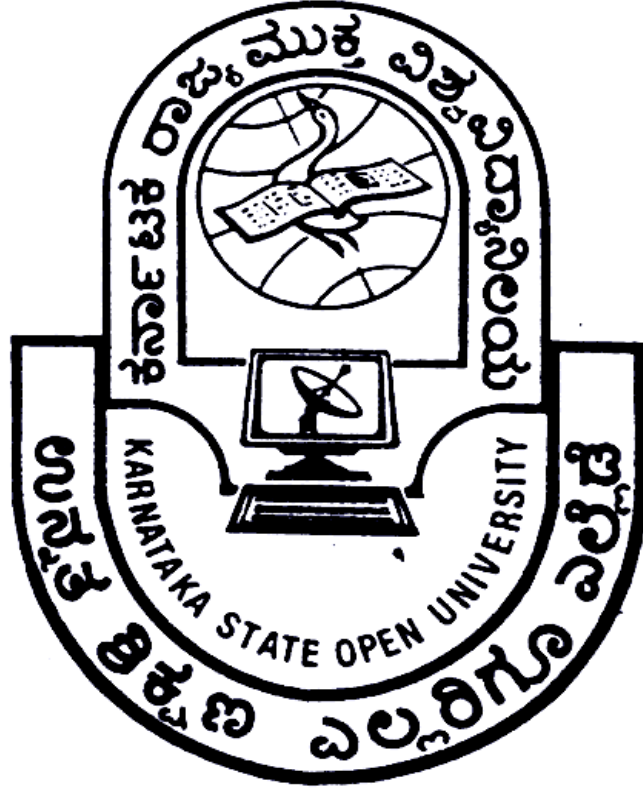


KARNATAKA STATE OPEN UNIVERSITY

PROGRAMME GUIDE

M.Sc in Microbiology



**DEPARTMENT OF POST GRADUATE STUDIES AND
RESEARCH IN MICROBIOLOGY**

Mukthagangothri, Mysore – 570 006

VICE-CHANCELLOR'S MESSAGE

Dear Learner,

The family of KSOU welcomes you to pursue the academic programmes you have chosen to achieve not only academic excellence but also to fulfill the desire of your career. The University, established by the Act of State Legislature has created wonderful academic ambience. The programmes offered by the University have been recognized by University Grants Commission. Therefore, the degrees are valid for employment opportunities across the country. The 'core values' of the University are derived from its vision 'Higher Education to Everyone, Everywhere'. The ultimate touchstone of quality higher education is the motto of the University. Today, higher education stands at the crossroads of keeping pace with the emerging needs of the country.

The University has adopted a school concept in its functioning. The school of science headed by a Director offers academic programmes in basic and applied sciences. It combines an inter disciplinary and professional approach to pedagogy and research. The University believes that rigors of the contemporary world require competent quality human resources to create knowledge based society. The academic activities of M.Sc. programmes are routed through well-established department/s led by the Chairperson/s. Well-qualified teaching faculty with equally dedicated non-academic team is an asset to the University, which is always, committed for the welfare of the students.

The University functions in a 3-tier system of student support service, namely Headquarters, Regional Centres and Learners Support Centres spread all over Karnataka. The learners can undergo teaching-learning process in the notified Regional Centres/Learner Support Centres. The University has adopted a mechanism to deliver Self Learning Material by print, limited audio visual and Counseling/Personal Contact Programme. As a learner, you will have greater opportunity to gain knowledge and skill through those mechanisms. The academic counselors will play a strategic role and supports you from the enrollment of the programme till you accomplish the goal. A proper blending of the knowledge and skill will be imparted so that you will be transformed as a good citizen to contribute to the development of society and the country.

The UGC in its Public Notice dated: 23.02.2018 stated that the Degree/Diploma/Certificate Programme awarded through distance mode are at par with corresponding Degree/ Diploma/ Certificate Programme obtained through conventional universities. The degrees acquired through distance education are recognized for the purpose of employment in State/Central Government, MNCs, Private Sector etc. and also for pursuing higher education in other educational institutes. Therefore, you have greater opportunity of pursuing Higher Education without any kind of fear about your career.

I am sure you will enjoy good experience with services rendered by the university through its Regional centres and Learner Support Centres, besides Headquarters. I wish you all the best in your academic endeavors.

Prof. Vidyashankar S

Programme Guide

1. **Department:** Department of Studies in Microbiology

2. **Chairman's message –**

Education has witnessed a rapid and tremendous transformation globally boosting a worldwide demand for online and distance education. Globalization, modern technologies, knowledge explosion, and increased international competition have only fueled the growing demand for distance mode of education delivery.

Science is defined as the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence. It is a vast field concerning almost everything that our eyes can see or cannot see. Biology is a natural science concerned with the study of life and living organisms. Biology has many sub-categories of which one important subject is Microbiology.

Microbiology is the — ‘scientific study of the microorganisms’. It essentially deals with the elaborated investigation of ‘microscopic organisms’ termed as microbes that are composed of single cell. Microbiology has grown leaps and bounds widening its horizons and opening new frontiers of knowledge.

There are many learners, both young and old, who could not afford to join the conventional microbiology degree course due to personal and professional responsibilities. This distance education mode of the M.Sc. in Microbiology is specially tailored to cater to those category of students who may not afford to attend full time classes like the employed persons, those who may not have secured admission in regular University/college, those who may have discontinued studied but interested to improve career opportunities and most importantly for those who want to gain knowledge in Microbiology.

Successful students rely on their proficiency to learn and monitor their own learning. In this context, this course has a well-structured set of self-learning material customized to learner's capacity and aptitude. This essentially is a self-study course along with required coaching through contact classes. However, the course is modulated to assess the pupils progress through checks involving direct dialogue between the instructors and learners. Laboratory and field work component are designed at regular stages which will add to the experience of the learner.

The scope of microbiology is immense and multifaceted with applications in various fields like agriculture, industry, dairy, medicine, forensics, pharmaceutical, clinical, environment, nanotechnology etc. A career in Microbiology holds tremendous scope and a bright future. Most lucrative and best job opportunities await microbiologists. After completion of the course these postgraduates have huge opportunities in various research and development laboratories of hospitals, research organizations, pharmaceutical, food, beverage and chemical industries labs, research institutes, industries, teaching filed etc.,

3. About the Department

Introduction

Microbiology has grown leaps and bounds widening its horizons and opening new frontiers of knowledge. The scope of microbiology as a subject is immense due to its ability to control all critical points of many fields like medical, dairy, pharmaceutical, industrial, clinical, research, water industry, agriculture, nanotechnology, etc. A career in microbiology is lucrative option and trained microbiologists are in demand in a vast range of industries and institutes like research and development laboratories of government and private hospitals, research organizations, pharmaceutical, food, beverage and chemical industries. The WTO, international relations between countries and liberalization, privatization and globalization have created conducive atmosphere in the country to establish several industries. At the same time a plethora of job opportunities have been emanated for the formal graduates/post-graduates in the relevant fields. Therefore, this program is offered in the distance mode as a parallel to the programmes offered by conventional mode.

Established in 2012 as one of the department of Faculty of Sciences in KSOU, the Department of Studies in Microbiology offers a Master's of Science programme in Microbiology. The Department has established state of art infrastructure and provides a good learning environment and focuses on providing students with best learning experience. In addition to the well qualified in-house teaching faculty, resource persons from other universities/institutes are invited to give lectures and seminars. The Department consists well equipped class-rooms and practical laboratories for lectures, exercises and practicums. The curriculum is comprehensive, updated and covers many aspects of microbiology which caters to employability, leadership, and an international outlook. Students also undergo training in basic experimental techniques required for both teaching and research. The Department also provides learners an exposure to research by including a dissertation research in the final semester to actively engage in research, by conducting independent research projects in the department laboratory or any other institute of their choice.

Vision

To provide excellent learning and knowledge enriching experience to the learners that has a transformative impact on society.

Mission

- To provide education to the learners to embrace the philosophy of learn, earn and return.
- To impart the knowledge and skill to the learners and thereby increase his/her professionalism.
- To create effective human resources by employing the ICT.

- To enhance the capacity of the learners to realize their individual, corporate and social responsibility.
- To impart education such that the learners inculcate moral, civil and ethical values.
- To provide education at affordable cost to the masses.

a. Faculty Details

a. Department of Microbiology

Sl. No.	Name of the Faculty	Designation	Qualification	Specialization	Experience in Years	Mobile Number
1	Dr. S. Niranjana Raj	Assistant Professor & Chairperson	M.Sc., M.Phil., Ph.D.	Mol. Plant Pathology	15	9886859350
2	Dr Syed Baker	Assistant Professor (Contract Basis)				
3	Dr. Mahadeva Kumar S	Assistant Professor (Contract Basis)				

4. Programmes Offered: M.Sc. in Microbiology

5. Preamble

Objectives:

- To provide advanced learning of core principles and specialized knowledge in the field of Microbiology.
- To pursue an efficient and less expensive option to acquire or update knowledge in Microbiology for qualified and willing learners.
- To familiarize the students with necessary laboratory techniques and tools of microbiology and provide an exposure in research, analytical and presentational skills.
- To acquire competency by adopting advanced scientific methods and exposure in clinical, practical and other research skills.
- To train the learners with appropriate critical thinking and problem-solving skills and aptitude for taking up various microbiology related job opportunities.

6. Course details

- a. *Syllabus* along with paper code, title of the course and credits

M.Sc. Microbiology – Revised Syllabus as per CBCS

M.Sc. Microbiology - First Semester

Course	Course Code	Course Title	Credits
HC Course 1	MB-1.1	Microbiology: Perspectives and Classification	4
HC Course 2	MB-1.2	Morphology and Ultrastructure of Bacteria (Prokaryotes)	4
SC Course 1	MB-1.3	Bacterial Growth and Physiology	3
SC Course 2	MB-1.4	Microbial Techniques	3
SC Course 3	MB-1.3	Cell and Molecular Biology	3
SC Course 4	MB-1.4	Enzymology and Techniques	3
HC Course 3(Practical)	MB-1.5	Practical 1 and Practical 2	4
Interdisciplinary Elective 1	IE -1	-	2
Total			20

Note: Out of the four soft core (SC) papers, students can choose any two.

M.Sc. Microbiology - Second Semester

Course	Course Code	Course Title	Credits
HC Course 1	MB 2.1	Mycology & Phycology (Eukaryotes)	4
HC Course 2	MB 2.2	Virology	4
SC Course 1	MB-2.3	Microbial Metabolism and Physiology	3
SC Course 2	MB-2.4	Analytical Techniques in Microbiology	3
SC Course 3	MB-2.3	Microbial Metabolites	3
SC Course 4	MB- 2.4	Microbial Fermentation Technology	3
HC Course 3(Practical)	MB 2.5	Practical 3 and Practical 4	4
Interdisciplinary Elective2	IE -2	-	2
Total			20

Note: Out of the four soft core (SC) papers, students can choose any two.

M.Sc. Microbiology - Third Semester

Course	Course Code	Course Title	Credits
HC Course 1	MB 3.1	Microbial Genetics	4
HC Course 2	MB 3.2	Agricultural Microbiology	4
SC Course 1	MB-3.3	Food & Dairy Microbiology	3
SC Course 2	MB-3.4	Industrial Microbiology	3
SC Course 3	MB-3.3	Molecular Biology and Genetic Engineering	3
SC Course 4	MB-3.4	Microbial Biotechnology	3
HC Course 3(Practical)	MB 3.5	Practical 5 and Practical 6	4
Skill Enhancement Course T	SEC-1	Development of Biofertilizers and Biopesticides	2
Total			20

Note: Out of the four soft core (SC) papers, students can choose any two.

M.Sc. Microbiology - Fourth Semester

Course	Course Code	Course Title	Credits
HC Course 1	MB 4.1	Medical Microbiology	4
HC Course 1	MB 4.2	Environmental Microbiology	4
HC Course 2	MB 4.3	Dissertation	5
SC Course 1	MB-4.4	Microbial Diversity, Evolution and Ecology	3
SC Course 2	MB 4.5	Immunology	3
SC Course 3	MB 4.6	Pharmaceutical Microbiology	3
HC Course 3(Practical)	MB 4.7	Practical 7 and Practical 8	4
Skill Enhancement Course -P	SEC-2	Development of Biofertilizers and Biopesticides	2
Total			22

Note: Out of the three soft core (SC) papers, students can choose any two.

