Nervous System
  - Primitive Nervous System – Echinodermata
  - Advanced Nervous System –
    - Annelida (Class Oligochaeta)
    - Arthropoda (Class Insecta)
    - Mollusca (Class Cephalopoda)

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### MSZO113 VERTEBRATE PHYSIOLOGY I

#### Unit 1
- Digestion:
  - Digestive glands and alimentary canal
  - Digestive enzymes and their secretion
  - Digestion of Protein, Fat and Carbohydrate
- Vitamins:
  - Types
  - Sources
  - Physiological Functions
  - Diseases Caused By Deficiency

#### Unit 2
- Respiration
  - Respiratory Organs Structure – Structure of lungs
  - Mechanism of Breathing:
    - Inspiration
    - Expiration
- Exchange and Transport of Gasses:
  - Oxygen dissociation curve
  - Regulation of Breathing
  - Respiratory Pigments: Hemoglobin structure

#### Unit 3
- Blood
  - Composition
  - Function of Blood & Lymph
  - Blood Clotting – Factor theory
  - Heart beat Origin and Conduction
  - **Heart diseases – causes, prevention and treatment.**
    - Cardiac Cycle
    - E.C.G
    - Blood Pressure
    - Anemia

#### Unit 4
- Excretion:
Unit 5

- Muscles-
  - Types
  - Ultra structure
  - Muscle Proteins-
- Actin
- Myosin
- Tropomyosin
- Troponin
  - Physiology of Muscle Contraction – Sliding filament theory, Cori Cycle,
  - Muscle Properties-
- Muscle twitch
- Summation
- Tetanus
- Isometric and Isotonic contraction
- Muscle fatigue

MSZ0114  ECOLOGY AND ANIMAL BEHAVIOR

Unit 1

- Ecological Energetics
  - Concept of energy
  - Laws governing energy transformation
  - Energy flow in ecosystem
  - Energy flow models
- Theories of limiting similarity
  - Community
  - Introduction
  - Classification
  - Characteristics
- Succession
  - Types
  - Process
  - Patterns
  - Climax concept
  - Models of succession

Unit 2

- Secondary Productivity
- Characteristics of Secondary Production in a Ecosystem
- Methods of estimating secondary production
  - Increment summation
  - Removal summation,
  - The instantaneous growth method
  - The Allen curve method
- Predation
  - Models of predatory dynamics
  - Optimal foraging theory

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
| Unit 3 | - Patch choice  
- Diet choice  
- Prey selectivity  
- Foraging time  
- Role of predation in nature - with reference to Blackbuck, chinkara, and bluebull. |
|--------|-----------------------------------------------------------------------------------------------------------------------------------|
| Unit 3 | - Demography of Population  
- Structure and patterns of population  
- Life tables and its Statistical analysis  
- Population growth  
- Growth of organisms with non-overlapping and overlapping population  
- Population growth model – Verhulst- Pearl Logistic Model |
| Unit 4 | - Animal behavior  
- Innate behavior- Types  
- Taxis  
- Kinesis  
- Reflexes  
- Fixed action pattern (Instinct)  
- Motivation and its different phases  
- Learned behavior- Types  
- Habitation  
- Conditioned reflexes  
- Trail & error  
- Latent learning  
- Insight learning  
- Reasoning  
- Imprinting  
- Rhythmical behaviour and Biological clocks  
- Man- animal conflict with reference to – Blackbuck, chinkara, bluebull, Rehuseus monkey, and Leopard |
| Unit 5 | - Role of hormones in Behavior  
- Role of pheromones in behavior  
- Communication in animals  
- Social behavior and organization in  
  - Insects  
  - Fishes  
  - Birds  
  - Mammals (Primates) |

**MSZO 121 PRACTICAL**

C. Identification and Systematic position up to order of following Museum specimens-  
  Protozoa- *Paramecium*, *Noctiluca*, *Opalina*, *Balantidium*, *Nyctotherus*, *Vorticella*.  
  Porifera - *Sycon*, *Hyalonema*, *Euplectella*, *Euspongia*  
  Cnidaria- *Physalia*, *Porpita*, *Corallium*, *Gorgonia*, *Pennatula*  
  Platyhelminthes - *Fasciola*, *Taenia*, *Schistosoma*  
  Aschelmenthes- *Ascaris*, *Dracunculus*, *Wucheria*.  
  Annelida- *Nereis* and *Hetronereis* Phase, *Aphrodite*, *Hirudinaria*.  

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
Mollusca- Chiton, Mytilus, Ostrea, Teredo, Nautilus, Octopus
Echinodermata- Pentaceros, Holothuria, Antedon.


E. Physiology/ecology experiment
1. Estimation of Packed Cell Volume (P.C.V.)
2. Estimation of Hemoglobin in blood sample
3. Identification of Blood Groups
4. Estimation of Soil Moisture
5. Estimation of Water holding capacity of different soil.
6. Recording of Rainfall, Humidity and Air Pressure
7. To determine the minimum size of the quadrant by species area curve method.
8. To determine the minimum no of quadrant to be laid down in the field under study.
9. To study the community by quadrant method by determining frequency, density and abundance of different species present in community.

10. Assessing the biodiversity of a community using species diversity indices.

Marking Scheme

<table>
<thead>
<tr>
<th>Distribution of marks</th>
<th>Marks allotted</th>
<th>Time duration 6 hrs</th>
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<tbody>
<tr>
<td>1. Dissection –</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>2. Microscopic preparation –</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>3. Spots – (8 x 3)</td>
<td>24</td>
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</tr>
<tr>
<td>4. Physiology / Ecology experiment-</td>
<td>18</td>
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<tr>
<td>5. Year work/ practical record – (CIA)</td>
<td>10</td>
<td></td>
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<tr>
<td>6. Seminar – (CIA)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>7. Viva voice -</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Suggested Readings
2. Elements Of Taxonomy – E. Mayer – Tata Mcgraw Hill Co
3. Biosystematics And Taxonomy – R.C. Tripathi- University Book House
5. Theory And Practices Of Animal Taxonomy- VC Kapoor – Oxford And Ibh Co
7. The Invertebrates- Vol I- VI –L.H Hyman – Mcgraw Hill Co
8. The Invertebrate Structure And Function – E.J.W Barrington- Thomas Nelson And Sons
9. Invertebrate Zoology – Re Barnes- W.B Saunders And Co, Philidelphia
12. General And Comparative Animal Physiology- Ws Hoar – Prientice Hall Of India
14. Animal Physiology : Mechanism And Adaptation- R Eckert Randall- Wh Freeman And Co
15. Principles Of Animal Physiology (PB) – Christopher Moyes- Pearson Education
16. Text Book Of Animal Physiology By Sherwood – Cengage Learning India
17. Introduction To Animal Physiology – I Kay- Garland Publishing
18. Animal Physiology By Margaret Brown- Apple Academic

