OPJS UNIVERSITY, CHURU (RAJ.)

SYLLABUS

for

M.Sc. (Bio-Technology)

(Annual Scheme)

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School of Science

OPJS UNIVERSITY, CHURU (RAJASTHAN)

2014-15

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### M.Sc. (Bio-Technology)

#### (Previous)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Paper code</th>
<th>Name of Papers</th>
<th>M.M.(T./S./P.)</th>
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<tbody>
<tr>
<td>1.</td>
<td>MSBY-101</td>
<td>Cell Biology</td>
<td>70+30</td>
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<tr>
<td>2.</td>
<td>MSBY-102</td>
<td>Biological Macromolecules and Basic Enzymology</td>
<td>70+30</td>
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<td>3.</td>
<td>MSBY-103</td>
<td>Microbial diversity, Physiology and Genetics</td>
<td>70+30</td>
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<td>4.</td>
<td>MSBY-104</td>
<td>Molecular Biology</td>
<td>70+30</td>
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<td>5.</td>
<td>MSBY-105</td>
<td>Virology Immunology</td>
<td>70+30</td>
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<td>6.</td>
<td>MSBY-106</td>
<td>Genetic Engineering</td>
<td>70+30</td>
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<td>7.</td>
<td>MSBY-107</td>
<td>Practical-I(Based on theory papers-I,II,andIII)</td>
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#### (Final)

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<tr>
<td>1.</td>
<td>MSBY-201</td>
<td>Animal Cell Science and Technology</td>
<td>70+30</td>
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<td>2.</td>
<td>MSBY-202</td>
<td>Plant biotechnology</td>
<td>70+30</td>
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<td>3.</td>
<td>MSBY-203</td>
<td>Bioprocess Engineering and Technology</td>
<td>70+30</td>
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<td>4.</td>
<td>MSBY-204</td>
<td>Bioresource and Environmental Biotechnology</td>
<td>70+30</td>
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<td>5.</td>
<td>MSBY-205</td>
<td>Practical-II( Based on theory papers-VII to X)</td>
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<td>6.</td>
<td>MSBY-206</td>
<td>Elective (Internal evaluation)</td>
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<td>6.</td>
<td>MSBY-207</td>
<td>Dissertation</td>
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Details of Syllabus

(Previous)

MSBY-101 - CELL BIOLOGY

I.


II.

The cytoskeleton: The self assembly and dynamic structure of cytoskeletal filaments, how cells regulate their cytoskeletal filaments; molecular motors, the cytoskeleton and cell behavior. Microtubule motors & movements. Cell-cell interactions: Cell Adhesion proteins, tight & gap junctions, plant cell adhesion & plasmodesmata.

III.

Techniques for cell study: Different types of microscopy, cell fractionation methods, X-ray diffraction & NMR spectroscopy, Histochemistry, Microtomy, FISH, GISH.


IV.


V.

Cellular basis of differentiation and development - mitosis, gametogenesis and fertilization. Development in Drosophila and Arabiopsis; PM5 spatial & temporary regulation of gene
expression.

Biostatistics brief description and tabulation of data and its graphical representation. Measures of central tendency and dispersion: mean, median, mode, range, standard deviation, variance, idea of two types of errors and level of significance, test of significance (F & T test), chi-square tests. Simple linear regression and correlation.

Practicals:-
1. Microscopy: Demonstration of different types of microscopes.
2. Microtomy
3. Instrumental methods for the cell biology.
4. Sub-cellular fractionation & marker enzymes.
5. Histochemical localization of protein, carbohydrate, fats, starch, lignin, DNA, RNA etc.
6. Mitosis and Meiosis

Books:-
1. Molecular Biology of Cell, Alberts, B et al.

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MSBY-102 - BIOLOGICAL MACROMOLECULES AND BASIC ENZYMEOLOGY

I.

Principles of thermodynamics, first and second law, concept of free energy, high energy compounds, Amino acids and peptides- classification, chemical reactions and physical properties.
Proteins-classification, hierarchy in structure, Ramachandran map. Protein sequencing, Glyco and lipoproteins-structure and function.