Interdisciplinary Electives to be offered by Department of Microbiology

- Microbial World and Microbial Diversity
- Food Microbiology
- Microbes in Sustainable Agriculture and Development

Skill Enhancement Course to be offered by Department of Microbiology

- Development of Biofertilizers and Biopesticides

Detail *Syllabus* (Block and Unit wise)

Interdisciplinary Electives

SL No	Department	Sub Code	I Semester	Sub Code	II Semester
1	KANNADA	ELK-01	ಅಧುನಿಕ ಕನ್ನಡ ಸಾಹಿತ್ಯದ ಇತಿಹಾಸ	ELK-02	ಪ್ರಾಚೀನ ಕನ್ನಡ ಸಾಹಿತ್ಯದ ಇತಿಹಾಸ
2	ENGLISH	ELE-01	Indian Literature -I	ELE-02	Indian Literature -II
3	HINDI	ELH-01	Vyavaharik Hindi Vyakaran	ELH-02	Hindi Cinema
4	TELUGU	ELT-01	Tilak	ELT-02	Telugu Samskruthi – Samaajam
5	HISTORY	ELHS-01	Ancient World Civilisations (Egypt, Mesopotamia, Greek, Roman, Inca, Chinese)	ELHS-02	Social Reform Movement in India
6	ECONOMICS	ELEC-01	Economic Policies of India Since 1991	ELEC-02	Institutions for International Development
7	POLITICAL SCIENCE	ELP-01	Local Government in India.	ELP-02	Indian Constitution
8	PUBLIC ADMINISTRATION	ELPA-01	Indian Polity-1	ELPA-02	Indian Polity-2
9	SOCIOLOGY	ELS-01	Invitation to Sociology	ELS-02	Study of Indian Society
10	JOURNALISM AND MASS COMMUNICATION	ELJ-01	Aspects of Journalism and Mass Communication - I	ELJ-02	Aspects of Journalism and Mass Communication - II
11	ANCIENT HISTORY AND ARCHEOLOGY	ELA-01	World heritage sites of India	ELA-02	Cultural History of Hoysalas
12	EDUCATION	ELED-01	Foundations of Education	ELED-02	Higher Education
13	COMMERCE	ELC –01	Personal Financial Planning	ELC –02	Entrepreneurship Development
14	MANAGEMENT	ELM –01	Disaster Management	ELM –02	E-Commerce
15	BIOCHEMISTRY	ELMBC –01	Basics of Bioinorganic and Biophysical chemistry for Biology graduates.	ELMBC –02	Basic Bioorganic chemistry for Biology graduates.
16	BIOTECHNOLOGY	ELMBT –01	Biotechnology Principles and applications	ELMBT –02	Fundamentals of Biotechnology

17	CHEMISTRY	ELMC –01	Open Elective I	ELMC –02	Open Elective II
18	CLINICAL NUTRITION AND DIETETICS	ELMCND –01	Healthy lifestyles and nutrition	ELMCND–02	Nutraceuticals and health foods
19	COMPUTER SCIENCE	ELMCS –01	Mobile App Development	ELMCS –02	E-Commerce
20	ENVIRONMENTAL SCIENCE	ELMES –01	Basics of Environmental Science	ELMES –02	Advances in Environmental Science
21	GEOGRAPHY	ELMG –01	Introduction to Physical Geography	ELMG –02	Geography of Karnataka
22	MATHEMATICS	ELMM –01	Fundamentals of Mathematics	ELMM –02	Combinatorics and Graph Theory
23	MICROBIOLOGY	ELMMB –01	Microbial World and Microbial Diversity	ELMMB –02	Microbes in Sustainable Agriculture and Development
24	PHYSICS	ELMP –01	Mechanics	ELMP –02	Waves and Optics
25	PSYCHOLOGY	ELMPsy –01	Introduction to Psychology	ELMPsy –02	Psychology in Everyday Life
26	INFORMATION TECHNOLOGY	ELMIT –01	Green Computing	ELMIT –02	E-Commerce
27	BOTANY (NEW)	ELMBOT –01	Plant-Microbe Interactions	ELMBOT –02	Plant Diversity and Human Welfare
28	ZOOLOGY (NEW)	ELMZ –01	Parasites Vectors & communicable diseases	ELMZ–02	Essential of Reproductive Health
29	FOOD AND NUTRITION SCIENCES	ELMFNS –01	Food Psychology	ELMFNS –02	Nutritional Management in Disaster Conditions

Note:

- A. I and II Semester Open elective (Interdisciplinary Electives) syllabus are attached in Annexure – I and Annexure - II respectively.
- B. The Students may contact respective department chairperson in case of any queries regarding open elective course. The contact details available in the university website.

DETAILED SYLLABUS

FIRST SEMESTER

HC Course: MB 1.1 Microbiology: Perspectives and Classification

4 Credits

Comparison of the world prior to, and after the discovery of microorganisms in the fields of medicine, agriculture and industrial processes.

The discovery of microorganisms and the question of spontaneous generation; experiments conducted to prove / disprove it

Early contributors to the discipline of microbiology (I): Antonie Von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Luis Pasteur, Robert Koch, Martinus Beijerinck, Sergei Winogradsky, F.W.Twort, F.H. Herelle, H.C. Gram.

Later contributors to the discipline of microbiology (I) Alexander Fleming, A. Selman Waksman, Salvador E. Luria, Joshua Lederberg, David A. Hopwood, The impact of advent of the microscope on biology as a whole. The cell theory, Contributions of Robert Hook, Robert Brown, Mathias Schleiden, Theodar Schwann, Rudolf Virchow.

The scope of microbiology to developments in modern basic biology and molecular biology.

The scope of microbiology and the future in the fields of agriculture, medicine, and environment management.

Identification and Classification of Microorganisms. C. Linnaeus's (1707-1778) system of nomenclature in biology. Inclusion of Microbiology as a branch of Biology. E.H. Haeckel's (1866) Protista; Recognition of microbes having membrane-free and membrane bound nuclear material as prokaryotes and eukaryotes respectively. R.H. Whittaker's (1969) five kingdom system.

The contributions of D.H. Bergey and his international scientist-associates; Bergey's Manual of Determinative Bacteriology - 8 volumes based on bacterial taxonomy (classification) (1923–74).

Bergey's Manual of Systematic Bacteriology brought out in 4 volumes in 1984 had all bacteria placed under the kingdom Prokaryotae and classified into 4 divisions as Gracilicutes, Firmicutes, Tenericutes, and Mendosicutes, included besides classification, information on ecology, enrichment, isolation, preservation and characteristics of bacteria.

Volume 1 (1984) Information on different types of Gram-negative bacteria of general medical and industrial importance. i. Volume 2 (1986) Information on Gram-positive bacteria other than Actinomycetes.

Volume 3 (1989) Archaeobacteria, Cyanobacteria and the remaining Gram-negative bacteria. Volume 4 (1989): <http://en.wikipedia.org/wiki/Actinomycetales> Actinomycetes and other similar bacteria.

Bergey's Manual of Systematic Bacteriology: Subsequently 5 volumes were published from 2001 to 2012 without defining many of the higher taxa in terms of phenotype, but solely on 16S phylogeny (e.g. Proteobacteria.) Volume 1 (2001): The Archaea and the deeply branching and phototrophic bacteria; Volume 2 (2005): The Proteobacteria — divided into three books: 2A: Introductory essays; 2B: The

Gammaproteobacteria; 2C: Other classes of Proteobacteria. Volume 3 (2009): The Firmicutes. Volume 4 (2011) The Bacteroidetes, Tenericutes (Mollicutes), Acidobacteria, Fibrobacteres, Fusobacteria, Dictyoglomi, Gemmatimonadetes, Lentisphaerae, Verrucomicrobia, Chlamydiae, and Planctomycetes; Volume 5 (in two parts) (2012): The Actinobacteria. Modern trends in the classification of microbial world including 16S; rDNA sequencing, Numerical and molecular taxonomy.

References:

1. Alcamo. 2001. Fundamentals of Microbiology Sixth Edition. By, Edward Alcamo. Jones and Bartlett Publishers, London.
2. Aneja, K.R., Jain, P., and Aneja R. 2008. A text book of basic and applied microbiology. New Age International Publications, New Delhi.
3. Ankit Gupta and Prafulla Songara. 2012. Smart Study Series in Microbiology. Elsevier Publishers, Netherlands.
4. Hans G Schiegl. 2008. General Microbiology. 7th Edition. Cambridge University Press, UK.
5. Jayaram Paniker, C.K., and Ananthanarayan, R. 2009. Ananthanarayan and Paniker's textbook of microbiology, 8th Edition. Universities Press, Chennai.
6. Pelczar, M.J, Chan, E.C.S & N. R. Krieg. Microbiology- Concepts and Applications (International Edition), Fifth Edition, 2009. McGraw- Hill Inc. New York.
7. Prescott, L. M, Harley, J.P & D.A. Klein. Microbiology. Third Edition, 1996. Wm. C. Brown Publishers, Dubuque, Iowa, USA.
8. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L. & P.R. Painter. 1992. General Microbiology. Fifth Edition, MacMillan, UK.
9. Tortora, G.J. 2008. Microbiology - An introduction. Pearson Publishers, UK.
10. Trivedi, P.C. 2006. Applied Microbiology. Agrobios (India) Publishers, Jodhpur.

HC Course: MB 1.2 Morphology and ultra-structure of Bacteria(Prokaryotes) 4 Credits

Size, shape and arrangement of bacterial cells.

Structure and function of Gram positive bacterial cell wall.

Structure and function of Gram negative bacterial cell wall.

Structure and function of Archae bacteria.

Structures and function of bacterial capsule, cell wall, and cell membrane.

Bacterial nuclear material.

Bacterial ribosomes.

Structure and function of bacterial flagella and pili.

Vacuoles in Bacteria

Inclusion bodies in bacteria – Metachromatic granules, Poly beta-hydroxy butyrate and Poly beta-hydroxy acetate,

Inclusion bodies in bacteria volutin granules and other bodies

Bacterial pigments, spores and cysts

References:

1. Arora, D.R., and Arora B.B. 2012. Textbook of microbiology. Fourth edition. CBS Publishers, New Delhi.
2. Arthur L. Koch. 2007. The Bacteria: Their Origin, Structure, Function and Antibiosis. Springer, New York.
3. Darralyn McCall, David Stock. 2001. 11th Hour: Introduction to Microbiology 1st Edition. Blackwell Science, UK.
4. Heritage. 2008. Introductory Microbiology. Cambridge University Press, UK.
5. John L. Howland. 2000. The Surprising Archaea. New York and Oxford: Oxford University Press.
6. Kim, B. H., and Gadd, G. M. 2008. Bacterial Physiology and Metabolism. Cambridge University Press, UK.
7. Prescott. 2006. Prokaryotic cell structure and function, Chapter 3. pp.39-78.
8. Purohit, S.S. 2006. Microbiology – Fundamentals and Application. Seventh Edition. Agrobios (India) Publishers, Jodhpur.
9. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. 2007. General Microbiology Fifth Edition. McMillan Publishers, London.
10. Veena. 2008. Microbiology. Sonali Publications. New Delhi.

SC Course: MB 1.3 Bacterial growth and physiology**3 Credits**

Nutritional types of bacteria; based on basic growth requirements with dependence on the type of sources of energy, electrons and carbon.

Autotrophs and heterotrophs.

Chemotrophs, chemo-organotrophs, chemo-lithotrophs.

Phototrophs, photo-organotrophs photo-lithotrophs.

Influence of oxygen: aerobic, anaerobic and micro-aerophilic growth of bacteria.

Design of culture media for autotrophic bacteria and cultivation conditions.

Design of culture media for heterotrophic bacteria and cultivation conditions.

Bacterial growth curve, generation time, growth kinetics.

Synchronous growth; batch and continuous culture of bacteria.

Measurement of bacterial growth (biomass, turbidity, dry weight and protein content).

Physical factors affecting bacterial growth.

Chemical factors affecting bacterial growth.

Biological factors affecting bacterial growth.

Hydrolysis of Carbohydrates, proteins and lipids.

Hydrolysis of Hemicelluloses and Lignocelluloses.

Bacterial growth under extreme conditions.

References:

1. Alcamo. 2001. Fundamentals of Microbiology Sixth Edition. By, Edward Alcamo. Jones and Bartlett Publishers, London.
2. Ankit Gupta and Prafulla Songara. 2012. Smart Study Series in Microbiology. Elsevier Publishers, Netherlands.
3. Arora, D.R., and Arora B.B. 2012. Textbook of microbiology. Fourth edition. CBS Publishers, New Delhi.
4. Betsey Dexter Dyer. 2003. A field guide to bacteria. Comstock Publishing.
5. Jennifer M. Warner, I. Edward Alcamo. 2009. Schaum's Outline of Microbiology 0002 Edition. McGraw-Hill Publications, UK.
6. Jennings, D., Susan Isaac, Isaac, S. 1995. Microbial Culture. Garland Publishing, USA.
7. John L. Howland. 2000. The Surprising Archaea. New York and Oxford: Oxford University Press.
8. Meena Kumari, S. 2006. Microbial Physiology. MJP Publishers, Chennai.
9. Ravi Mantha. 2012. All about bacteria. Collins Publications, UK.
10. Sivakumaar, P.K. 2010. An introduction to industrial microbiology. S. Chand Publishers.

SC Course: MB 1.4 Microbial Techniques

3 Credits

Layout of microbiology lab – Tools and equipment.

Bio-safety precautions and National and International Regulations and Guidelines.

Microscopy: Specimen preparation and basic principles, simple and Gram's, staining, Micrometry.

Basic principles for the examination of microbes by light, dark field, phase contrast, confocal, fluorescent microscopy.

Biological stains and their importance in microbiology: Capsule, Endospore, Flagella, and Acid fast staining. Fluorochrome and Nuclear or Geimsa's Staining.

Electron (transmission and scanning) microscopy.

Methods of control of microorganisms by physical methods: heat, filtration and radiation. Principle and functioning of Laminar air flow.

Chemical methods of control of microorganisms: Phenolics, alcohols, halogens, heavy metals, quaternary ammonium compounds, aldehydes and sterilizing gases.

Evaluation of antimicrobial agent effectiveness.