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
25. A Text Book Of Animal Behavior – F.B.Manda- Phi Publication
27. Animal Behavior – V.K Agarwal – S. Chand And Co, India

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
M.SC ZOOLOGY II SEMESTER

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
<th>PD/W</th>
<th>EXAM</th>
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<tbody>
<tr>
<td>MSZO 211</td>
<td>DEVELOPMENTAL BIOLOGY</td>
<td>4</td>
<td>3hrs</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSZO212</td>
<td>MICROBIOLOGY</td>
<td>4</td>
<td>3hrs</td>
<td>20</td>
<td>80</td>
<td>100</td>
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<tr>
<td>MSZO 213</td>
<td>VERTEBRATE PHYSIOLOGY II</td>
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<td>3hrs</td>
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<td>80</td>
<td>100</td>
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<td>MSZO214</td>
<td>QUANTITATIVE BIOLOGY</td>
<td>4</td>
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<td>80</td>
<td>100</td>
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<td>MSZO221</td>
<td>PRACTICAL</td>
<td>24</td>
<td>6 hrs</td>
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<td>80</td>
<td>100</td>
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<td></td>
<td></td>
<td></td>
<td>100</td>
<td>400</td>
<td>500</td>
</tr>
</tbody>
</table>

**MSZO211 DEVELOPMENTAL BIOLOGY**

| Unit 1 | Origin of germ cells –
|        | Spermatogenesis –
|        |   • Formation of spermatid
|        |   • Spermiogenesis
|        |   • Spermiatation
|        |   • Structure of mammalian sperm
|        | Oogenesis
|        |   • Formation of ova
|        |   • Structure of mammalian ova
|        | Types of eggs
|        |   • On basis of amount of yolk
|        |   • On basis of distribution of yolk
|        | Egg membranes
|        |   • Primary egg membranes
|        |   • Secondary egg membranes

| Unit 2 | Fertilization:
|        |   • Biochemical aspect of fertilization
|        |   • Penetration and activation of ova,
|        |   • Formation of fertilization membrane,

| Unit 3 | Early development –
|        |   • Cleavage
|        |   • Characteristics
|        |   • Planes and patterns,
|        | Blastulation
|        |   • Prominent physiological features
|        | Gastrulation
|        |   • Epiboly
|        |   • Emboly
|        |   • Invagination, ingestion, and involution
|        |   • Gastrulation in amphioxus, amphibian, and Birds
|        | Fate map
|        |   • Mapping techniques
|        | Early embryonic induction and differentiation.

| Unit 4 | Organogenesis of following organs / organ system of mammal
|        |   • Eye
|        |   • Brain,
|        |   • Alimentary canal,
|        |   • Kidney
|        |   • Gonads

| Unit 5 | Assisted reproductive technologies (ART)-

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
### IVF – Procedure
- Ovarian hyper stimulation
- Natural and Mild IVF
- Egg retrieval
- Fertilization
- Embryo culture
- Embryo transfer
- Complications of the IVF procedure

### ICSI - Procedure

### GIFT
- Method
- Indications
- Success rate

### Cloning in mammals by nucleus transfer techniques

---

**MSZO212 MICROBIOLOGY**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Content</th>
</tr>
</thead>
</table>
| Unit 1 | Historical background of Microbiology:  
- Contribution of  
  a) Antonie Von Leeuwenhoek,  
  b) Lazaro Spallanzani,  
  c) Robert Koch,  
  d) John Tyndall  
  e) Edward Jenner,  
  f) Louis Pasteur,  
  g) Alexander Fleming,  
- Description of Protist, Prokaryotes and Eukaryotes  
- Classification of bacteria: Bergeys manual |
| Unit 2 | Bacteria  
1. Gram Positive Bacteria  
2. Gram Negative Bacteria  
3. Gram staining Techniques  
- Bacterial Culture- Pure culture (Axenic culture)  
- Culture media:  
  A. Components of media  
  B. Types of media  
    1. Natural and synthetic media  
    2. Chemically defined media  
    3. Complex media  
    4. Selective and enrichment media  
  C. Handling Method  
- Types of Culture Techniques:  
  2. Pure culture techniques; Streak plate and spread plate method  
  3. Enrichment culture technique: - Rolling tube and Candle jar method |
| Unit 3 | Medical Microbiology:  
- Pathogenecity, infection, mode of transmission of Coliform bacteria- (*Escherichia coli*, and *Salmonella*)  
- Causative agents, mode of transmission and control measures of diseases- Malaria and AIDS.  
- Microbial control: Physical, chemical and anti microbial (Antibiotics) |
| Unit 4 | Food Microbiology  
1. Important microbes involved in spoilage of food - meat, poultry, Fish and |
### Unit 1

#### Endocrine system – I
- Location, structure and function and their hormones and diseases caused by deficiency
  - Pineal
  - Hypothalamus
  - Pituitary
  - Thymus
  - Thyroid
  - Parathyroid
  - Pancreas

#### Endocrine system – II
- Location structure and function and their hormones and diseases caused by their deficiency
  - Adrenal - cortex and medulla
  - Testis
  - Ovary
  - Mechanism of action of peptide and steroid hormones

### Unit 2

#### Nerve conduction-
- Conduction of nerve impulse – neuronal and synaptic transmission
- Neurotransmitters and their mode of action
- Structure and physiology of eye
- Retinal pigments
- Photoreception
- Photochemistry of vision

### Unit 3

#### Physiology of reproduction –
- Mammalian reproductive system
  - Structure and function of Male and Female
  - Reproductive cycles
  - Hormonal control

### Unit 4

- Osmoregulation in different animal groups.
- Thermoregulation

### Unit 5

- Role of Microbes in Environment Protection
  - Biodegradation-Cellulose, plastics and pesticides
  - Biopesticides -Introduction types (bacterial- *Bacillus thuringiensis*, Viral –NPV, fungal- *Trichoderma*)
  - Biofertilizers-Definition, Types (bacterial, Mycorrhizal -fungal, Plants-Azolla); kind of association, mode of application and merits.
  - Bioleaching – Role of microbes in metal and petroleum recovery