II.
Sugars-Classification and reactions, Polysaccharides-types, structural features, methods for compositional analysis.
Lipids-Classification, structure and functions, glycerophospholipids, sphingolipids, cholesterol and its biosynthesis. Polynucleotides: biosynthesis of purines and pyrimidines, de novo and salvage pathway.
Secondary metabolites in living systems: Alkaloids, Steroids and Flavonoids. Macromolecules and
super molecular assemblies-like membranes, ribosomes, chromosomes.

III.

Enzymes and coenzymes, classification, enzyme inhibition, enzyme kinetics Michalis Menten Equation, Km value, Kinetics of bi-bi substrate reaction, regulation of enzyme activity, feedback inhibition and allosteric control. Enzyme catalysis in solution, effect of organic solvents on enzyme catalysis, Immobilization of enzymes and its application, determination of active sites.

IV.


V.

Protein and nucleic acid data bases: structural comparison at secondary and tertiary levels. Computer aided drug designing, Computational techniques in structural analysis; Nanoparticles.

Practical:-
1. Reactions of amino acids, sugars and lipids.
2. Isolation, purity determination and quantitation of cholesterol, DNA and RNA.
3. Electrophoresis of Proteins-native and under denaturing conditions.
5. Peptide mapping.
6. Quantitation of Proteins and Sugars.
7. Analysis of oils-iodine number, saponification value, acid number.
8. UV, Visible, Fluorescence and IR Spectroscopy. Absorption spectra.
9. Separation techniques-Centrifugation, Chromatography (Gepermeation, Ion exchange, TLC etc.) and Electrophoresis.
10. Separation techniques (HPLC, GPC, FPLC)

Books:-
**MSBY-103- MICROBIAL DIVERSITY, PHYSIOLOGY AND GENETICS**

I.

History and Development of Microbiology. Microbial evolution, systematic and taxonomy - Evolution of earth and earliest life forms; primitive organisms and their metabolic strategies and molecular coding; New approaches to bacterial taxonomy classification including ribotyping; Ribosomal RNA sequencing; Characteristics of primary domains; Taxonomy, Nomenclature and Bergey's Manual.

II.

Prokaryotic and eukaryotic diversity. Prokaryotic Cells: Structure and Function - Cell wall composition of Gram+ve & -ve bacteria; Cell wall and cell membrane synthesis; Flagella and motility; cell inclusions like endospores, gas vesicles. Bacteria: Purple and green bacterial, Cyanobacteria; budding bacteria, Spirochaetes; Sheathed bacteria, Endospore forming rods and cocci; Mycobacteria; Rickettsias, Chlamydia and Mycoplasmas, Archaea: Archaea as earliest life forms; Halophiles, Methanogens; Hyperthermophilic archaea and Thermoplasma. Eukarya: Algae, Fungi, Slime molds and Protozoa.

III.

Methods in Microbiology: Pure culture technique; and auxotrophs. Microbial Growth - The definition of growth, mathematical expression of growth, growth cure, measurement of growth and growth yields, Synchronous growth, Continuous, Batch and Fed Batch Culture; Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen; Culture collection maintenance and preservation.

III.

Physiology and Metabolic Diversity among Microorganisms - Nutritional classification of microorganisms - chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. Photosynthesis in microorganisms; Role of Chlorophylls, Carotenoids and phycobilins; Light and Dark Reaction; Chemolithotrophy; Hydrogen, Iron, Nitrate and oxidizing bacteria; Nitrate and sulfate reduction; Syntrophy; Role of anoxic decomposition; Nitrogen metabolism; Nitrogen fixation; Hydrocarbon transformation.
IV.

Microbial Diseases-Disease reservoirs; Epidemiological terminologies; infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including; Disease transmitted by animals (rabies), insects and ticks (rickettsias, malaria), Food and water borne diseases; Public health and water quality; Pathogenic fungi; Emerging and resurgent infectious diseases.

Host Parasite Relationships-Normal microflora of skin, oral cavity, gastrointestinal tract; entry of pathogens into the host; colonization and factors predisposing to infections; types of toxins (Exotoxin, Endotoxin and Enteroxin) and their structure; mode of actions; virulence and pathogenesis.

V.

Chemotherapy and Antimicrobial agents; Sulfur drugs; Antibiotics; Pencillins and Cephalosporins; Broad-Spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.