Methods of media preparation: types of culture media: simple media, complex media, synthetic media, enriched media, selective media, differential media and anaerobic media.

Measurement of Biological oxygen demand and Chemical oxygen demand; Preparation of standard solutions: Buffers; Molar solutions.

Pure culture techniques: Streak plate, pour plate and spread plate method; maintenance of pure culture; methods of preservation of various microbes.

Cultivation of microorganisms and growth measurement.

Identification of Microorganisms: Morphological, Cultural Characteristics.

Identification of Microorganisms: Biochemical Characteristics.

Maintenance and Preservation of Microorganisms.

References:

1. Alcamo. 2001. Fundamentals of Microbiology Sixth Edition. By, Edward Alcamo. Jones and Bartlett Publishers, London.
2. Arora, D.R., and Arora B.B. 2012. Textbook of microbiology. Fourth edition. CBS Publishers, New Delhi.
3. Arthur L. Koch. 2007. The Bacteria: Their Origin, Structure, Function and Antibiosis. Springer, New York.
4. Gerhardt P.R., Murray G.E., Costlow R.N., Nester E.W., Wood E.A., Kreig N.R., and Phillips G.B.(eds). 1981. Manual of Methods for General Bacteriology. American Society for Microbiology, Washington D.C.
5. Hans G Schiegl 2008. General Microbiology. 7th Edition. Cambridge University Press, London.
6. Heritage. 2008. Introductory Microbiology. Cambridge University Press, UK.
7. James T. Drummond, David White, Clay Fuqua. 2011. The Physiology and Biochemistry of Prokaryotes 0004 Edition. Oxford University Press, USA
8. Jennings, D., Susan Isaac, S, S. Issac. 1995. Microbial Culture. Garland Publishing, USA.
9. Lynne Mc Landsborough. 2004. Food Microbiology Laboratory. CRC Press. USA.
10. Purohit, S.S. 2008. Microbiology – Fundamentals and Application. Sixth Edition. Student Edition Publishers, Jodhpur.

SC Course: MB 1.3 Cell and Molecular Biology

3 Credits

Concepts of cell- Prokaryotic & Eukaryotic cells. Cell organization of Prokaryotic cells with special reference to Bacteria.

Eukaryotic cells - cell wall & plasma membrane; structure & function of cell organelles and inclusions. Episome, Mesosome, Flagella and Fimbriae.

Experimental evidences for nucleic acid as genetic material. Structure of DNA; Models of DNA replication. Enzymes, proteins and other factors involved in DNA replication.

Mechanism of DNA replication in prokaryotes & eukaryotes. Superhelicity in DNA, linking number, topological properties, mechanism of action of topoisomerases. Plasmids: Concept, Properties, types and application.

Cell cycle: Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis and Fertilization.

Cell cycle and Programmed cell death- Control system, intracellular control of cell cycle events, Apoptosis, extracellular control of cell growth and apoptosis. Growth phase in Bacteria.

Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit.

Transcription in Eukaryotes: RNA polymerases, general Transcription factors. Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases,

Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation,

Inhibitors of protein synthesis in prokaryotes and eukaryote.

Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping,

Processing of rRNA, RNA interference: si RNA, miRNA and its significance. Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons,

Sporulation in Bacillus, Yeast mating type switching , Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.

References:

1. Benjamin Lewin, Gene VII, Oxford University Press, (2000).
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc. (2002).
3. Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000).
4. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R., Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub. Co. Inc. (2003).
5. Brown, T.A., Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004).
6. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).
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10. Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; Hidde Ploegh; Angelika Amon; Kelsey C. Martin, Stephen C. Harrison. Molecular Cell biology
11. David Baltimore and Harvey Lodish. Molecular and Cell Biology. Macmillan learning. 2016

Enzymes kinetics Overview of Michaelis-Menten equation and its transformation,
 Evaluation of kinetic parameters, Kinetics of bisubstrate reaction, multistep reactions,
 Kinetics of enzyme inhibition, Classification of enzymes

Catalytic mechanisms Concept of active site, determination of active site, acid –base catalysis, covalent catalysis, metal ion cofactors, proximity and orientation effects, preferential binding.

Active site determination and mechanism of lysozyme,
 Active site determination and mechanism of serine protease.

Regulation of Enzyme activity Allosterism, Kinetic analysis of allosteric enzymes

Covalent Modification, Feed -back inhibition Membrane bound enzymes, isoenzymes and marker enzymes.

Constitutive and inducible enzymes.

Techniques Protein: ligand binding studies: association and dissociation constants, co-operative ligand binding

MWC or concerted model, sequential model.

Enzyme biosensors: General concept, glucose biosensor.

Industrial applications of enzymes. Protein engineering.

References

1. Tortora, G.J., Funke, B.R and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
2. Stanbury, Biochemistry
3. Voet. Fundamentals of biochemistry Wiley
4. M.M. Cox, D. L. Nelson. Lehninger's principles of biochemistry. W H Freeman
5. Stryer. Biochemistry W H Freeman

HC Course: MB 1.5 (Practical)

Practical 1 and Practical 2

4 Credits

List of Experiments

1. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
2. Preparation of culture media (liquid & solid) for bacterial cultivation.

3. Handling and care of laboratory equipment - autoclave, hot air oven, incubator, and laminar airflow.
4. Sterilization of media using autoclave and assessment of sterility.
5. Sterilization of glassware using hot air oven.
6. Sterilization of heat sensitive material by membrane filtration.
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
8. Observation of microorganisms - bacteria, cyanobacteria protozoa, fungi, yeasts, and algae from natural habitats.
9. Study of common fungi, algae and protozoan using temporary / permanent mounts.
10. Preparation of different media: synthetic media, complex media- Nutrient agar, McConkey agar, EMB agar.
11. Simple staining
12. Negative staining
13. Gram staining
14. Acid fast staining – study using permanent slide.
15. Capsule staining
16. Endospore staining.
17. Isolation of pure cultures of bacteria by streaking method.
18. Preservation of bacterial cultures by various techniques.
19. Estimation of CFU count by spread plate method/pour plate method.
20. Motility by hanging drop method.
21. Study of fluorescent micrographs to visualize bacterial cells.
22. Separation of mixtures by paper / thin layer chromatography.
23. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
24. Separation of components of a given mixture using a laboratory scale centrifuge.
25. Study of the structure of cell organelles through electron micrographs.

SECOND SEMESTER

HC Course: MB 2.1 Mycology & Phycology (Eukaryotes)

4 Credits

General characteristics of eukaryotic microbes; Ultrastructure and organization of a typical eukaryotic cell.

Fungi: classification and identification; general characters, somatic structure.

Asexual reproduction in fungi.

Sexual reproduction in fungi.

Characteristics of Zygomycotina and Characteristics of Ascomycotina.

Characteristics of Basidiomycotina, Characteristics of Deuteromycotina.

Heterothallism, parasexuality and sex hormones in fungi.

Symbiotic associations of fungi with algae.

Association of fungi with plants: Mycorrhiza.

Algae; general characters, classification, somatic structure.

Characteristics, asexual and sexual reproduction of Chlorophyceae.

Characteristics, asexual and sexual reproduction of Phaeophyceae.

Characteristics, asexual and sexual reproduction of Bacillariophyceae.

Characteristics, asexual and sexual reproduction of Rhodophyceae.

References:

1. Alcamo. 2001. Fundamentals of Microbiology Sixth Edition. By, Edward Alcamo. Jones and Bartlett Publishers, London.
2. Aneja K.R., Jain P. and Aneja R. “*A Text Book of Basic and Applied Microbiology*” New Age International Pub. New Delhi (2008).
3. Arora, D.R., and Arora B.B. 2012. Textbook of microbiology. Fourth edition. CBS Publishers.
4. Arthur L. Koch. 2007. The Bacteria: Their Origin, Structure, Function and Antibiosis. Springer.
5. Hans G Schiegel. 2008. General Microbiology. 7th Edition. Cambridge University Press.
6. Purohit, S.S. 2008. Microbiology – Fundamentals and Application. Sixth Edition. Student Edition Publishers, Jodhpur.
7. Sateesh, M.K. 2007. Comprehensive Biotechnology-2. First Edition. New Age International Publications. New Delhi.
8. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. 2007. General Microbiology Fifth Edition. McMillan Publishers, London.
9. Tortora, G.J. 2008. Microbiology: An introduction. Ninth Edition. Pearson Publishers.
10. Veena. 2008. Microbiology. Sonali Publications.

HC Course: MB 2.2 Virology

4 Credits

Nomenclature and classification of viruses.

Viruses-Properties, morphology & ultra-structure; capsids & their arrangements; types of envelopes and their composition,

Viral genome, their types and structures.

Major plant, animal and human viruses.

Mechanism of virus infection - molecular and biochemical events.

Bacteriophages: Structure and life cycle patterns. One step growth curve and burst size.

Phage-typing and Phage therapy.

Structure and function of viroids and prions.

Cultivation of viruses: In embryonated egg, in experimental animals and in cell cultures.

Assay of viruses: Physical and chemical methods.

Infectivity methods of virus assay.

Importance of phage in Dairy.

References:

1. Carl Zimme. A Planet of Viruses. 2012. Publisher: University of Chicago Press.
2. Dimmock N.J. and Primrose S.B. 1994. Introduction to Modern Virology 4th edn. Blackwell Scientific Publication, Oxford.
3. Dorothy H. Crawford. 2003. The Invisible Enemy: A Natural History of Viruses Publisher Oxford University Press
4. Edward K. Wagner, Martinez J. Hewlett, David C. Bloom, David Camerini. 2007. Basic Virology, 3rd Edition. Publisher Blackwell Publishing.
5. Haddidi, A., R.K. Khertarpal, and H. Koganezawa, (eds.). 1998. Plant Virus Disease Control. APS Press, St. Paul, MN.
6. Hull, R. 2002. Matthews' Plant Virology. 4th Edition. Academic Press, San Diego, CA.
7. John B. Carter and Venetia A. Saunders, 2007, Virology, Principles and applications, Pub: Chichester, England; John Wiley & Sons, c2007. ISBN10: 0470023864
8. Luria S.E., Darnell Jr. J.E., Baltimore D.E., and Campbell A. 1978. General Virology 3rd edn. John Wiley & Sons, N.Y.
9. Mattern CFT: Symmetry in virus architecture. In Nayak DP (ed): Molecular Biology of
10. Teri Shors. 2011. Understanding Viruses Publisher: Jones & Bartlett Publishers.

SC Course: MB 2.3 Microbial Metabolism and Physiology

3 Credits

Enzymes: nomenclature; physical and chemical properties.

Assay of enzymes.

Nature of enzymes and mechanism of action.

Factors influencing enzyme activity.

Constitutive and induced enzyme production in microbes.

Regulation of enzymes; energy linked control of regulation; feed-back inhibition; precursor activation; catabolite repression.

Enzyme regulation in prokaryotic and eukaryotic microorganisms.

Energy production in aerobic process: tricarboxylic acid cycle; respiration; respiration without oxygen in some bacteria.

Energy production in anaerobic process: glycolysis, pentose phosphate pathway; Entner-Doudoroff pathway; fermentative metabolism.

Catabolism of lipids.

Catabolism of proteins.

Glyoxalate Cycle.

Photosynthesis in Bacteria.

Photosynthesis in Cyanobacteria.

Biosynthesis: protein synthesis – transcription and translation of genetic information.

Protein synthesis in prokaryotes and Eukaryotes.

References:

1. Aneja K.R., Jain P. and Aneja R. 2006. A Text Book of Basic and Applied Microbiology. New Age International Pub. New Delhi.
2. Athel Cornish-Bowden. 2012. Fundamentals of Enzyme Kinetics. Wiley-VCH-Verlag-GmbH. Weinheim.
3. Cox, M.M. and Nelson D.L. Leninger. 2008. Principles of Biochemistry 5th edn. W.H. Freeman & Co., N.Y (Printed in India).
4. Jayaram Panicker, C.K., and Ananthanarayan R. 2009. Publisher: Universities Press
5. Joanne M. Willey, Christopher J. Woolverton, Linda M. Sherwood. 2011. Prescott's Microbiology 8th Edition (Paperback). Publisher: Tata McGraw-Hill Education.
6. Kenneth B. Taylor (editor). 2009. Enzyme Kinetics and Mechanisms. Kluwer Academic Publishers. The Netherlands.
7. Nicholas Price and Lewis Stevens. 1999. Fundamentals of Enzymology. Oxford University Press, U.K.
8. Purohit, S.S. 2008. Microbiology – Fundamentals and Application. Sixth Edition. Student Edition Publishers, Jodhpur.
9. Talaro K.P. and Talaro A. 2006. Foundations in Microbiology” 6th edn. McGraw Hill
10. Veena. 2008. Microbiology. Sonali Publications. New Delhi.

SC Course: MB 2.4 Analytical Techniques in Microbiology

3 Credits

Aerobic and anaerobic culture methods for determination of microbial populations.

Water analysis - Chemical, physical and biological.

Evaluation of food ingredients and products for selected pathogenic microbes by conventional isolation methods.

Evaluation of food ingredients and products for selected pathogenic microbes by DNA based methods.

Spectroscopy – principle and application in microbiological analysis.

Chromatographic methods for purification of microbial metabolites and enzymes.

Assay (qualitative and quantitative) for microbial enzymes and metabolites.