---

**MSZO213 VERTEBRATE PHYSIOLOGY II**

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**2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)**
<table>
<thead>
<tr>
<th>Unit</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introduction to biostatistics:</td>
</tr>
<tr>
<td></td>
<td>2. Graphical representation of data- Bar, Pie, Histogram, Frequency Polygon, frequency curve</td>
</tr>
<tr>
<td></td>
<td>3. Measures of central tendency- Mean, Median and Mode in grouped and ungrouped data</td>
</tr>
<tr>
<td>2.</td>
<td>• Matrix: Types, Addition, Multiplication &amp; Uses</td>
</tr>
<tr>
<td></td>
<td>• Vectors: Types, Addition &amp; Multiplication,</td>
</tr>
<tr>
<td></td>
<td>• Data analysis: Collection, classification, Tabulation</td>
</tr>
<tr>
<td>3.</td>
<td>Measures of dispersion-</td>
</tr>
<tr>
<td></td>
<td>1. Range, mean deviation, standard deviation, and variance</td>
</tr>
<tr>
<td></td>
<td>2. Concept of Skewness and kurtosis</td>
</tr>
<tr>
<td></td>
<td>3. ANOVA.</td>
</tr>
<tr>
<td>4.</td>
<td>Probability theory – Introduction, theorem and distribution patterns</td>
</tr>
<tr>
<td></td>
<td>Test of significance</td>
</tr>
<tr>
<td></td>
<td>1. Hypothesis testing: Null Hypothesis and alternative hypothesis,</td>
</tr>
<tr>
<td></td>
<td>2. Chi square test,</td>
</tr>
<tr>
<td></td>
<td>3. Student “t” test</td>
</tr>
<tr>
<td>5.</td>
<td>• Correlation- definition, kinds &amp; measures</td>
</tr>
<tr>
<td></td>
<td>• Regression analysis- kinds, Regression analysis X on Y &amp; Y on X, Regression coefficient</td>
</tr>
<tr>
<td></td>
<td>• SPSS package and Statistical Analysis Software</td>
</tr>
</tbody>
</table>

### MSZO221 PRACTICAL

A. Physiology experiment
1. Total RBC count
2. Total WBC count
3. DLC (Differential Leucocyte Count)
4. Qualitative test for urea, creatinine and chloride in urine
5. Detection of carbohydrate, protein and lipid in milk
6. Blood sugar estimation
7. Separation of amino acid with paper chromatography & TLC

B. Ecological experiments
1. Water analysis for pH, dissolved oxygen, free carbon dioxide, alkalinity/salinity and hardness.
2. Estimation of conductivity of water sample by conductivity meter
3. Identification, study and permanent preparation of zooplanktons from various water bodies

C. Microbiology Experiments
1. Study of microbes in food material – fish and fish products
2. Bacteriological analysis of potable water
3. Identification of gram positive and gram negative bacteria
4. Brief idea of composition of readymade culture media
5. Preparation of bacterial broth, slants, plating and streaking
6. Preparation of bacterial growth curve of *E.coli*, and finding its generation time.
7. Counting of bacterial colony using colony counter.

D. Biostatistics problem

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
1. To derive mean, median, mode
2. Derivation of standard deviation
3. To determine correlation between two data
4. Application of chi square test
5. Use of computers for analysis of variance (ANOVA)
6. Use of SPSS software package for statistical analysis

Marking Scheme

<table>
<thead>
<tr>
<th>Distribution of marks</th>
<th>Marks allotted</th>
<th>Time duration 6 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physiology experiment</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>2. Ecological experiment</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>3. Microbiology experiment-</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>4. Biostatistics problem-</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>5. Year work/practical record and Submission of slides – (CIA’ )</td>
<td>10 (5+5)</td>
<td></td>
</tr>
<tr>
<td>6. Seminar – (CIA’ )</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>7. Viva voice -</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>8. Tour report</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Suggested Readings
1. Developmental Biology – Scott Gilbert – PB- Palgrave Publication
2. Foundations Of Embryology – Bradley M Patten And Carlson
3. Human Embryology And Developmental Biology – Bruce Carlson – Mosby Publication
5. Developmental Biology – Weiner A Muller- Springer Publication
10. Microbiology – An Introduction – Gerard Tortora- Pearson Education
11. Food Microbiology – William Frazier, Dennis Westhoff-Pb- Tatamcgraw Hill Education
12. A Text Book Of Microbiology – R. Ananthnaryan , Ck Jayaram Paniker
14. Text Book Of Microbiology And Immunology – Sc Parija- Elsevier India
15. Introduction To Food Microbiology- Kamal Duggal- Cybertech Publication
16. Food Microbiology – Sk Sinha, Ashok Kumar Shroma-Hb- Oxford Book Co
17. Fundamentals Of Food Microbiology – Bebek Ray, Arun Bhunia-Hb- Taylor And Francis Group
18. Medical Microbiology – Michael Fraud-Pb- Oxford Univerity Press
19. Essential Of Medical Microbiology- Volkwesely- Lippincott Williams And Wikins Publisher
20. Microbial Taxonomy And Culture Techniques- R P Singh- Kalyani Publisher
21. Introduction To Parasitology – C. Chandler And C.P Read- John Wiley And Sons

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
**M.SC ZOOLOGY III SEMESTER**

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
<th>PD/W</th>
<th>EXAM</th>
<th>CIA</th>
<th>ESE</th>
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</thead>
<tbody>
<tr>
<td>MSZO 311</td>
<td>CHORDATE BIOLOGY I</td>
<td>6</td>
<td>3hrs</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSZO312</td>
<td>VERTEBRATE IMMUNOLOGY AND ANIMAL CELL CULTURE</td>
<td>6</td>
<td>3hrs</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSZO 313A</td>
<td>ENVIRONMENTAL BIOLOGY I / ENTOMOLOGY-I (INSECT- STRUCTURE &amp; FUNCTION)</td>
<td>3/3</td>
<td>3hrs</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSZO 313B</td>
<td>ENVIRONMENTAL BIOLOGY II /ENTOMOLOGY-II (SYSTEMATICS, ECOLOGY AND ECONOMIC ENTOMOLOGY)</td>
<td>3/3</td>
<td>3hrs</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSZO321</td>
<td>PRACTICAL</td>
<td>12</td>
<td>6 hrs</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSZO322A</td>
<td>PRACTICAL</td>
<td>12</td>
<td>6 hrs</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>MSZO322B</td>
<td>PRACTICAL</td>
<td>12</td>
<td>6 hrs</td>
<td>20</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>120</td>
<td>480</td>
<td>600</td>
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</table>

**MSZO311 CHORDATE BIOLOGY I**

**Unit 1**
Classification of Protochordata and Cyclostomata (up to order), Evolution and affinities of Protochordata, Life history of *Pyrosoma, Doliolum, Salpa*, Evolution and affinities of Cyclostomata.