Practicals:

1. Preparation of liquid and solid media for growth of microorganisms.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution methods, slants and stab cultures, storage of microorganisms.
3. Isolation of pure cultures from soil and water.
5. Microscopic examination of bacteria, yeast and molds and study of organisms by Gram stain, Acid fast stain and staining for spores.
7. Assay of antibiotics and demonstration of antibiotic resistance.
8. Analysis of water for potability and determination of MPN.
9. Biochemical characterization of selected microbes.
10. Effect of antibiotics on microbes.
11. Other practical based on theory syllabus.
Books:

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MSBY-104 - MOLECULAR BIOLOGY

I


II.


III.

Oncogenes and Tumor Suppressor Genes-Viral and cellular oncogenes, tumor suppressor genes from humans, Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins. Antisense and Ribozyme Technology-Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, Applications of antisense and ribozyme technology.
IV.

Homologous Recombination-Holiday junction, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination, Rec A and other recombinases.
Molecular Mapping of Genome-Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, Southern and fluorescence in situ hybridization in genome analysis: RELP, RAPD and AFLP analysis, Molecular marker linked to disease resistance genes, Application of RFLP in forensic, diseases prognosis, genetic counselling, and Pedigree, varietal etc. Animal trafficking and poaching; Germplasm maintenance, taxonomy and bio-diversity.

V.

Genome Sequencing-Genome sizes, organelle genomes, Genomic libraries, YAC, BAC libraries, Strategies for sequencing genome, Packaging, transfection and recovery of clones, Application of sequence information for identification of defective genes.

Practical:

1. Isolation of genomic DNA.
2. Southern blotting.
3. RFLP analysis
4. Isolation of RNA.
5. Isolation of polyA+RNA.
7. Preparation of probes.
8. In vitro transcription
10. Metabolic labelling of proteins and immunoprecipitation.

Books:

MSBY-105- VIROLOGY AND IMMUNOLOGY

I.

Brief outline on discovery of viruses, nomenclature and classification of viruses (LHT system; Classification as per VII report of the international committee on taxonomy of viruses), distinctive properties of viruses; morphology and ultrastructure; capsids and their arrangements; envelopes and their composition; viral genome, their types and structure; virus related agents (viroids, prions), Bacteriophage-structural organization; replication, one step growth curve; eclipse phase; phage production; burst size; lysogenic cycle brief details of X174, t7, t4 M13, Mu, Lambda and PI.

II.

Cultivation of viruses in embryonated eggs, experimental animals and cell cultures; primary and secondary cell cultures; suspension cell cultures and monolayer cell cultures; assay of viruses- physical and chemical methods (Protein, nucleic acid, electron microscopy), brief account of assay of viruses using serological techniques. Infectivity assay (plaque method, end point method).

III.

Effects of viruses on plants; appearance of plants; histology, physiology and cytology of plants; common virus diseases of plants; paddy, tomato and sugarcane; viruses of cyanobacteria, algae, fungi; replication of plant viruses; type species of plant viruses like TMV, Cauliflower mosaic virus and potato virus X; transmission of plant viruses with vectors (insects, nematodes, fungi) and without vectors (contact, seed and pollens). Brief account of diagnostic techniques in plants; infectivity assay of plant viruses, indicator plants, isolation and purification of plant viruses, serological methods, histochemical tests. Prevention of crop loss due to virus infection - virus-free planting material; vector control.

IV.

Animal and human viruses - epidemiology replication, pathogenicity, diagnosis prevention and treatment of RNA Viruses, Picorna, Orthomyxo, Parmyxo, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic viruses; DNA viruses; Pox, Herpes, Adeno, SV 40; Hepatitis viruses. Viral vaccines (conventional vaccines, genetic recombinant vaccines used in national immunization programmes with examples) interferons, and antiviral drugs.
V.


Major histocompatibility complex - cells of the immune system, haematopoesis and differentiation, lymphocyte trafficking, B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, langerhan cells, Natural killer cells and lymphokine activated killer cells, eosinophils, neutrophils and mast cells.

VI.

Regulation of immune response - antigen processing and presentation, generation of humoral and cell mediated immune responses; activation of B and T-lymphocytes, cytokines, and their role in immune regulation. T-cell regulation, MHC restriction, immunological tolerance.