Characterization microbial enzymes and metabolites for functional attributes.

Structural characterization of functional bioactives by instrumental techniques – HPLC, GC/GLC, LC-MS, NMR and others.

Animal and cell culture methods for evaluation of biological activities associated with active principles of microbial sources.

Introduction, history and applications of Bioinformatics; Databases – introduction, types, applications and limitations; Literature search databases - PUBMED, MEDLINE; Nucleic acid and protein databases - NCBI, EMBL, DDBJ, SWISS PROT, UNIPROT, etc.; Biotechnological databases - EST, STS, GSS, HTG, SNP, etc.

Web tools and resources for sequence analysis; Pair-wise and multiple sequence Alignment; Sequence similarity search; BLAST & FASTA; Pattern recognition; Motif and family prediction; Restriction map analysis; Primer design; Gene prediction; Phylogenetic Tree.

Statistics in microbiological studies; Sampling design and criteria in selecting size of samples and related parameters; Determination of analysis; Data collection and presentation (Histogram, Bar & Pie chart, Frequency table).

Measure of central tendency – mean, median and mode; Measure of dispersion – range, inter-quantile range, standard deviation, standard error and coefficient of variation.

Design of experimental studies – cohort, double blind, placebo control and others; Statistical methods – Binomial, Poisson and Normal distribution; ANOVA (one and two-way analysis).

Hypothesis testing – ‘Z’ score, ‘t’ test, ‘F’ test, chi-square test, regression analysis, multiple range test and others.

References:

1. Alcamo. 2001. Fundamentals of Microbiology Sixth Edition. By, Edward Alcamo. Jones and Bartlett Publishers, London.
2. Arthur M. Lesk. 2002. Introduction to Bioinformatics. Oxford University Press, Great Clarendon Street, Oxford OX2 6DP.
3. Arumugam, N. 2010. Basic Concepts of Biostatistics. Saras Publications, Biosciences Book Publishers,
4. Bernard Rosner. 2010. Fundamentals of Biostatistics Seventh Edition. Brooks/Cole 20 Channel Center Street, Boston, MA 02210, USA.
5. Heitor Silvério Lopes and Leonardo Magalhães Cruz (Eds). 2011. Computational Biology and Applied Bioinformatics, Published by In: Tech Janeza Trdine 9, 51000 Rijeka, Croatia.
6. James T. Drummond, David White, Clay Fuqua. 2011. The Physiology and Biochemistry of Prokaryotes 0004 Edition. Oxford University Press, USA
7. Rijpens, N.P., and Herman, L.M.F. 2002. Molecular methods for identification and detection of bacterial food pathogens. J. AOAC Int. 85: 984–995.

8. Robert R. Sakal and F. James Rohlf. 2009. Introduction to biostatistics second edition. Dover Publications, inc., Mineola, New York.
9. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. 2007. General Microbiology Fifth Edition. McMillan Publishers, London.
10. Suresh Kumar and Satya Veeri. 2007. Basic Biostatistics. Campus Books International, New Delhi.

SC Course: MB 2.3 Microbial Metabolites

3 Credits

Overview of metabolites Metabolites: General account of metabolites, secondary metabolites. Classification, structure and mode of action of secondary metabolites.

Plants secondary metabolites: Digitoxine, Salicylic acid, Mycotoxins-Aflatoxin, Ochratoxin, Patulin.

Biopolymers: Polypeptides (collagen, casein and serum albumin), Polynucleotides and polysaccharides(amylose, amylopectin, alginate, cellulose) and other biopolymers like chitin, Xanthan, dextrin, Gellan, Pullulan, curdlan and hyaluronic acid. Polyamines:

Brief outline and functions of polyamines. Synthesis of linear polyamine-putrescine, cadoverine, spermidine and spermine.

Antimicrobial drugs: Secondary metabolites Antibiotics: History and discovery of antibiotics, Antibiotic resistance, Mechanisms of antibiotic resistance.

Structure and mode of action of antibiotics: Aminoglycosides (Amikacin), Carbapenems (Imipenim), Microlids (Azithromycin), Nitrofurantoin (Nitrofurantoin), Penicillin (Amoxicillin), Quinolones (Gatifloxacin/Ciprofloxacin), Sulphonamides (Sulfamethoxazole),Tetracyclines (Doxycyclines), Chloramphenicol, Fucanazole.

Pigments as secondary metabolites General account of pigments, Chlorophylls, Carotenoids of eukaryotes, phycobilliproteins. Hemoglobin, Myoglobin, Melanin and bile pigments.

Microbial pigments: Bacteriochlorophylls, Carotenoids of prokaryotes, rhodopsin and accessory pigments(Pulcherrimin, indigoidin, voalecin) Defensive role of pigments.

Microbial vitamins Characteristics of fats and water soluble vitamins. Structure, function and chemistry of: Retinol (vitamin A), Riboflavin (vitamin B2), Cynocobalamine (Vitamin B12) and ascorbic acid (vitamin C).

Deficiency diseases in humans: Xerophthalmia, Beri Beri, Pellegra, Scurvey, Keratomalacia, osteoporosis, Osteomalacia, Cheilosis, Glossitis, Pernicious anemia and Erythroid hypoplassia.

References:

1. Alcamo. 2001. Fundamentals of Microbiology Sixth Edition. By, Edward Alcamo. Jones and Bartlett Publishers, London.
2. Arthur M. Lesk. 2002. Introduction to Bioinformatics. Oxford University Press, Great Clarendon Street, Oxford OX2 6DP.
3. Arumugam, N. 2010. Basic Concepts of Biostatistics. Saras Publications, Biosciences Book Publishers,
4. Bernard Rosner. 2010. Fundamentals of Biostatistics Seventh Edition. Brooks/Cole 20 Channel Center Street, Boston, MA 02210, USA.
5. Heitor Silvério Lopes and Leonardo Magalhães Cruz (Eds). 2011. Computational Biology and Applied Bioinformatics, Published by In: Tech Janeza Trdine 9, 51000 Rijeka, Croatia.
6. James T. Drummond, David White, Clay Fuqua. 2011. The Physiology and Biochemistry of Prokaryotes 0004 Edition. Oxford University Press, USA
7. Rijpens, N.P., and Herman, L.M.F. 2002. Molecular methods for identification and detection of bacterial food pathogens. J. AOAC Int. 85: 984–995.
8. Robert R. Sakal and F. James Rohlf. 2009. Introduction to biostatistics second edition. Dover Publications, inc., Mineola, New York.
9. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. 2007. General Microbiology Fifth Edition. McMillan Publishers, London.
10. Suresh Kumar and Satya Veeri. 2007. Basic Biostatistics. Campus Books International, New Delhi.

SC Course: MB 2.4 Microbial Fermentation Technology

3 Credits

General Principles of Fermentation Bioreactors: Bioreactor types, immobilized bioreactors, types of fermentation.

Fermentation kinetics and Monods Model:-Growth kinetics and Monod's Model, Substrate accelerated death, specific growth rate, stringent response,

Ntr and Pho system, growth limiting substrate, maintenance energy, growth yield and product formation.

Process optimization: factors of optimization, rheology of fermentation fluid, oxygenation, and oxygen transfer kinetics. chemostat, turbidostat.

Downstream Processing and scale up. Downstream processes: types of processing units and systems,

Storage and packaging methods. Scale up; scale down, criteria involved in scale up.

Productivity, power requirements Basic control theory.

Industrial Fermentation Products Biofuels:-Ethanol, Hydrogen, Methane Antibiotics:- β -lactum antibiotics (Synthetic penicillin), Streptomycin, Cephalosporin.

Biopreservative: Lactobacillus sakei. Biopolymers:- Xanthan, Polyhydroxyalkanoates

Thermostable enzymes:-Proteases. Biosurfactants: a comparative account. Food and Healthcare products SCP, various types and processes. Carotenoids Aminoacids:-Lysine, Glutamic acid. Vitamins:- riboflavin, Vit.B12. Fatty acids (Palmitate, oleate).

References:

1. Stanbury, PF., Principles of Fermentation Technology. Whittaker, A and Hall, S.J 2nd Edition. Pergamon Press (1995).
2. Banwart, GJ. Basic Food Microbiology. CBS Publishers and Distributors, Delhi. (1989).
3. Hobbs BC and Roberts D. Food poisoning and Food Hygiene. Edward Arnold (A division of Hodder and Stoughton) London.
4. Dolle Michael P.. Food Microbiology: Fundamentals and Frontiers.
5. Joshi. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2.
6. John Garbult. Essentials of Food Microbiology. Arnold International.
7. John C. Ayres. J. Orwin Mundt. William E. Sandinee. Microbiology of Foods. W.H. Freeman and Co.
8. E. M. T. El-Mansi (Editor), C. F. A. Bryce (Editor), Arnold L. Demain (Editor), & 1 More Fermentation Microbiology and Biotechnology Hardcover CRC Press 2012

HC Course: MB 2.5 (Practical)

Practical 3 and Practical 4

4 Credits

List of Experiments

1. Measurement of Growth of bacteria: Turbidometry; Total plate count(viable).
2. Mycology: Identification of soil fungi.
3. Enumeration of live yeast by Trypan blue staining/ Methylene blue.
4. Virology: Infected materials; study of general symptoms.
5. Biochemical tests; Catalase, indole production, etc.

6. Test for Aerobes and Anaerobes.
7. Microscopy of Spirulina, Nostoc and Chlorella.
8. Preparation of Potato Dextrose Medium.
9. Isolation and identification of pathogenic and non-pathogenic fungi.
10. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor*, *Saccharomyces*, *Penicillium*, *Agaricus* and *Alternaria*
11. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo, hepatitis and retroviruses) using electron micrographs.
12. Study of the structure of important plant viruses (caulimo, gemini, tobacco ringspot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs.
13. Study of the structure of important bacterial viruses (ϕ X174, T4, λ) using electron micrograph.
14. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique.
15. Studying isolation and propagation of animal viruses by chick embryo technique.
16. Study of cytopathic effects of viruses using photographs.
17. Perform local lesion technique for assaying plant viruses.
18. Study and plot the growth curve of *E.coli* by turbidometric and standard plate count methods.
19. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
20. Demonstration of alcoholic fermentation.

THIRD SEMESTER

HC Course: MB 3.1

Microbial Genetics

4 Credits

History and development of Microbial genetics.

Genetic tools for basic and applied genetic studies.

Generalized reproductive cycles of microbes (bacteria, viruses, fungi).

Viral lytic and lysogenic cycles, Phage phenotypes, phenotypic mixing, Recombination in viruses: Mapping of rII loci.

Bacterial Transformation: types of transformation mechanism found in prokaryotes.

Bacterial Conjugation: Properties of the F plasmid, HFR conjugation, Bacterial Transduction: Generalized and specialized transduction, Transposable elements.

Fungal genetics: *Neurospora* Tetrad Analysis linkage detection-2 point and 3 point crosses, chromatic and chiasma interference.

Mitotic recombination in *Neurospora* and *Aspergillus* (Fungi).

Extra nuclear (Cytoplasmic) inheritance in Algae.

Phenomenon of Mutation; Brief outline of theory of mutation.

Types and effects of mutation.

Mutagens; Physical and chemical mutagens, base and nucleotide analog, alkylating agents, intercalating agents, ionizing radiation.

References:

1. Alcamo. 2001. Fundamentals of Microbiology Sixth Edition. By, Edward Alcamo. Jones and Bartlett Publishers, London.
2. Bernard R. Glick, Jack J. Pasternak, and Cheryl L. Patten. 2004. Molecular biotechnology: principles and applications of recombinant DNA. 4th ed. ASM Press, 1752 N St. NW, Washington, DC 20036-2904, USA.
3. Birky, C.W. 2001. The inheritance of genes in mitochondria and chloroplasts: Laws, mechanisms, and models. Proc. Nat. Acad. Sci. USA 35: 125–148.
4. Brooker, Robert J. 2012. Genetics: analysis & principles / Robert J. Brooker. — 4th ed. McGraw-Hill, NY.
5. Edward A. Birge. 2006. Bacterial and bacteriophage genetics. 5th Edition. Springer Science+Business Media, Inc.
6. Mark Achtman and Michael Wagner. 2008. Microbial diversity and the genetic nature of microbial species. Nature Reviews-Microbiology 6: 431-440.
7. Pelczar M.J., Chan E.C.S. and Kreig N.R. “Microbiology – 5th edn., Tata McGraw-Hill Pub. Co. New Delhi (1986)
8. Phil Turner, Alexander McLennan, Andy Bates and Mike White. 2005. Bios Instant Notes-Molecular Biology. Third Edition. Taylor & Francis Group, NY.
9. Sateesh, M.K. 2007. Comprehensive Biotechnology-2. First Edition. New Age International Publications. New Delhi.
10. Uldis N. Streips and Ronald E. Yasbin. 2002. Modern Microbial Genetics. Second Edition. Publisher-Wiley- Liss, NY.

HC Course: MB 3.2

Agricultural Microbiology

4 Credits

Microbiology of soil fertility and its management.

Biofertilizer: *Rhizobium*.

Biofertilizer: *Azospirillum* and *Azotobacter*.

Cyanobacteria.

Mycorrhiza.

Endophytes.

Applications and limitations for biofertilizers.

Biopesticides; *Bacillus thuringiensis*; integrated pest management.

Microbiology of composting and compost and green manuring.