**Unit 2**
Origin and Classification of Pisces, Adaptations in Fishes- Deep sea Adaptations, Offensive and Defensive Adaptations, Parental care in Fishes, Accessory Respiratory organs, Migration in Fishes. Sensory organs and lateral line System in Fishes.

**Unit 3**
Classification, Origin and Adaptive Radiations in Amphibia, Extinct Amphibia (Stegocephalia), Parental care in Amphibia, Neoteny & Paedogenesis.

**Unit 4**
Origin and Adaptive Radiations in Reptiles, Extinct reptiles (Dinosaurs), Comparative account of Snakes and Lizards. Temporal regions of Chelonia, Crocodilia and Ophidia. Locomotion in Snakes.

**Unit 5**

**MSZO312 VERTEBRATE IMMUNOLOGY AND ANIMAL CELL CULTURE**

**Unit 1**
Types of Immunities - Innate, Acquired, Active, Passive. Hematopesis. Cells of Immune system and their differentiation, Organization and structure of Primary and Secondary lymphoid organs

**Unit 2**
Antigen and Super antigen, antigenic determinates (Isotypes, Allotypes and idiotypes) , Epitope and haptens , Structure and types of various classes and sub classes of immunoglobulin. Evolution of antibody diversity

**Unit 3**
Antigen – antibody interaction- Agglutination, RIA, ELISA and its types- "Indirect" ELISA, Sandwich ELISA, Competitive ELISA, Western blotting, MHC I and II molecules, expression and diversity, compliment system : Classical and alternate pathway, lymphocyte trafficking

**Unit 4**
Regulation of immune response, antigen processing and presentation, Hypersensitivity and its types, Autoimmune disorders (Autoimmunity), Immunodeficiency and AIDS, Hybriodoma technology and production of monoclonal antibodies.

**Unit 5**
Animal cell culture, equipments needed for cell culture. Culture procedure , Disintegration of tissue and primary cell culture, culture media and nutritional requirement of cell in vitro, types of culture media, evolution and maintenance of cell lines, Cryopreservation.
MSZO321 PRACTICALS

A. Dissection
1. Scoliodon – Efferent & Afferent System, Cranial nerves, Internal Ear, Brain & Scroll valve
2. Wallago - Cranial nerves
3. Torpedo - Electric organs

B. Osteology of representative classes- Amphibia, Reptiles,

C. Permanent Slides
1. Scoliodon T.S. Gill,
3. Histology of various Amphibia organs- Liver, Intestine, Duodenum, Stomach, Spleen, Kidney, Ovary, Testis

D. Permanent stain preparation- Placoid, Ampulla of Lorenzini

E. Immunological exercise –
1. Electrophoresis
2. Radial immunodiffusion ( RID)
3. Ouchterlony double diffusion ( ODD)
4. ELISA

F. Museum Specimens
1. Hemichordate:-Balanoglosus
2. Urochordate:- Salpa, Doliolum, Oikopleura, Herdmania
3. Cephalochordate:- Petromyzon, Myxine
4. Pisces: Zygaena, Scoliodon, Pristis, Torpedo, Trygon, Belone, Exocoetus, Anabas, Echeneis

G. Microtomy- Microtomy of different organs of Rat- Liver, Lung, Kidney, Intestine, Stomach, Heart, Testis, Ovaries (Submission of 15 Microtomy Slides)

Marking Scheme

<table>
<thead>
<tr>
<th>Distribution of Marks</th>
<th>Marks allotted</th>
<th>Time Duration – 6 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dissection</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2. Spots 6 spots x 3</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>3. Immunological</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>4. Year work / practical record ( CIA)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>5. Seminar ( CIA)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>6. Microtomy</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>7. Viva voice</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
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</tr>
</tbody>
</table>

Suggested readings
(COVERING MSZO311 AND MSZO312)
2. Vertebrate life- Pough and McFerland
3. Life of Vertebrates : J. Z. Yong
4. Vertebrates : Comparative anatomy, function, Evolution- K. V. Kardong
5. (Tata MaGraw-Hill Edition)
7. The Vertebrate body- Romer & Parsons
8. Biology of Vertebrates- Walter & Sayles
9. Elements of Chordate Anatomy- Weichert
10. Analysis of Vertebrate Structure- Hildebrand

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
12. Immunobiology by Janeway, Travers, and Walport and Shlomchick, Garland science publication  
13. Essential Immunology by Lan M. Roitt, etc Blackwell science publication  
14. Fundamentals of Immunology by William Paul, Lippinot Williams and Wilkins publication  
15. Understanding immunology –by A.J Cunnigham , Academia press publication  
16. Immunology by Benjaminii  
17. Immunology- an introduction by Ian Tizzard, Saunders college publication  
18. Animal cell culture techniques by Martin Clynes  
22. Animal Cell Culture: Concept and Application by Sheelendra Mangal Bhatt, Alpha Science International Ltd  
25. Animal cell culture by Ravi, Samanthi Publication,  
27. Animal tissue culture , by Aruni, A.W, 2011- Scientific publisher  
28. Cell and tissue culture (HB) – by C.K.Arora and M Prakash –Anmol publication –  
30. Cell culture techniques – ( PB) – by Swati Rauthan – Lambert academic publishing  
31. Lab Manual in Biochemistry, Immunology and Biotechnology -Arti Nigam Book