Practical:

1. Study of various symptoms produced in plants due to virus infection.
2. Study of viral diseases of plants/animals/human (Specimen/photographs).
3. Different type of viruses (Photographs/ sketches).
4. Raising virus free plants through apical meristem culture.
6. Lymphoid organs and their microscopic organization.
7. Immunization, Collection of Serum.
8. Double diffusion and Immuno-electrophoresis.
12. Con-A induced proliferation of thymocytes (by MTT method).
13. Western-blotting.
14. ELISA.
15. Hapten Conjugation and quantitation.
16. Immunodiagnostics (demonstration using commercial kits).

Books:

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MSBY-106- GENETIC ENGINEERING

I.


II.


III.

Site-directed Mutagenesis and Protein Engineering. How to Study Gene Regulation? DNA transfection, Northern blot, Primer extension, SI mapping, RNase protection assays, Reporter assays. Expression Strategies for Heterologous Genes - Vector engineering and codon optimization, host engineering, in vitro transcription and translation, expression in bacteria, expression in
yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants. Processing of Recombinant proteins - Purification and refolding, characterization of recombinant proteins, stabilization of proteins. Phage Display.

IV.


V.


Practical:

1. Bacterial culture and antibiotic selection media. Preparation of competent cells.
2. Isolation of plasmid DNA.
3. Isolation of Lambda phage DNA.
4. Quantitation of nucleic acids.
5. Quantitation of nucleic acids.
6. Construction of restriction map of plasmid DNA
7. Cloning in plasmid/phagemid vectors.
9. Preparation of single stranded DNA template.
10. DNA sequencing.
12. PCR

Books:

I.
Introduction to the balance salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements.

II.

III.
Basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture; maintenance of cell culture; cell separation. Scaling-up of animal cell culture, Cell synchronization.

IV.

V.
and tissue engineering.

**Practical:**

1. Preparation of tissue culture medium and membrane filtration.
2. Preparation of single cell suspension from spleen and thymus.
3. Cell counting and cell viability.
4. Macrophage monolayer from PEC, and measurement of pathogenicity activity.
5. Trypsinization of monolayer and subculturing.
6. Cryopreservation and thawing.
8. Role of serum in cell culture.
9. Preparation metaphage chromosome from cultured cells.
10. Isolation of and demonstration of apoptosis of DNA laddering.
11. MTT assay for cell viability and growth.
12. Cell fusion with PEG.

**Books:**


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**MSBY-202 - PLANT BIOTECHNOLOGY**

I.

Initiation and maintenance of callus and suspension culture; single cell clones. Organogenesis; somatic embryogenesis; transfer and establishment of whole plants in soil. Shoot-tip culture: rapid clonal propagation and production of virus-free plants.

II.

Embryo culture and embryo rescue. Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids. Another, pollen and ovary culture for production of haploid plants and homozygous lines. Cryopreservation, slow growth and DNA banking for germ plasm conservation. Basic techniques in rDNA technology.

III.
Plant Transformation Technology: basis of tumor formation, hairy root, features of TI and RI plasmid, mechanisms of DNA transfer, role of virulence genes, use of TI and RI as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, reporter gene with introns, use of scaffold attachment regions, methods of nuclear transformation, viral vectors and their application, multiple gene transfers, vector less or direct DNA transfer, particle bombardment, electroporation, microinjection, transformation on monocots. Transgene stability and gene silencing.

IV.

Application of plant Transformation for productivity and performance herbicide resistance, phosphinothricin, glyphosate, sulfonyl urea, atrazine, insect resistance, Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated, nucleocapsid gene disease resistance, chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, PR proteins, nematode resistance, abiotic stress, post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase.

V.


VI.


Practical:

1. Preparation of media.
2. Surface sterilization
3. Organ culture.
4. Callus propagation, organogenesis, transfer of plants to soil.
5. Protoplast isolation and culture.
6. Anther culture, production of Haplods.
7. Cytological examination of regenerated plants.
8. Agrobacterium culture, selection of transformants, reporter gene (GUS) assays.
9. Developing RFLP and RAPD maps.

Books:

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MSBY-203- BIOPROCESS ENGINEERING AND TECHNOLOGY

I.

Isolation preservation and maintenance of industrial microorganisms, media for industrial fermentation, Air and media sterilization.

Types of Fermentation processes: Analysis of batch, fed batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations.

II.