Plant pathology: etiology and control of economically important crop diseases.

Microbial infectious diseases of Cereals, sugarcane and pulses.

Microbial infectious diseases vegetables and fruits caused by fungi, bacteria and viruses.

References

1. Agrios, G. N. 1997. Plant Pathology, 4th ed. Academic Press, Inc., New York, NY.
2. APS Press. The Disease Compendia Series. American Phytopathological Society, 3340 Pilot Knob Road, St. Paul, MN 55121.
3. Arora, D.R., and Arora B.B. 2012. Textbook of microbiology. Fourth edition. CBS Publishers.
4. Fuchs, J.G. 2010. Interactions between beneficial and harmful microorganisms: from the composting process to compost application. In: Microbes at work. Eds. H. Insam et al., Springer-Verlag.
5. Horst, R. K. 2001. Wescott's Plant Disease Handbook, 6th Ed. Kluwer Academic Publishers, Massachusetts.
6. Insam H, Riddech N, Klammer S (eds.), Microbiology of Composting. Berlin/Heidelberg 2002: Springer
7. PNW Plant Disease Control Handbook. Oregon State University, Administrative Services–A442, Corvallis, OR 97331.
8. Sateesh, M.K. 2007. Comprehensive Biotechnology-2. First Edition. New Age International Publications. New Delhi.
9. Schumann, G. L. and D'Arcy, C. J. 2006. Essential Plant Pathology. APS Press.
10. Yousten, A.Y., Federici, B., Roberts, D.W. 1991. Microbial Insecticides. In: Encyclopedia of Microbiology Vol 2, Academic Press Sandiego, USA. pp. 521-531.

SC Course: MB 3.3 Food & Dairy Microbiology

3 Credits

Intrinsic factors of microbial food spoilage.

Extrinsic factors of microbial food spoilage.

Microbial spoilage of Meat and poultry.

Microbial spoilage of Fruit and vegetables.

Microbial spoilage of Cereals.

Microbial spoilage of thermally processed products.

Physical food preservation methods; dehydration, heat, filtration, irradiation, high pressure.

Chemical method of food preservation; Food preservatives.

Food-borne pathogens, their detection and control.

Water-borne pathogens, their detection and control.

Important toxin producing bacteria in food; chemical nature of bacterial toxins; role in food poisoning; modification and detoxification.

Important toxin (mycotoxins) producing fungi of food, chemical nature of fungal toxins; role in food poisoning; modification and detoxification.

Prevention and control of toxin contamination of food.

Composition of milk; role of microbes in milk and dairy products: Microbiological examination of milk; standard plate count, direct microscopic count and reductase test.

Manufacture of cheeses, butter, yoghurt and fermented milk.

Probiotics and Prebiotics; evidences for role in human and animal wellness/health.

References:

1. Betts R, Blackburn CW. 2009. Detecting pathogens in food. In: Foodborne pathogens: hazards, risk analysis and control, 2nd edn. Edited by: Blackburn CW, McClure PJ. Woodhead Publishing, Oxford, UK. pp. 17–65.
2. Binns, N. 2013. Probiotics, prebiotics and gut microflora. International Life Sciences Institute (ILSI). Belgium.
3. de Vrese M, and Schrezenmeir J. 2008. Probiotics, prebiotics, and synbiotics. *Adv Biochem Eng Biotechnol* 111: 1-66.
4. Doyle, M. P. and Beuchat, L. R. 2007. *Food Microbiology: Fundamentals and Frontiers*, Third Edition, ASM Press.
5. Feng P. 2007. Rapid methods for the detection of foodborne pathogens: current and next-generation technologies. In: *Food microbiology, fundamentals and frontiers*, 3rd edn. Edited by: Doyle MP, Beuchat LR. ASM Press, Washington, D.C. pp 911–934.
6. Frazier, W. C. and Westhoff, D. C., *Food Microbiology*, 4th ed., McGraw-Hill, New York, 1988.
7. Gibson, G.R., et al. 2011. Dietary prebiotics: current status and new definition. *IFIS Functional Foods Bulletin*, 7:1–19.
8. ICMSF, ‘Microbial Ecology of Foods. Volume 2 Food Commodities’, Academic Press, New York, 1980, 664pp.
9. Jay, J.M., Loessner, M.J., and Golden, D.A. 2005. *Modern Food Microbiology – Seventh Edition*. Springer, New York, USA.
10. Martin R. Adams and Maurice O. Moss. 2008. *Food Microbiology – Third Edition*. Published by The Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge CB4 0WF, UK.

Industrially important microorganisms; Sources and characteristics of industrially potent microorganisms, their isolation, purification & maintenance.

Screening and strain improvement through random mutation (random & rational selection).

Strain improvement genetic manipulation (brief outline).

Microbial growth kinetics in batch, continuous & fed-batch fermentation process.

Design of Fermenters.

Raw materials used in industrial fermentation media. Solid state fermentation & submerged fermentation.

Microbial production of organic acids (acetic, lactic, citric acid & gluconic acids).

Microbial production of amino acids (lysine, tryptophan & mono sodium glutamate).

Microbial production vitamins (vitaminB12 & riboflavin).

Microbial production of industrial enzymes; cellulases, xylanases, pectinases and their applications.

Microbial production of industrial enzymes; amylases, lipases, proteases and their application.

Production of ethanol for beverages (Brewing, wine making and distilled liquors) and for biofuel.

Microbial production of antibiotics by fermentation (penicillin, streptomycin etc.).

Microbial transformation of steroids & alkaloids.

Bioleaching of minerals.

Immobilization of microbial enzymes and cells and their applications.

References:

1. Ahuja, S. 2000. Handbook of Bioseparations. Vol 2 Academic Press. San Diego, USA.
2. Atkinson, B., and Mavituna, F. 1991. Biochemical Engineering and Biotechnology Handbook, 2nd edition. Macmillan Press, Basingstoke.
3. Barnett, J.A., Payne, R.W., Yarrow, D. 2000. Yeasts: Characterization and Identification. 3rd Edition. Cambridge University Press. Cambridge, UK.
4. Chaplin, M.F., Bucke, C. 1990. Enzyme Technology. Cambridge University Press. New York, USA.
5. Demain, A. L., and Davis, J. E., editors. 1999. Manual of industrial microbiology and biotechnology. Washington, D.C.: American Society for Microbiology.
6. Dobie, M., Kruthiventi, A.K., Gaikar, V.G. 2004. Biotransformations and Bioprocesses. Marcel Dekker, New York, USA.
7. Murooka, Y., and Imanaka, T. (eds) 1994. Recombinant Microbes for Industrial and Agricultural Applications. Marcel Dekker, New York, USA.
8. Naduka Okafor. 2007. Modern Industrial Microbiology and Biotechnology. Science Publishers, Enfield, New Hampshire 03748, United States of America.
9. Tanaka, A, Tosa, T, Kobayashi, T, (1993). Industrial Applications of Immobilized Biocatalysts New York: Dekker.

10. Waites, M.J., Morgan, N.L., Rockey, J.S., and Gary Higton, G. 2001. Industrial Microbiology: An Introduction. Publishers: Blackwell Science Ltd Iowa State University Press. A Blackwell Science Company 2121 S. State Avenue Ames, Iowa 50014-8300, USA.

SC Course: MB 3.3 Molecular Biology and Genetic Engineering 3 Credits

Structures of DNA and RNA/Genetic Material: DNA structure, Salient features of double helix, Types of DNA, denaturation and renaturation, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes.

RNA Structure. Replication of DNA: Bidirectional and unidirectional replication, semi-conservative, semi-discontinuous replication

Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends.

Gene Expression: Transcription - Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription.

Translation - Genetic code, Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides.

Regulation of gene Expression: Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons.

Mutation: Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Uses of mutations, DNA repair mechanisms

Mechanisms of Genetic Exchange: Transformation - Discovery, mechanism of natural competence
Conjugation - Discovery, mechanism, Hfr and F' strains

Transduction - Generalized transduction, specialized transduction

Plasmids and Transposable Elements: Property and function of plasmids, Types of plasmids.

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition,

Uses of transposons and transposition.

Introduction to genetic engineering: Milestones in genetic engineering and biotechnology Restriction modification systems: Mode of action, applications of Type II restriction enzymes in genetic engineering.

DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases

Cloning: Use of linkers and adaptors: Transformation of DNA: Chemical method, Electroporation.

Methods of DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE, and Western blotting

Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors

Cosmids, BACs, YACs Expression vectors: E.coli lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors .

DNA Amplification and DNA sequencing: PCR: Basics of PCR, RT-PCR, Real-Time PCR

Genomic and cDNA libraries: Preparation and uses, Genome sequencing Sanger's method of DNA Sequencing: traditional and automated sequencing

Application of Genetic Engineering and Biotechnology: Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral- mediated delivery, Agrobacterium - mediated delivery.

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules.

Bt transgenic - cotton, brinjal, flavosavo tomato, Gene therapy, recombinant vaccine, protein engineering

References:

1. Benjamin Lewin, Gene VII, Oxford University Press, (2000).
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc. (2002).
3. Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000).
4. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R., Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub. Co. Inc. (2003).
5. David Frifielder, Stanley R. Maloy, Molecular biology and Microbial genetics. 2nd Edition, Jones and Barlett Publishers. (1994).
6. Brown T.A., Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004).
7. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).
8. Glick BR and Pasternak JJ, Molecular Biotechnology, 2nd Ed. ASM press. (2003).
9. Udis N. Streips, Ronald E. Yasbin. Modern Microbial Genetics. 2nd Edition Wiley-Liss, Inc. (2002).
10. Desmond S. T. Nicholl. An Introduction to Genetic Engineering. Cambridge University Press; (2008)

SC Course: MB 3.4 Microbial Biotechnology

3 Credits

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology.

Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial applications: Bacteria and yeast

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine).

Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors

Microbial based transformation of steroids and sterols. Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

Microbial product purification: filtration, ion exchange & affinity chromatography techniques

Immobilization methods and their application: Whole cell immobilization. RNAi and its applications in silencing genes, drug resistance, therapeutics, and host pathogen interactions

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass,

Biogas production: Methane and hydrogen production using microbial culture.

Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents

References:

1. Richard H. Baltz. Julian E Davies and Arnold L.Demain Manual of Industrial Microbiology and Biotechnology. 3rd edition, ASM Press (2010).
2. Daniel Forciniti. Industrial Bioseparation :Principles and practice. 1st edition edition, Wiley-Blackwell (2008).
3. Reed. G. Prescott and Dunn's Industrial Microbiology. CBS Publishers. (1999).
4. Demain, A. L. Industrial Microbiology and Biotechnology. 2nd Edition. (2001).
5. EL Mansi. E.M.T., FermentationMicrobiologyand Biotechnology. 2ndEdition,CRC Taylor&Francis (2007).
6. Waites,M.J.,Morgan, N.L.,Rockey, J.S.andHigton,G.Industrial Microbiology: An Introduction. Blackwell SciencePublishers(2002).
7. Casida LE, Industrial Microbiology, J. Wiley, (1968).
8. James Bailey and David Ollis, Fundamentals of Biochemical Engineering, 2nd edition, McGraw-Hill, (1986).
9. Jayanta Kumar Patra Gitishree Das Han-Seung Shin. Microbial Biotechnology. Springer

HC Course: MB 3.5 (Practical)

Practical 5 and Practical 6

4 Credits

List of Experiments

1. Preparation of Master and Replica Plates.
2. Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells.
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light.
4. Isolation of Plasmid DNA from *E.coli*.
5. Demonstration of bacterial conjugation
6. Demonstration of bacterial transformation and transduction.
7. Demonstration of Ames test.
8. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
9. Study of important diseases of crop plants by cutting sections of infected plant material-*Albugo*, *Puccinia*, *Ustilago*, *Fusarium*, *Colletotrichum*
10. MBRT of milk samples and their standard plate count.
11. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
12. Isolation of any foodborne bacteria from food products. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
13. Isolation of spoilage microorganisms from bread.
14. Preparation of Yogurt/Dahi.
15. Microbial fermentations for the production and estimation (qualitative and quantitative) of Ethanol
16. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.
17. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
18. Ligation of DNA fragments
19. Designing of primers for DN Aamplification
20. Amplification of DNA by PCR

FOURTH SEMESTER

HC Course: MB 4.1 Medical Microbiology

4 Credits

History of Medical Microbiology in different systems.

Infective etiology of human diseases, microbial virulence factors.

Study of bacterial infections; 1. staphylococci, 2. Streptococci 3. Neisseria 4. Corynebacteria 5. Clostridia, and 6. Mycobacteria.

Bacterial infections: Spirochetes, Helicobacter, Enterobacteriaceae, Pseudomonas, Haemophilus.

Antimicrobial susceptibility testing, disc diffusion, MIC Estimation, Bacterial Resistance detection methods with emphasis on emerging MDR bacteria like MRSA, ESBL producers, MBL pathogens and VRE.

Bacterial Vaccines.

Infective syndromes Meningitis, UTI, STDs, Pneumonias.

Infective Syndromes, Septicemia, Diarrhoeal diseases, Soft tissue and wound infections, Nosocomial infections.

Diseases caused by viruses; Poxviruses, Herpes viruses, Myxoviruses, Enteroviruses, Adenoviruses.

Infections caused by Hepatitis viruses, HIV, Arboviruses.