<table>
<thead>
<tr>
<th>MSZO313A</th>
<th>ENVIRONMENTAL BIOLOGY I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>Ecosystem – Dynamics, Management and stability, homeostasis, niche and its overlapping Biosphere – composition and characteristics and types - Lithosphere, hydrosphere and atmosphere</td>
</tr>
<tr>
<td>Unit 2</td>
<td>Biosphere- Bio geochemical cycle. C, O, N, P, and S. Types of ecosystem- Terrestrial Ecosystem- characters and biota of forest, grassland, and desert. Desertification – causes creation and control, Deserts of World</td>
</tr>
<tr>
<td>Unit 3</td>
<td>Thar Desert: Its Biota and geophysiological adaptation. Aquatic ecosystem- characteristics, and biota of Fresh water, Estuarine and marine. Ecological adaptations of animals in – cold desert, high altitude, lotic and marine environment.</td>
</tr>
<tr>
<td>Unit 4</td>
<td>Wildlife zoogeography of India and World with reference to Amphibia, Reptiles, Birds and Mammals. Endangered &amp; Threatened species of Amphibia, Reptiles, Birds and Mammals of India. (with examples)</td>
</tr>
<tr>
<td>Unit 5</td>
<td>National parks and sanctuaries- with reference to Corbett, Ranthambore, Manas, Desert National Park, Tal Chhapar Sanctuary, Keoladev National Park. Biosphere reserves- with reference to Nanda devi, Agasthiayalalai, Dibru-Saikhowa, Nilgiri, Panchmarhi, and Sunderbans</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MSZO314A</th>
<th>ENVIRONMENTAL BIOLOGY II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>Basic concept of Ecology - Holism, Ecosystem, Succession and Conservation. Ecological</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
<table>
<thead>
<tr>
<th>Unit 2</th>
<th>Sustainable development – concept, strategies, principles, threats, and Commissions (national and internationals). Unsustainability – concept cause, effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 3</td>
<td>Biodiversity: Types, Mega diversity with special reference to India. Hot spots of biodiversity of India, conservation of biodiversity.- introduction to strategies, insitu, exsitu, protected areas, biosphere reserve, restoration of endangered species, public participation</td>
</tr>
<tr>
<td>Unit 4</td>
<td>Natural resources- Management, monitory and conservation, watershed and wetland management, Energy crisis</td>
</tr>
<tr>
<td>Unit 5</td>
<td>Impact of urbanization and Industrialization on environment, environmental awareness - role of Government and voluntary organization. Environment education and role of information technology, role of women in environmental awareness</td>
</tr>
</tbody>
</table>

**MSZO322A PRACTICAL (COVERING MSZO313A AND MSZO314A)**

| 1. Measurement of Dissolved oxygen in water | 20 |
| 2. Measurement of free carbon dioxide in water | 15 |
| 3. Measurement of Total Alkalinity in water | 15 |
| 4. Measurement of Sodium in water using flame photometric method. | 10 |
| 5. Measurement of Sulphide in water | 10 |
| 6. Measurement of Nitrate in water | 10 |
| 7. Measurement of phosphate in water | 10 |
| 8. Estimation of biochemical oxygen demand (BOD). | 10 |
| 9. Estimation of chemical oxygen demand (COD). | 10 |
| 10. Zooplankton identification, count, and its diversity study | 10 |
| 11. Estimation of Soil variables- EC (Electrical conductivity), Phosphate and Nitrate | 10 |

**Marking scheme**

<table>
<thead>
<tr>
<th>Distribution of Marks</th>
<th>Maximum marks 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Experiment A</td>
<td>20</td>
</tr>
<tr>
<td>2. Experiment B</td>
<td>15</td>
</tr>
<tr>
<td>3. Spots 5 x 3</td>
<td>15</td>
</tr>
<tr>
<td>4. Preparation</td>
<td>10</td>
</tr>
<tr>
<td>5. Year work / practical record (CIA)</td>
<td>10</td>
</tr>
<tr>
<td>6. Project work review of literature and synopsis preparation (CIA)</td>
<td>10</td>
</tr>
<tr>
<td>7. Slide preparation and submission</td>
<td>10</td>
</tr>
<tr>
<td>8. Viva voice</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

**Suggested Readings**

1. Environmental Law for the Built Environment by Jack Rostron
2. Fundamental of Ecology by Odum
3. Environment Protection and the Law by Dr. R K Khitoliya
4. Environmental Studies by Singh, Thakur & chauhan
5. Concepts of Ecology by Edward J. Kormondy
7. Ecology and Environment by P D Sharma
8. Modern Concept of Ecology by H D Kumar
9. Biodiversity: Science and Development by Castri, f d & Younes

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
11. Biodiversity by E O Wilson
13. Diversity of Life by E O Wilson
14. Threatened Animals of India- B K Tikadar
15. Environmental science – A Practical manual – l.g Swarjya –PB- B.S Publication
16. Practical skills in Environmental science – PB – by Allen Jones
17. Water analysis – by N.K Dutta – University book house
18. Handbook of water and waste water analysis – by Kanwaljeet Kaur ( HB) –Atlantic publisher
21. Soil analysis –P.C Bandyopadhyay ( HB) Daya Publishing house
22. Modern methods in environmental pollution analysis- Harh Kumar – Sarup and sons
23. Principles and practices of air pollution, control & analysis – J.R Mundakavi –IK P. house
24. Environmental pollution analysis - S.M Khopkar – PB- New Age publication

### MSZO313B ENTOMOLOGY-I
**INSECT- STRUCTURE & FUNCTION**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Insect morphology - Head- Structure &amp; Different Mouth parts. Thorax- Appendages and Wings, &amp; Wing venation, Flight Mechanism, Abdomen &amp; its Appendages</td>
</tr>
<tr>
<td>2</td>
<td>Structure &amp; Function of Alimentary Canal &amp; Associated glands, Feeding, Nutrition, Digestion and Absorption</td>
</tr>
<tr>
<td>3</td>
<td>Excretory organs, Elimination of Nitrogenous Waste, Salt and water regulation, Detoxification</td>
</tr>
<tr>
<td>4</td>
<td>Tracheal system &amp; Respiration in Terrestrial Insects. Respiration in Aquatic insects &amp; Endoparasitic insects</td>
</tr>
<tr>
<td>5</td>
<td>Circulatory system, Composition and function of Haemolymph, Insect immunity.</td>
</tr>
</tbody>
</table>