Measurement and control of bioprocess parameters, Downstream processing: Introduction, Removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, Drying and crystallization. Whole Cell immobilization and their industrial Applications.

III.

Industrial Production of chemicals utilizing wastes: Alcohol (ethanol) Acids (citric, acetic and gluconic), solvents (glycerol, acetone, butand), antibiotics (Penicillin, streptomycin, tetracycline), Amino acids (lysine, glutamic acid), Single Cell Protein.

Use of microbes in mineral beneficiation and oil recovery.
IV.

Introduction to food Technology, Principles of food processing, Elementary idea of canning and packing, sterilization and pasteurization of Food Products, Technology of typical Food/Food Products (bread, cheese idli), Food Preservation.

Practicals:
1. Isolation of industrially important microorganisms for microbial processes.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
3. Comparative studies of Ethanol production using different substrates.
5. Microbial production of antibiotics (Penicillin).
7. Use of alginate for cell immobilization.

Books:
2. Biochemical Reactors, Atkinson, B., Pion Ltd. London.

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MSBY-204- BIORESOURCE AND ENVIRONMENTAL BIOTECHNOLOGY

I.

Water: Natural (scarce) resource and its management, Sources of water pollution and biological treatment processes and their microbiology: Aerobic Processes - Oxidation ponds, rotating discs, rotating drums; Anaerobic processes - Anaerobic digestion, anaerobic filters, Upflow anaerobic sludge blanket reactors.

II.

Microbiology of degradation of xenobiotics in Environment - Ecological hydrocarbons, oil pollution, surfactants, pesticides.
Solid wastes: Sources and management (composting, wormiculture and methane
production), bioremediation of contaminated soils and waste-land; Biopesticides in integrated pest management.

Global environmental problems: UV-B and Ozone depletion, Green house effect and acid rain, their effects and biotechnological approaches for management. Methodology of environmental management—the problem solving approach, its limitations.

III.

Biodiversity and its conservation; Plant germ plasm collection including of wild species, intraspecific variations in crop plants, molecular characterization of variations, issues of intellectual property rights and legal concerns of bioresource.

IV.

Origin of crop plants and their domestication, plants in human nutrition and animal food, human population growth and global food prospects, food security and availability of food, International agricultural research, CGIAR and agricultural research and development.

V.

Classical plant breeding, molecular basis of genetic modification and crop improvement programmes, GM food crops, biotechnology in controlling crop diseases, weeds, insects and pests.

Seed-biology, technology and role in agriculture, Seed certification, seed banks, terminator gene technology and implications, plant as chemical and pharmaceutical factories, biokosafety and GM food crops, international and local regulations.

Practical:

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of total dissolved solids of water.
3. Determination of dissolved oxygen concentration of water sample.
4. Determination of biological oxygen demand (BOD) of a sewage sample.
5. Determination of chemical oxygen demand (COD) of sewage sample.
7. Isolation of xenobiont degrading bacteria by selective enrichment technique.
8. Test for the degradation of a aromatic hydrocarbons by bacteria.
10. Effect of Sulphur dioxide on crop plants.
12. Estimation of nitrate in drinking water.
13. Study on biogenic methane production in different habitats.

**Books:**
2. Economic Botany, S.L. Kocher.

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**MSBY-205- ELECTIVE**

The Elective paper in the M.Sc. final year will be based on detailed review report on one of the courses listed in the syllabus. The student will make a complete report in about 100 pages that shall be evaluated by the course co-ordinator and one internal teacher. The marks will be awarded internally. It is proposed to include the following areas as part of elective papers.
2. Topics on human genetics and genetic dissection of heritable diseases and detection of associated mutations and diagnostics based on PCR.
3. Technologies being adapted for further applications like closing of animal with a capacity to produce human macromolecules.

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**MSBY-206- DISSERTATION**

Dissertation. The Project work will involve in depth practical work on a problem suggested by the supervisor of the candidate. The student will submit the dissertation of the work done. The dissertation submitted by the candidate shall be evaluated by one external expert, head of the department and supervisor of the candidate. The seminars, in-plant training and industrial visit reports will also be submitted by the candidate to the Head of the Department who will submit these to the external examiner. The examination shall be held in the department and the dissertation etc. will NOT be required to be mailed to the external examiner.

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