Tumourviruses, Slowviruses, Antiviral chemotherapy, Viral vaccine.

Diseases caused by Fungi: Candidiasis, Dermatophytosis, Aspergillosis, Otomycosis, Subcutaneous mycoses, Systemic mycoses, Opportunistic Mycoses, Antifungal chemotherapy, Mycotoxins.

Diseases caused by parasites; Entamoeba, Giardia, Trichomonas, Trypanosoma, Leishmania,

Diseases caused by parasites; Plasmodia, Toxoplasma, Cestodes and Trematodes.

Parasitic infections Ascariasis, Ankylostomiasis, Enterobiasis, Trichuriasis, Filariasis.

Laboratory diagnosis of parasitic infections, Anti parasitic agents, Opportunistic parasitic infections in HIV.

References:

1. Abilo Tadesse and Meseret Alem. 2006. Medical Bacteriology. USAID.
2. Greenwood. 2012. Medical Microbiology. Eighteenth Edition. Elsevier Ltd. UK.
3. Kenneth J. Ryan and George C. Ray. 2004. Sherris Medical Microbiology – An Introduction to Infectious Diseases. Fourth Edition. McGraw-Hill, Medical Publishing Division, New York.
4. Marie B. Coyle. 2005. Manual of Antimicrobial Susceptibility Testing. American Society for Microbiology.
5. Mark Gladwin, Bill Trattler and Scott Mahan. 2013. Clinical Microbiology made ridiculously simple. Third Edition. Medmaster Publications.
6. Pelczar M.J., Chan E.C.S. and Kreig N.R. “Microbiology – 5th edn., Tata McGraw-Hill Pub. Co. New Delhi (1986).
7. Purohit, S.S. 2008. Microbiology – Fundamentals and Application. Sixth Edition. Student Edition Publishers, Jodhpur.
8. Stanier R.L., Ingram J.L. and Wheelis M.L. “General Microbiology” Macmillan Press Ltd (2007)
9. Stephen H. Gillespie and Kathleen B. Bamford. 2012. Medical Microbiology and Infection at a Glance. Fourth Edition. Wiley-Blackwell Publications. John Wiley & Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK.
10. William Irving, Tim Boswell, Dlawer Ala'Aldeen. 2007. Medical Microbiology. First Edition. Taylor & Francis Limited. UK.

HC Course: MB 4.2 Dissertation

4 Credits

During the fourth semester a student will have to complete one project work and submit its report in the form of a dissertation.

The duration of the project is a minimum of two months and maximum of 6 months.

The project work can be carried out in the department itself (based on the availability of the supervisors and other research infrastructure) or any other university or research institution/industry.

Students will choose the topic of in consultation with their supervisors, and get the same approved from the department chairman.

On completion of the research project, the candidates will give a research seminar (viva voce) describing their work, which will be evaluated and graded by a departmental academic committee.

Submission of dissertation and successful project seminar presentation will give the candidate 4 credits.

HC Course: MB 4.3 Environmental Microbiology

4 Credits

Environment and ecosystems.

Characteristic features of thermophiles, psychrophiles, methanogens, methylophiles, acidophiles, alkalophiles, halophiles and their survival strategies.

Biodegradation and biogeochemical cycling.

Microbiology of Soil.

Microbiology of water.

Determination of sanitary quality of water.

Disinfection of potable water supplies; Bacterial indicators of water safety; Water quality standards.

Microbiology of Air.

Biodegradation of paper, textile, wood, paint and metal and their protection methods.

Bioremediation: Microbial degradation of pesticides; hydrocarbons, Bioremediation of sites polluted with oil spills, heavy metals and chlorinated solvents.

Biological treatment of industrial effluents (sugar, pulp and paper industry) and sewage.

Aquatic blooms in water bodies.

References:

1. Anjaneulu, Y. 2007. Introduction to Environmental Science B.S. Pub. New Delhi.
2. Bertrand, J.-C., Caumette, P., Lebaron, P., Matheron, R., Normand, P., Sime-Ngando, T. (Eds.). 2015. Environmental Microbiology: Fundamentals and Applications. Springer Science.
3. Charles Gerba, Charles P. Gerba, Ian L. Pepper. 2004. Environmental Microbiology: A Laboratory Manual 0002 Edition. Academic Press, USA.
4. Falkiewicz-Dulik, Michalina., Janda, Katarzyna. and Wypych, George., 2010. Handbook of Biodegradation, Biodeterioration and Biostabilization. Toronto: ChemTec Publishing.
5. Geohab. 2006. Global Ecology and Oceanography of Harmful Algal Blooms, Harmful Algal Blooms in Eutrophic Systems. P. Glibert (ed.). IOC and SCOR, Paris and Baltimore, 72 pp.

6. Ian L. Pepper, Charles P. Gerba and Terry J. Gentry. 2015. Environmental Microbiology. Third Edition. Elsevier Inc. Academic Press is an imprint of Elsevier 525 B Street, Suite 1800, San Diego, CA 92101-4495, USA
7. Marcos von Sperling. 2007. Basic principles of waste water treatment. Biological waste water treatment series. Volume 2. IWA Publishing, UK.
8. Peter Spencer Davies. 2005. The biological basis of waste water treatment. Published by Strathkelvin Instruments Ltd. 1.05 Kelvin Campus, West of Scotland Science Park Glasgow G20 0SP, UK
9. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. 2000. Environmental Microbiology. Gulf Professional Publishing, Science - 585 pages.
10. Sharma, P.D. 2005. Environmental Microbiology. Alpha Science International, Ltd

SC Course: MB 4.4 Microbial diversity, Evolution and Ecology 3 Credits

Microbial Evolution and Systematic Evolution of Earth and early life forms. Primitive life forms:-RNA world, molecular coding, energy and carbon metabolism, origin of Eukaryotes, endosymbiosis.

Methods for determining evolutionary relationships:-Evolutionary chronometers, Ribosomal RNA sequencing, signature sequences, phylogenetic probes, microbial community analysis.

Derivation of Microbial Phylogeny:- characteristics of domain of life, classical taxonomy, chemotaxonomy, bacterial speciation.

Microbial Diversity: Archea General Metabolism and Autotrophy in archea Phylum Euryarchaeota:- Halophilicarchaea, methanogens, thermoplasma. Phylum Crenarchaeota:- Energy metabolism, Thermoproteales, sulfobacterales, desulfobacterales. Phylum Nanoarchaeota:- Nanoarchaeum. Heat stable biomolecules and extremophiles, Evolutionary significance of hyperthermophiles.

Microbial Diversity: Bacteria Phylum Proteobacteria:-Free living N₂ fixing bacteria, purple phototrophic bacteria nitrifying bacteria, sulphur and iron oxidizing bacteria, sulphate and sulphur reducing bacteria. Phylum prochlorophytes and cyanobacteria, Phylum: Planctomyces, Phylum: Verrucomicrobia.

Microbial Diversity. Phylum: Cytophaga, Phylum: Green Sulfur Bacteria. Phylum: Deinococci. Phylum: Green non –sulfur bacteria. Phylum: Branching Hyperthermophiles, Thermotoga and Aquifex. Phylum: Nitrospira and Deferribacter.

Microbial Ecosystems Population, guilds, communities, homeostatis, Environment and microenvironment. Biofilms.

Terrestrial environment, deep surface microbiology.

Fresh water environment, lake and river microbiology.

Marine Microbiology and Hydrothermal vents.

Diversity, stability and succession Diversity indices, dominance indices, information statistics indices, Shannon index, Brillouin Index, Rank abundance diagrams, community similarity analysis, Jaccard Coefficient, Sorensen coefficient, cluster analysis.

Community stability, stability hypothesis, Intermediate-disturbance hypothesis.

Meaning of succession: Tolerance and inhibition patterns of succession, theories of succession.

Ecology and Genetics Genetic structure of population:- Genotype frequency, allele frequencies. Hardy-Weinberg Law: - Assumptions, predictions, derivation, extension and natural selection.

Measuring genetic variation at protein level, measuring genetic variation at DNA level.

Factors effecting gene frequencies:-Mutation, Random genetic drift, migration, Hardy-Weinberg natural selection, Assortative mating, Inbreeding.

Interactions and Ecosystem Management Microbial Interactions: Competetion and coexistence, Gause hypothesis, syntrophy,

Commensalism and Mutualism, predation, parasitism, and antagonism, Interaction with plants and animals.

Concept of sustainable development: microbial technology and sustainable development.

Management and improvement of waste land/barren land. Oil spills, damage and management petroleum and oil shore management.

SC Course: MB 4.3 Immunology

3 Credits

Innate immunity (anatomic, physiological, phagocytic and inflammatory barrier) and Adaptive immunity (natural and artificial).

Cells in immune response: lymphoid lineage (B & T lymphocytes).

Cells in immune response: myeloid lineage (phagocytes, macrophages, neutrophils & eosinophils; Auxiliary cells: basophils, mast cells & platelets).

Organs in immune system: Primary, secondary and lymphoid organs.

Antigens: haptens, super antigens and clusters of differentiation molecules (CDs). Processing and presentation of antigens, Exogenous and endogenous antigen processing.

Immunoglobulins: Structure and types; genetic diversity; major histocompatibility complex (MHC), HLA and H-2 systems.

Vaccines: attenuated cells, peptides, multivalent antigens, DNA and rDNA antigens.

Immunization and immune disorders; regulation of immune response.

Auto immune disorders.

Production and applications of Monoclonal antibodies.

Microscopic and culture methods of detection of pathogenic microorganisms.

Serological testing for pathogens: in vitro agglutination tests (Widal, Haemagglutination), precipitation tests (immune-diffusion, immune-electrophoresis); Immuno-blotting; ELISA, RIA fluorescence immunosorbent assay, immuno-electromicroscopy. Serological testing for bacterial pathogens.

References:

1. Rao, C.V. 2005. An introduction to Immunology. Narosa Publication house. New Delhi.
2. Apurba Sankar Sastry, and Sandhya Bhat K. 2012. Review of Microbiology and Immunology. Second Edition. JPB Publishers.
3. Delvis, P.J., Martin, S.J., Burton, D.R. and Roitt, I.M. "Roitt's Essentials of Immunology" Blackwell Sci. Pub., (2001)
4. Dulsy Fatima and Arumugam, N. "Immunology". Saras Publications, New Delhi (2000), Lydyard, P.M., Whelan, A. and Fanger, M.A. "Instant Notes in Immunology" Viva Books Pvt. Ltd. New Delhi (2003)
5. Julius M. Cruse and Robert E. Lewis. 2010. Atlas of Immunology, Third Revised Edition. Publisher: CRC Press.
6. Lydyard, P.M., Whelan, A., and Fanger, M.W. 2004. Instant notes – immunology. Garland Science/BIOS Scientific Publishers Limited, 2004. 4 Park Square, Milton Park, Abingdon, Oxon OX14 4RN, UK.
7. Pelczar M.J., Chan E.C.S. and Kreig N.R. "Microbiology – 5th edn., Tata McGraw-Hill Pub. Co. New Delhi (1986).
8. Playfair, J.H.L. and Lydyard, P.M. "Medical Immunology for Students" 2nd edn. Churchill Livingstone, Edinburgh, U.K. (2000).
9. Purohit, S.S. 2008. Microbiology – Fundamentals and Application. Sixth Edition. Student Edition Publishers, Jodhpur.
10. Stanier R.L., Ingram J.L. and Wheelis M.L. "General Microbiology" Macmillan Press Ltd (2007)

SC Course: MB 4.4 Pharmaceutical Microbiology

3 Credits

Antibiotics and Synthetic antimicrobial agents microbial resistance;therapeutic, prophylactic usage and adverse reactions;Antibiotic and Synthetic antimicrobial agents: Mechanism of action of antibiotics

Inhibition of cell wall synthesis,nucleic acid and protein synthesis. β -lactam, aminoglycosides, tetracyclines, macrolides.Antifungal antibiotics: Griseofulvin.

Antiviral drugs: Amantidines;Nucleoside analogues, interferons.

Peptide antibiotics. Synthetic antibiotics: Sulphonamides Chloramphenicol; Quinolone

Bacterial resistance to antibiotics;Penetration of antimicrobial agents (cellular permeability barrier, cellular transport system and drug diffusion).

Sources /types of microbial contaminants, assessment of microbial contamination and spoilage.

Preservation of pharmaceutical products using antimicrobial agents, evaluation of microbial stability of formulations.

Classification and mode of action of disinfectants. Factors influencing disinfection, antiseptics and their evaluation. For bacteriostatic and bactericidal actions Evaluation of bactericidal & Bacteriostatic agents. Sterility testing of products (solids, liquids, ophthalmic and other sterile products) according to IP, BP and USP.

Designing of aseptic area, laminar flow equipments; study of different sources of contamination in an aseptic area and methods of prevention, clean area classification. Principles and methods of different microbiological assay. Methods for standardization of antibiotics, vitamins and amino acids.

Assessment of a new antibiotic and testing of antimicrobial activity of a new substance.

Safety profile of drugs (Pyrogenicity, Toxicity –hepato, - nephro, -cardio and -neurotoxicity) ;Toxicological evaluation of drug: LD50, Acute, subacute and chronic toxicity ;Mutagenicity (Ames test, micronucleus test), Carcinogenicity and Teratogenicity

Growth of animal cells in culture, general procedure for cell culture, Primary, established and transformed cell cultures.Application of cell cultures in pharmaceutical industry and research.Molecular principles of drug targeting;Drug delivery system in gene therapy.