### MSZO314B ENTOMOLOGY-II
**SYSTEMATICS, ECOLOGY AND ECONOMIC ENTOMOLOGY**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Systematics- Classification, habit, habitat and distinguishing characters of different orders of class insect ( up to major families.)</td>
</tr>
<tr>
<td>2</td>
<td>Thysanura</td>
</tr>
<tr>
<td>3</td>
<td>Collembolla</td>
</tr>
<tr>
<td>4</td>
<td>Thysanoptera</td>
</tr>
<tr>
<td>5</td>
<td>Hemiptera</td>
</tr>
<tr>
<td>6</td>
<td>Lepidoptera</td>
</tr>
<tr>
<td>7</td>
<td>Isoptera</td>
</tr>
<tr>
<td>2</td>
<td>Ecology-Intraspecific &amp; Interspecific relations, Social behavior in Hymenoptera and Isoptera, Effect of various Abiotic factors on Insect life.</td>
</tr>
<tr>
<td>3</td>
<td>Medical entomology- Morphology, Vectorship, Pathogenicity, &amp; Control of –</td>
</tr>
<tr>
<td>1</td>
<td>Anopheles, Culex, Aedes- (Mosquito)</td>
</tr>
<tr>
<td>2</td>
<td>Musca (Housefly)</td>
</tr>
<tr>
<td>3</td>
<td>Xenopsylla (Rat flea)</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
### Unit 4: Industrial entomology - Biology Cultivation of beneficial insects -
1. *Laccifera lacca*
2. *Bombyx mori*
3. *Apis* sp

### Unit 5: Household pests: Morphology, damage caused & control measures -
1. Cockroach
2. Cricket
3. Ants & termites
4. Bedbugs
5. Silver fish
6. Carpet beetle

### MSZO322B PRACTICAL (COVERING MSZO313B AND MSZO314B)

1. To study variations and different modifications of external morphology of insects.
2. To study variations and different modifications of Antennae, Mouth parts, Wings, Legs, genitalia & ovipositor of different insects.
4. To study different developmental stages of life cycle of mulberry silk worm (*Bombyx mori*) & lac insects (*Laccifer lacca*).
5. To study different developmental stages of life cycle of stored grain pests - *Oryzaephilus/ Callosobruchus/ Rhyzopertha/ Sitophilus*.
6. To study different developmental stages of life cycle of butterfly (*Daniadae / Papilionidae*).
7. To study the food preference of *Tribolium* in different food grains.
8. To study different types of insects traps.
9. To study haemolymph of cockroach and identification of different types of haemocytes.
11. Dissection of Digestive system & nervous system of -
   1. *Gryllus*
   2. Cockroach
12. Insect’s collection, preservation & identification (25 insects) of the orders Hemiptera, Lepidoptera, Isoptera.
13. Identification of different insect upto families using dichotomous key.
14. Preparation and submission of 20 permanent entomological slides.
15. Preparation of Synopsis of assigned Project Work.

#### Marking scheme

<table>
<thead>
<tr>
<th>Distribution of Marks</th>
<th>Maximum marks</th>
<th>Time duration</th>
<th>Marks allotted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dissection</td>
<td>20</td>
<td>6 hrs</td>
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</tr>
<tr>
<td>2. Slide preparation-</td>
<td>10</td>
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<tr>
<td>3. Spots(5 spots X 3)</td>
<td>15</td>
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<tr>
<td>4. Collection of insects, preservation &amp; identification</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>5. Year work / practical record (CIA)</td>
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<td>6. Project work Synopsis (CIA)</td>
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<tr>
<td>7. Slide submission(20 slides)</td>
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<tr>
<td>8. Viva voice</td>
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</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
9. Identification from dichotomous key  05
Total  100

**Suggested Readings**

3. Useful and Destructive Insects by Matcalf & infl
4. Elements of Entomology- Rajendra Singh- Rastogi Publications.
6. Applied Entomology by Nigum & Kumar
7. Introduction to General and Applied *Entomology* by V B Avasthi
12. A Text Book of General Entomology by M.S. Mani
13. Modern Entomology by Tembhare, D.B.
15. How to Collect and Preserve Insects: Guide Leaflet Series, No. 39 - Frank Eugene Lutz (Author) , Publisher: Literary Licensing, LLC (Aug 25 2012),
16. Handbook of Entomology- M. R. Dhingra, Publisher- Oxford Book Company,
17. Medical Entomology for Students - Mike Service (Author), Publisher: Cambridge University Press; 4 edition,
18. Handbook of Medical Entomology- William A. Riley, Publisher- Dyson Press, 2009,
19. Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods- B.F. Eldridge, J.D. Edman, Publisher- Springer, 2003,
21. Ray, D.N. and A.W.A. Brown : Entomology Medical & Veterinary
22. Bursel, E. : An Introduction to Insect Physiology
23. Rockstein M. : The Physiology of Insects (Vol. 1–VI)
**MSC ZOOLOGY IV SEMESTER**

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
<th>PD/W</th>
<th>EXAM</th>
<th>CIA</th>
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<tr>
<td>MSZO 411</td>
<td>CHORDATE BIOLOGY II</td>
<td>6</td>
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<td>100</td>
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<tr>
<td>MSZO412</td>
<td>APPLIED ZOOLOGY – ITS TOOLS AND TECHNIQUES</td>
<td>6</td>
<td>3hrs</td>
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<td>100</td>
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<tr>
<td>MSZO 413A</td>
<td>ENVIRONMENTAL BIOLOGY I / ENTOMOLOGY-I (INSECTS-FUNCTION AND DEVELOPMENT)</td>
<td>3/</td>
<td>3hrs</td>
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<td>80</td>
<td>100</td>
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<tr>
<td>MSZO 413B</td>
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<tr>
<td>MSZO414A</td>
<td>ENVIRONMENTAL BIOLOGY II / ENTOMOLOGY-II (SYSTEMATICS, AGRICULTURE ENTOMOLOGY AND PEST MANAGEMENT)</td>
<td>3/</td>
<td>3hrs</td>
<td>20</td>
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<tr>
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<tr>
<td>MSZO421</td>
<td>PRACTICAL</td>
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<td>6hrs</td>
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<tr>
<td>MSZO422A</td>
<td>PRACTICAL</td>
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<td>100</td>
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<tr>
<td>MSZO422B</td>
<td>PRACTICAL</td>
<td>12</td>
<td>6 hrs</td>
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</table>

**MSZO411 CHORDATE BIOLOGY II**

**Unit 1**
Origin of birds, Affinities, Feathers in birds, Mechanism of flight in birds, Flightless birds, Palate, Aquatic birds

**Unit 2**
Types of Beaks and Claws in birds, Parental Care in Birds, Migration in birds, Economic importance of birds, connecting link- *Archaeopteryx*

**Unit 3**
Origin and Classification (up to sub orders) of Mammals, Prototheria, Metatheria and Eutheria, Parental care in Mammals, Aquatic Mammals, Dentition in Mammals

**Unit 4**
Flying mammals (Chiroptera) and their adaptation, Comparative account of Old & New world Monkeys, Ancestry of Horse and Man

**Unit 5**

**MSZO412 APPLIED ZOOLOGY – ITS TOOLS & TECHNIQUES**

**Unit 1**
Microscopy: Principle of light transmission, Light Microscopy, Phase contrast, fluorescence microscopy, confocal electron microscopy, *Golgi complex and mitochondria* separation by centrifugation, Spectrophotometry - Principle & application of UV and visible spectrophotometer

**Unit 2**
Medical Zoology: Host-Parasite relationship, Mode of infection & pathogenicity of following pathogens with reference to main prophylaxis and treatment – *Plasmodium*, *Giardia*, *Schistosoma*, *Wucheria*, *Taenia*, *Enterobius*

**Unit 3**
Apiculture: Species of Honey bees in India, identification of Queen, worker, drone, Types of care & maintenance of bee colonies. Bee hives, Bee Enemies, Extraction of honey and Processing, Nutritive & Medicinal values of Honey. Lac culture- cultivation, processing, enemies and uses of lac

**Unit 4**
Aquaculture: Fresh water fishes, Transportation of fish seed & brooders, Induced breeding, Composite fish culture, Fish Farm layout and its management, Fish products, Fresh water Prawn culture – Species, Technology and Economics, Pearl culture - Culture techniques

**Unit 5**
Population dynamics of Insect Pests, Principles of biological, chemical, mechanicals, Cultural control of pest, Integrated Pest Management

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
<table>
<thead>
<tr>
<th>Distribution of Marks</th>
<th>Marks allotted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dissection</td>
<td>15</td>
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<tr>
<td>2. Spots 5 spots x 3</td>
<td>15</td>
</tr>
<tr>
<td>3. Preparation</td>
<td>10</td>
</tr>
<tr>
<td>4. Year work/practical record (CIA)</td>
<td>10</td>
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<tr>
<td>5. Seminar (CIA)</td>
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<tr>
<td>6. Awareness file</td>
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<tr>
<td>7. Tour Report</td>
<td>20</td>
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<tr>
<td>8. Viva voice</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**Suggested readings**

2. Vertebrate life- Pough and McFerland
3. Life of Vertebrates . J. Z. Young
6. The Vertebrate body- Romer & Parsons
7. Biology of Vertebrates- Walter & Sayles
8. Elements of Chordate Anatomy- Weichert
9. Analysis of Vertebrate Structure- Hildebrand
10. Fish and Fisheries- Shukla, Pandey
11. Applied Entomology- P. G. Fenemore, A Prakash
12. Freshwater Aquaculture- Santhanam et al.
13. Sericulture & Silk Industry- D. C. Sarkar
14. Economic Zoology- Shukla Upadhyay
15. Elements of Entomology - Rajendra Singh
16. Insect Pest of crop - S. Pradhan
17. Applied zoology - Ansari, Varma, Sharma
18. Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods - B.F. Eldridge, J.D. Edman, Publisher - Springer, 2003,

**MSZO413A ENVIRONMENTAL BIOLOGY I**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 2</td>
<td>Environmental Pollution – Air pollution – Types of pollutants, secondary air pollution, effect and control. Water pollution – Types of pollutants, sources, effects and control. Noise pollution – Source, properties, measurements of noise, effect &amp; control.</td>
</tr>
<tr>
<td>Unit 3</td>
<td>Environmental Pollution – Soil pollution- sources, effects and control, Radiation Pollution – Types of radiation, nuclear fallouts, effect of radiation on ecosystem, Nuclear accident. Thermal Pollution – Source, effect and control</td>
</tr>
<tr>
<td>Unit 4</td>
<td>Impact of environmental pollution – Global warming, Acid rain, Green house effect, Ozone layer depletion, Solid Waste – Disposal &amp; Management.</td>
</tr>
<tr>
<td>Unit 5</td>
<td>Ecotoxicology – Introduction, types of ecotoxicants, Dose –Response Relationship. Toxic effects and impact from individual to ecosystem</td>
</tr>
</tbody>
</table>

**MSZO414A ENVIRONMENTAL BIOLOGY II**

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Bioaccumulation, Biomagnifications – Biological transfer of bioaccumulation in ecosystem. Bioremediation – Need, merits, scope and current status. Biodegradation – plastic and pesticides.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 2</td>
<td>Health Hazards – Pesticides, Heavy metals, Dyes, Detergents and Fertilizers. Monitoring and remedial measures to control these pollutants</td>
</tr>
<tr>
<td>Unit 4</td>
<td>Remote Sensing – Introduction, physical basis for remote sensing, process, specified remote sensing satellites , system for data collection. Application &amp; advantages of remote sensing.</td>
</tr>
</tbody>
</table>

**MSZO422A PRACTICALS**

<table>
<thead>
<tr>
<th>Practical</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Biomass and population density of terrestrial group, sampling and statistical analysis.</td>
</tr>
<tr>
<td>2</td>
<td>Measurement of potassium in water using flame photometric method.</td>
</tr>
<tr>
<td>3</td>
<td>Measurement of magnesium in water</td>
</tr>
<tr>
<td>4</td>
<td>Measurement of Chloride in water</td>
</tr>
<tr>
<td>5</td>
<td>Measurement of Silicate in water</td>
</tr>
<tr>
<td>6</td>
<td>Estimation of tannin in polluted water</td>
</tr>
<tr>
<td>7</td>
<td>Estimation of water quality index</td>
</tr>
<tr>
<td>8</td>
<td>Assessing the noise pollution level</td>
</tr>
<tr>
<td>9</td>
<td>Assessing the respirable particulate matter (PM$<em>{10}$)/ fine particulate matter (PM$</em>{2.5}$) in ambient air</td>
</tr>
<tr>
<td>10</td>
<td>Assessing the gaseous pollutants (SO$_2$, NO$_x$), and ozone in ambient air</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
11. Study of microbes in polluted and fresh water
12. Identification and study of different migratory birds of this region
13. Visit to environmental important site.
14. Project Report

<table>
<thead>
<tr>
<th>Marking scheme</th>
<th>Maximum marks 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution of Marks</td>
<td>Marks allotted</td>
</tr>
<tr>
<td>1. Experiment A</td>
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</tr>
<tr>
<td>2. Experiment B</td>
<td>15</td>
</tr>
<tr>
<td>3. Experiment C</td>
<td>10</td>
</tr>
<tr>
<td>4. Spots 5x3</td>
<td>15</td>
</tr>
<tr>
<td>5. Year work/practical record (CIA)</td>
<td>10</td>
</tr>
<tr>
<td>6. Project work report submission and presentation (CIA)</td>
<td>10</td>
</tr>
<tr>
<td>7. Visit to environmental important site</td>
<td>10</td>
</tr>
<tr>
<td>8. Viva voice</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