References:

1. A Textbook of Pharmaceutical Microbiology Paperback (2018) by Pulak Mujumder, Sameer Rajan Sahoo Everest Publishing
2. A Textbook of Pharmaceutical Microbiology (2015) Mehra Prahlad Singh IK International Publishing
3. Pharmaceutical Microbiology (2015)by Sheth Z.PCBS Publisher
4. A.V.S.S. Sambamurty .A Textbook of Plant Pathology. IK International Publishing House 2009
5. 5.Nidhi Goel .Pharmaceutical Microbiology: A Textbook .Alpha Science Intl Ltd .2012
6. 5.Prahlad Singh Mehra .A Textbook of Pharmaceutical Microbiology .IK International Publications

HC Course: MB 4.5 (Practical) Practical 7 and Practical 8

4 Credits

List of Experiments

1. Identify bacteria (any three of *E.coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, *Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chickenpox, HPV warts, AIDS(candidiasis),dermatomycoses(ringworms)
6. Study of various stages of malarial parasite in RBCs using permanent mounts.

7. Isolation of microbes (bacteria & fungi) from soil (28°C&45°C), rhizosphere and rhizoplane.
8. Assessment of microbiological quality of water.
9. Determination of BOD of wastewater sample.
10. Isolation of *Rhizobium* from root nodules.
11. Antibiotic Potency Testing
12. Oral micro flora
13. Food borne pathogen; Hemolytic reaction of *Staphylococcus aureus*
14. Ecology: Microbial flora
15. Environmental: microbial flora from Sewage, Soil,
16. Industrial microbiology: micro flora from different depths of soil
17. Chemical oxygen demand
18. Air Sampling
19. Surface flora: Swab test
20. Visit to Vermi compost unit, Effluent treatment and Bio gas plant.

SKILL ENHANCEMENT COURSE

Development of Biofertilizers and Biopesticides

4 Credits

Biofertilizers: General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.

Symbiotic N₂ fixers: Rhizobium - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants Frankia - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis.

Cyanobacteria as bio-fertilizers- Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application. Non - Symbiotic Nitrogen Fixers. Free living Azospirillum, Azotobacter free isolation, characteristics, mass inoculums, production and field application

Phosphate Solubilizers :Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application. PGPR – Isolation and Characterization; mass production and application.

Mycorrhizal Bio-fertilizers: Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Bioinsecticides :General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications.

List of practical experiments:

1. Isolation and characterization of symbiotic and non-symbiotic N₂ fixing microorganisms.
2. Isolation and characterization of P, K and Zn solubilizing microorganisms.
3. Isolation and characterization of PGPR and biocontrol microorganisms.
4. Mass scale production of biofertilizer microbes and their quality control.
5. Isolation, characterization and culturing techniques of different bio-agents for biopesticides.
6. Evaluation of biofertilizers and biopesticides under greenhouse and field conditions.
7. Commercial bio-formulation and its production techniques.
8. Major steps in production process of biopesticides and quality control.

References:

1. Eldor A. Paul. Soil Microbiology. Ecology and Biochemistry. VI Edition: Academic Press, (2007).
2. Eugene L. Madsen. Environmental Microbiology : From Genome to Biogeochemistry. I Edition, Wiley Blackwell Publishing. (2008).
3. Agrios, G. N. Plant pathology. Harcourt Asia Pvt. Ltd. (2000).
4. Buchanan, B. B., Gruissem, W. and Jones, R. L. Biochemistry and Molecular Biology of Plants. I. K. International Pvt. Ltd. (2000).
5. Mehrotra R S and Ashok Agrawal. Plant Pathology. Tata Mc Graw Hill, 6th reprint (2006).
6. K. S. Bilgrami, H. C. Dube. A textbook of modern pathology. 6th Edition, Vani Educational Books, a division of Vikas, (1984).
7. Shalini Suri. Biofertilizer and Biopesticide Aph Publishing Corporation (2011)

b. **Duration of the course:** 2 years (spread across four semesters)

c. **Medium of Instruction:** English

d. **Mode of Instruction:** Print material, E-content, PCP/Counseling)

e. **Attendance (Minimum required):** 75% for counselling sessions of theory courses. 85% for practical sessions.

7. **Any other information:** Nil

* * * * *

CBCS Course Matrix

Course Code	Semester and Course	Credits	Counselling/PCP hours*	Maximum Marks			Examination duration
				Internal Assessment	Term-End Examination	Total	
HC 1.1	Semester - I Course 1	4	12	20	80	100	3
HC 1.2	Course 2	4	12	20	80	100	3
HC 1.3	Course 3 (Practical)	4	120	20	80	100	3
SC 1.1	Course 1	3	09	20	80	100	3
SC 1.2	Course 2	3	09	20	80	100	3
EL-1	Inter Disciplinary course – I	2	06	10	40	50	1 ^{1/2}
	Semester - I Total	20	168	110	440	550	
HC 2.1	Semester - II Course 1	4	12	20	80	100	3
HC 2.2	Course 2	4	12	20	80	100	3
HC 2.3	Course 3 (Practical)	4	120	20	80	100	3
SC 2.1	Course 1	3	09	20	80	100	3
SC 2.2	Course 2	3	09	20	80	100	3
EL-2	Inter Disciplinary course – II	2	06	10	40	50	1 ^{1/2}
	Semester - II Total	20	168	110	440	550	
HC 3.1	Semester - III Course 1	4	12	20	80	100	3
HC 3.2	Course 2	4	12	20	80	100	3
HC 3.3	Course 3 (Practical)	4	120	20	80	100	3
SC 3.1	Course 1	3	09	20	80	100	3
SC 3.2	Course 2	3	09	20	80	100	3
SEC-T	Skill Enhancement course – T	2	06	10	40	50	1 ^{1/2}
	Semester – III Total	20	168	110	440	550	
HC 4.1	Semester - IV Course 1	4	12	20	80	100	3
HC 4.2	Course 2	4	12	20	80	100	3
HC 4.3	Course 3 (Practical)	4	120	20	80	100	3
HC 4.4	Dissertation	5	15	20	80	100	3
SC 4.1	Course 1	3	09	20	80	100	3
SEC-P	Skill Enhancement course – P	2	06	10	40	50	1 ^{1/2}
	Semester – IV Total	22	174	110	440	550	
Semester I to IV Grand total		82	678	440	1760	2200	

Note: The Students shall study mandatory course, for which no assessment in III semester only

*10% of credits on total learning hours

#during 3rd and 4th Semester the department concerned may offer specialized soft courses with limited mobility.

HC-Hard Core, SC-Soft Core, EL-Interdisciplinary Elective, SEC-Skill Enhancement Course.

Credit System for the Programmes

The University follows the '**Credit System**' for all its Programmes. Each credit is of 30 hours of study comprising of all learning activities such as studying the self-learning material, participating in the counseling/contact classes, preparing assignment, visiting library/ industry/ institution, interacting through audio-visual related mode and preparing for exams. Thus, a four credit course involves 120 study hours, a six credit course involves 180 study hours and so on. This helps the students to understand the academic efforts she/ he will have to put in order to successfully complete the programme.

INTER- DISCIPLINARY COURSE

(Open Elective) for First Semester

ವಿಭಾಗ- ಕನ್ನಡ

ಪತ್ರಿಕೆ-೬: ಆಧುನಿಕ ಕನ್ನಡ ಸಾಹಿತ್ಯದ ಇತಿಹಾಸ EL 1.1 (ಕ್ರಿಡ್-೨)

ಬ್ಲಾಕ್-೧೯: ಆಧುನಿಕ ಕನ್ನಡ ಸಾಹಿತ್ಯದ ಮುಖ್ಯ ಘಟ್ಟಗಳು

ಘಟಕ-೨೩: ಆಧುನಿಕ ಕನ್ನಡ ಸಾಹಿತ್ಯದ ಹಿನ್ನೆಲೆ ಮತ್ತು ಪ್ರೇರಣೆಗಳು.

ಘಟಕ-೨೪: ನವೋದಯ ಪೂರ್ವ, ನವೋದಯ- ಬಿ.ಎಂ.ಶ್ರೀ., ಕುವೆಂಪು, ದ.ರಾ.ಬೇಂದ್ರೆ, ಶಿವರಾಮಕಾರಂತ, ಮಾಸ್ತಿವೆಂಕಟೇಶ್ ಅಯ್ಯಂಗಾರ್, ಕೆ.ಎಸ್. ನರಸಿಂಹಸ್ವಾಮಿ.

ಘಟಕ-೨೫: ಪ್ರಗತಿಶೀಲ ಮತ್ತು ನವ್ಯ: ಅನಕೃ, ಕಟ್ಟಿಮನಿ, ನಿರಂಜನ, ಚದುರಂಗ, ವಿ.ಕೃ. ಗೋಕಾಕ, ಅಡಿಗ, ಜಿ.ಎಸ್. ಶಿವರುದ್ರಪ್ಪ, ಶಾಂತಿನಾಥ ದೇಸಾಯಿ, ಅನಂತಮೂರ್ತಿ, ಯಶವಂತ ಚಿತ್ತಾಲ, ಲಂಕೇಶ್, ತೇಜಸ್ವಿ, ವೈದೇಹಿ, ವೀಣಾ ಶಾಂತೇಶ್ವರ, ವಿಜಯಾದಿಪ್ತಿ.

ಘಟಕ-೨೬: ಬಂಡಾಯ ಮತ್ತು ದಲಿತ:

ಬರಗೂರು ರಾಮಚಂದ್ರಪ್ಪ, ಬಿ.ಟಿ. ಲಲಿತಾನಾಯಕ, ಸಾರಾ ಅಬೂಬಕ್ಕರ್, ದೇವನೂರು ಮಹಾದೇವ, ಸಿದ್ದಲಿಂಗಯ್ಯ, ಅರವಿಂದ ಮಾಲಗತ್ತಿ, ಮೊಗ್ಗಿ ಗಣೇಶ.

ಬ್ಲಾಕ್-೨೦: ಆಧುನಿಕ ಕನ್ನಡ ಕಾವ್ಯ ಮತ್ತು ಸಾಹಿತ್ಯ ಪ್ರಕಾರಗಳು

ಘಟಕ-೨೭: ಕಾವ್ಯ ಪ್ರಕಾರಗಳು: ಭಾವಗೀತೆ, ಸುನೀತ, ಶೋಕಗೀತೆ, ಪ್ರಗಾಥ.

ಘಟಕ-೨೮: ಕಥನ ಕಾವ್ಯ, ಖಂಡ ಕಾವ್ಯ, ಮಹಾಕಾವ್ಯ.

ಘಟಕ-೨೯: ಸಾಹಿತ್ಯ ಪ್ರಕಾರಗಳು: ಕಥೆ, ಕಾದಂಬರಿ, ನಾಟಕ ಜೀವನ ಚರಿತ್ರೆ.

ಘಟಕ-೩೦: ಲಲಿತ ಪ್ರಬಂಧ, ಆತ್ಮಕತೆ, ಪ್ರವಾಸ ಸಾಹಿತ್ಯ, ಸಂಪಾದನೆ, ವಿಚಾರ ಸಾಹಿತ್ಯ, ವಿಜ್ಞಾನ ಸಾಹಿತ್ಯ

ಪರಾಮರ್ಶನ ಗ್ರಂಥಗಳು

೧. ಹೊಸಗನ್ನಡ ಸಾಹಿತ್ಯ: ಎಲ್.ಎಸ್. ಶೇಷಗಿರಿರಾವ್, ಕನ್ನಡ ಸಾಹಿತ್ಯ ಪರಿಷತ್, ಬೆಂಗಳೂರು, ೧೯೯೨

೨. ಯುಗಧರ್ಮ ಮತ್ತು ಸಾಹಿತ್ಯ ದರ್ಶನ: ಕೀರ್ತಿನಾಥ ಕುರ್ತಕೋಟಿ, ಮನೋಹರ ಗ್ರಂಥ ಮಾಲೆ, ಧಾರವಾಡ, ೧೯೯೧

೩. ಕನ್ನಡ ಸಾಹಿತ್ಯ ಇತಿಹಾಸ: ರಂ.ಶ್ರೀ. ಮಗುಳಿ, ಗೀತಾ ಬುಕ್ ಹೌಸ್, ಮೈಸೂರು, ೨೦೧೮

೪. ಕನ್ನಡ ಸಾಹಿತ್ಯ ಸಂಗಾತಿ: ಕೀರ್ತಿನಾಥ ಕುರ್ತಕೋಟಿ, ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಹಂಪಿ, ಹೊಸಪೇಟೆ, ೧೯೯೫

೫. ಕನ್ನಡ ಸಾಹಿತ್ಯ ಸಂಗಾತಿ: (ಪ್ರ.ಸಂ) ಬರಗೂರು ರಾಮಚಂದ್ರಪ್ಪ, ಕರ್ನಾಟಕ ಸಾಹಿತ್ಯ ಅಕಾಡೆಮಿ, ೨೦೧೮

೬. ಕನ್ನಡ ಸಾಹಿತ್ಯ ಚರಿತ್ರೆ: ತ.ಸು. ಶಾಮರಾಯ, ತಳುಕಿನ ವೆಂಕಣ್ಣಯ್ಯ ಸ್ಮಾರಕ ಗ್ರಂಥಮಾಲೆ, ಮೈಸೂರು, ೨೦೧೪