Suggested Readings
1. Environmental Law for the Built Environment by Jack Rostron
2. Fundamental of Ecology by Odum
3. Environment Protection and the Law by Dr. R K Khitoliya
4. Environmental Studies by Singh, Thakur & chauhan
5. Concepts of Ecology by Edward J. Kormondy
7. Ecology and Environment by P D Sharma
8. Modern Concept of Ecology by H D Kumar
9. Threatened Animals of India by B K Tikadar
10. Environmental science – A Practical manual – l.g Swariya –PB- B.S Publication
11. Practical skills in Environmental science – PB – by Allen Jones
13. Handbook of water and waste water analysis – by Kanwaljeet Kaur (HB) –Atlantic publisher
16. Soil analysis – by P.C Bandyopadhyay (HB) Daya Publishing house
17. Modern methods in environmental pollution analysis- Harh Kumar – Sarup and sons
18. Principles and practices of air pollution, control and analysis – by J.R Mundakavi –IK publishing house
21. Standard Methods For the Examination of Water and Wastewater (Hardcover) by Lenore S. Clesceri, Andrew D. Eaton, Eugene W. Rice, Rodger B. Baird (HB) – 22 nd Ed by American Public Health Association APHA – Published by Alpha publishing

**MSZO413B ENTOMOLOGY I**
*(INSECTS- FUNCTION AND DEVELOPMENT)*

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Nervous System – Basic Components, Basic Function Anatomy, Brain, Transmission of nerve, impulse in insects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 2</td>
<td>Endocrine System – Endocrine organs, Hormones and Pheromones, Endocrine control of Polymorphism in Insects.</td>
</tr>
<tr>
<td>Unit 3</td>
<td>Perception of the Environment:-</td>
</tr>
</tbody>
</table>

2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
| Unit 1 | Systematics  
Classification, habit, habitat and distinguishing characters of different order of class Insecta classification up to major families.  
1. Odonata  
2. Orthoptera  
3. Diptera  
4. Hymenoptera  
5. Coleopter |
|---|---|
| Unit 2 | Agriculture entomology - I  
Systematic position, morphology, Damage and Control Measures of –  
1. Pests of Vegetables & Fruits :-  
   a. *Dacus cucurbitae* (Melon fly)  
   b. *Papilio demoleus* (Lemon butterfly)  
2. Pests of Sugarcane:-  
   a. *Pyrilla perpusilla* (Sugarcane leaf hopper)  
   b. *Scirpophaga novella* (Sugarcane top borer)  
3. Pests of pulses and oilseeds:-  
   a. *Helicoverpa armigera* (Cotton boll worm)  
   b. *Lipaphis erysini* (Mustard Aphid)  
4. Polyphagus Pests :-  
   a. *Schistocerca gregaria* (Desert Locust)  
   b. *Locusta migratoria* (Migratory Locust) |
| Unit 3 | Agriculture entomology - II  
1. Pests of cereals :-  
   a. *Mythimna seperata* (Northern armyworm)  
   b. *Sitobion avenae* (Wheat Aphid)  
2. Pests of fiber crop:-  
   a. *Pectinophora gossypiella* (Pink boll worm )  
   b. *Dysdercus koenigii* (Cotton stainer)  
3. Pests of paddy:-  
   a. *Dicladispa armigera* (Spiny Leaf Beetle)  
   b. *Spodoptera sps* (African army worm)  
4. Pests of stored grains:- |
| Unit 4 | Forensic entomology:  
1. Introduction  
2. Insects of forensic importance  
3. Entomological evidence collection during death investigations  
4. Forensic entomological decomposition  
5. Preliminary idea about Post Mortem Interval (PMI)  
6. Preliminary idea about some forensic important insects- Flies & Beetles |
|---|---|
| Unit 5 | Pests management  
1. Concept of Pests.  
2. Physical, Mechanical, Cultural & Biological Control.  
4. Integrated pest management (IPM)  
5. Brief idea about Control of Bees and Wasps |

### MSZO422B PRACTICALS

1. Culture of *Drosophila* and study of its different developmental stages of life cycle.  
2. To isolate and mount salivary glands of *Drosophila*.  
3. To identify male and female individual from the given Grasshopper set.  
4. To study artificial bee hive structure and its different parts.  
5. To study different plant protecting equipments. (Spraying & Dusting)  
6. Method of formulation and dilution of different insecticides.  
7. Study of different castes of honey bee and termite.  
8. To study structure of termitarium / Bee Hive/ Wasp Hive  
9. Mounting : sting apparatus of Honey bee/ Wasp  
10. To identify and locate tympanum of Grasshopper  
11. Dissection :- Digestive and Nervous System of  
   a. Grasshopper  
   b. Honey bee  
   c. Wasp  
12. Insect Collection, preservation and identification of insects. 25 different insects of - Odonata, Orthoptera, Diptera, Hymenoptera, Coleoptera.  
13. Identification of different order of insects up to families by using dichotomous keys.  
14. Preparation and submission of 20 permanent entomological slides  
15. Project Report/ Presentation.

### Marking scheme

<table>
<thead>
<tr>
<th>Distribution of Marks</th>
<th>Maximum marks 100</th>
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<tbody>
<tr>
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<td>20</td>
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<tr>
<td>2. Slide preparation-</td>
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<td>5. Year work / practical record (CIA)</td>
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<tr>
<td>6. Project work report submission and presentation (CIA)</td>
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</tr>
<tr>
<td>7. Slide submission (20 slides)-</td>
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<td>10</td>
</tr>
<tr>
<td>8. Viva voice</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>9. Identification from dichotomous key.-</td>
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<td>05</td>
</tr>
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<td><strong>100</strong></td>
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2016-2017 (I & II Sem) and 2017-2018 (III & IV Sem)
Suggested reading

4. Agriculture Entomology, H. S. Dennis, Timber Press Inc.
5. A Text Book of Agricultural Entomology ESSIG : College Entomology by Hemsingh Pruthi
8. Oldoyd, N. : A Collection, Preserving and Studying Insects
9. Roger P. and Anderson : Forest and Shade Tree Entomology
11. Smith, K.G.V. : Insects and Other Arthropods of Medical Importance

Applied Entomology: ICAR JRF ARS SAUs Entrance Exams UPSC Civil Services Prelims 2nd ed , Author: D S Reddy