೭. ಹೊಸಗನ್ನಡ ಕಾವ್ಯ ಪ್ರಕಾರಗಳು: ಪ್ರಧಾನ ಸಂಪಾದಕರು, ಎ.ರಂಗಸ್ವಾಮಿ, ಲೇ. ಮ. ರಾಮಕೃಷ್ಣ, ಪ್ರಸಾರಂಗ, ಕರಾಮುವಿ, ಮೈಸೂರು, ೨೦೧೦

೮. ಆಧುನಿಕ ಸಾಹಿತ್ಯ ಪ್ರಕಾರಗಳು: ಪ್ರಧಾನ ಸಂಪಾದಕರು, ಎ. ರಂಗಸ್ವಾಮಿ, ಲೇ. ಡಾ. ಜಿ.ಆರ್. ಶಿಪ್ಪೇಸ್ವಾಮಿ, ಪ್ರಸಾರಂಗ, ಕರಾಮುವಿ, ಮೈಸೂರು, ೨೦೧೦

DEPARTMENT - ENGLISH

EL-1.1: INTER- DISCIPLINARY COURSE-I (OPEN ELECTIVE)

INDIAN LITERATURE-I

OBJECTIVES

- To help to understand the contribution of Kalidasa to Sanskrit drama as a playwright
- To create an awareness of the importance of Shakuntala and Mrichhakatika as classical Indian texts
- To evaluate Lord Macaulay and Raja Ram Mohan Roy writers of English Prose.
- To introduce the role of Autobiographies in Indian writing in English

BLOCK –I

Kalidasa: Shakuntala

Shudraka: Mrichhakatika

BLOCK -II

Jawaharlal Nehru: An Autobiography

Ram Mohan Roy: Letter to Lord Amherst

Macaulay: Minutes on Indian Education

Vivekananda: Address to the Parliament of Religions

Suggested Reading:

- **M.K.Naik:** Critical Essays on Indian Writing in English. Sahitya Akademi, 1969.

- **Narasimhaiah. C.D:** The Swan and the Eagle. Indian Institute of Advanced Study, 1987.
- **Meenakshi Mukherjee:** The Twice Born Fiction. Heinemann Educational Publishers, 1972.
- **Chirantan Kulshrestha.** Contemporary Indian English Verse: An Evaluation. Arnold-Heinemann, 1981.

DEPARTMENT - HINDI

व्यावहारिक हिंदी एवं व्याकरण

वर्ण विचार

- वर्ण
- स्वर और उसका वर्गीकरण
- व्यंजन और उसका वर्गीकरण
- वर्णों का उच्चारण स्थान
- संधि
- समास

शब्द विचार

- शब्द के भेद
- अर्थ के आधार पर शब्द भेद
- व्युत्पत्ति के आधार पर शब्द भेद
- रचना के आधार पर शब्द भेद
- प्रयोग के आधार पर शब्द भेद
- विकारी और अविकारी शब्द भेद
- अव्यय
- संज्ञा और उसके भेद
- वचन- उसके भेद, वचन परिवर्तन के नियम
- लिंग- उसके भेद, लिंग परिवर्तन के नियम
- काल और उसके भेद
- कारक और विभक्ति- उसके प्रकार,
- सर्वनाम और उसके भेद
- विशेषण और उसके भेद
- क्रिया और उसके भेद
- क्रिया विशेषण और उसके भेद

- समुच्चय बोधक और उसके भेद
- संबंधबोधक और उसके भेद
- विस्मयादिबोधक और उसके भेद
- परसर्ग और उपसर्ग
- वाच्य और उसके प्रकार

वाक्य विचार

- वाक्य का अर्थ और परिभाषा
- वाक्य के प्रकार आदि

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DEPARTMENT - TELUGU

E. L. 1.1 Thilak Prathyeka Adhyayanam

Block - 1:Thilak Kavithvam - 1

Unit - 1:Amrutham Kurisina Raathri

Unit - 2:Thilak Padhya Kavithaa Vaibhavam

Unit - 3:Thilak Abhiruchulu - Alavaatlu

Unit - 4: Thapala bantrothu

Block - 2: Thilak Kavithvam

Unit - 1:Thilak Sahithya Parichayam - 1

Unit - 2: Thilak Sahithya Parichayam - 2

Unit - 3:Thilak vachana kavithaa Vaibhavam - 1

Unit - 4: Thilak Vachana Kavithaa Vaibhavam – 2

DEPARTMENT - HISTORY

ANCIENT WORLD CIVILIZATIONS

(Egypt, Mesopotamia, Greek, Roman, Inca, Chinese)

Objective: The course is aims to understand major world civilizations. It is to provide a global historical perspective of ancient world which special reference to Egypt, china, Greek, Roman, Inca civilizations.

Pedagogy: personal contact programmes, audio video programmes, online lectures
Assignments, etc

Credits: 2.

Examination Duration: 11/2 hours and Maximum Marks:40

Course outcomes:

After completing this course the students should be able to

- Discuss the Egyptian and Mesopotamian civilizations.
- Analyse the political socio economic conditions of Greek Roman civilizations.
- Evaluate the Chinese contributions to ancient world.

Block – I

Unit-1

Egyptian Civilization: Importance of the Nile, Geographical importance, Gift of Nile, Political conditions.

Unit-2

Social, Economic and religious conditions, Literature and learning, arts and architecture.

Unit-3

Mesopotamian Civilization, Sumer and Babylonian, Hammurabi's code, Society and Culture, Economic conditions, art and literature, Assyrian Empire.

Unit - 4

Greek Civilization, Political Organizations, the city, State, Alexander the Great, Greek political theory, Religion, Philosophy, art and architecture, Characteristic of Hellenistic Civilization.

Block – II

Unit - 5

Roman Civilization, The Land and the people, the Government, Roman Republic, Roman Empire, Roman Republic, The Empire, The Patricians and Plebeians, Punic wars.

Unit – 6

Julius Caesar, his wars, fall Augustus Caesar, Social Economic Conditions, Roman art and architecture.

Unit - 7

Painting, Sculpture, Roman Law, Roman Religion, Philosophy, Roman literature, Decline of the Roman Empire.

Unit - 8

Inca Civilisation, Socio – economic Political conditions, Chinese Civilisation, Socio – economic Political conditions.

Suggested readings:

1. Breasted, J.H. : Ancient Times, A History of the early world.
2. Rostovzeff, M.S. : History of Ancient World
3. Schvinder, H. : The History of Civilization
4. Swain, J.E. : A History of World Civilization
5. Breasted, J.H. : History of Egypt
6. Jastrow, M. : The Civilization of Babylonia and Assyria
7. Bury, J.E. & OTHERS: The Hellenistic Age
8. Bailey, C. : The Legacy of Rome and others
9. Abot, F.F.: Society and Politics of Ancient Rome

DEPARTMENT – ECONOMICS

EL1.1: Economic Policies of India Since 1991.

- **Objective:** To enable the Students to understand the economic policies of India in the era of new economic policy.
- **Pedagogy:** A Combination of Lectures, Group Discussion, Assignments.

- **Credits:** 2 ; Examination Duration: 1½ and Maximum Marks: 50 (Internal Assessment Marks = 10 and Semester-end Examination =40)

Course Inputs

BLOCK – I: India’s Economic Policies

UNIT : 1 Economic Policies in India Since 1991

Economic reforms in India – Economic Scenario in India during 1990-91 – Domestic Financial Crisis – Balance of Payment Crisis – Extent of External debt and debt Trap Problem.

UNIT : 2 Need for Reforms

Measures Taken – Devaluation – Privatization – Liberalization – Globalization.

UNIT : 3 Monetary Policy and Fiscal Policy

Narasimhan Committee on Banking and Financial Sector Reforms Since 1998 – Fiscal Reforms: Raja Chellaiah Committee and Tax Reform Policies – Fiscal Prudence and Policies.

UNIT : 4 Structural Adjustments and External Sector in India

Foreign Trade: Trends in Exports and Imports – Balance of Payment and its Crisis – Export Import Policy – In Defence of Import Substitution – Foreign Exchange Policy.

BLOCK : II FDI and the Role of State

UNIT : 5 Foreign Direct Investment (FDI)

Trends in FDI – FDI Policy – Its Impact on the Domestic Economy – Labour Migration: causes and Consequences on Indian Economy – Information and Communication Revolution and India.

UNIT : 6 Challenges to Development in India

Poverty – Unemployment – Poverty alleviation Programmes - urban Poverty and Problems – Income Inequality – Employment Generating Schemes.

UNIT: 7 The Role of State

Parallel Economy in India – Black Money – Corruption – Slams – Redefining the Role of the State and the Markets – Balance between Economic and Socio - Political Goals.

UNIT : 8 Administrative Reforms

Rights to Information – Measures Towards Good Governance – NITI Ayoga and aftermath – Digitalized India – Demonetization – GST – Make in India.

References:

1. Acharya Shankar, (2003) India's Economy: Some Issues and Answers, Academic Foundation, New Delhi.
2. Byres J Terence (Ed.,) (1999) The Indian Economy, Major Debates since Independence, OUP, New Delhi.
3. Datt Ruddar, (2002) Economic Reforms in India - A Critique, S.Chand and Co, New Delhi.
4. Kapila Uma (Ed) (2015) Indian Economy since Independence, Academic Foundations, New Delhi.
5. Kapila Uma, (2005) Understanding the Problem of Indian Economy, Academic Foundation, New Delhi.
6. Misra S.K. & V.K. Puri, (2011) Indian Economy-Its Development Experience, Himalaya Pub., House, Mumbai.
7. NCAER, Economic and Policy Reforms in India, NCAER, New Delhi.
8. Rangarajan C, (1998) Indian Economy- Essays on Money and Finance, UBSPD, New Delhi.
9. Sachs D.Jeffrey, A.Varshney & N Bajpai (Ed)(1999) India in the Era of Economic Reforms,OUP, New Delhi.
10. Vaidyanathan A, India's Economic Reforms and Development, OUP, New Delhi

DEPARTMENT - POLITICAL SCIENCE

(OEL-I) Local Government in India

Block-I

- Unit:1 Meaning, Nature and Scope of Local Governments.
- Unit:2 Evolution of Panchayat Raj Institution in India.
- a) Constitute Assembly and Village Panchayat.
 - b) Balavanth Roy Mehta Committee Report
 - c) Ashok Mehta Committee Report.
 - d) G.V.K. Rao Committee Report.
- Unit:3 Constitutional Amendments and Panchayat Raj Institutions:
- a) Basis of Constitutional Amendment.
 - b) 73rd and 74th Constitutional Amendment.
 - c) Karnataka Panchayat Raj At of 1983.
 - d) Karnataka Panchayat Raj Act of 1993.
- Unit:4 Zilla Panchayat: Structure, Functions and Sources of Revenue.

Block-II

- Unit:5 Taluk Panchayat : Structure, Functions, Executive Officer, Powers and

Functions.

- Unit:6 Gram Panchayat: Gram Sabha, Ward Sabha: Structure, Functions and Sources of Revenue.
- Unit:7 Panchayat Development Officer and Secretary: Powers and Functions.
- Unit:8 Role of Panchayat Raj Institutions in Development (with Reference to Karnataka)
- a) Panchayat Raj in Rural Development.
 - b) Social Change: Empowerment of the Weaker Sections.

References:

1. Verma B. M, Social justice and Panchayath Raj
2. Mutarib-M.A. and Others, Theory of Local Government,
3. Dr. Arjun darshankar, Panchayath Raj aani Nagari.
4. V. B. Patil, Pancayath Raj.
5. A.N. Kulkarni, Bharatiya Sthanik Swashasan,
6. Shantaram Bhosale, Bharatiya Sthanik Shasan,
7. Kikherji. S, Essays on Rural Development.
8. Balaramu. C. H. Administration of Anty Poverty Programmes.
9. 73rd Constitutional Amendment Act, Government of India, 1993.
10. Karnataka Panchayatraj Acts, 1985, 1995.

DEPARTMENT – PUBLIC ADMINISTRATION

INDIAN POLITY – I

BLOCK – 1

- UNIT – 1 Indian Constitution.
- UNIT – 2 Preamble - Meaning and Importance.
- UNIT – 3 Fundamental Rights and Duties.
- UNIT – 4 Directive Principles of State Policy and Relation with Fundamental Rights.

BLOCK – 2

- UNIT – 5 Indian Federalism and Parliamentary system of Government.
- UNIT – 6 Centre - State Relations. Legislative Administrative and Financial

UNIT – 7 Union Executive - President Elections, Powers and Positions. .

UNIT – 8 Council of Ministers and Prime Ministers - Powers and Functions

DEPARTMNT - SOCIOLOGY

Invitation to Sociology

(02 Credits)

Course Description

This course introduces learners to the basic concepts of sociology. It is particularly designed to orient the learners from interdisciplinary background about the essence of sociology and intends to inculcate sociological imagination.

Course Objectives

- To introduce the learner to the basic concepts and processes of sociology
- to comprehend the structural and organizational aspects of society
- to examine the process of social change

Learning Outcomes and Competencies

After successfully completing the course, following outcomes and competencies are possible among the learners. Learner will have/can

- Conceptual precision and clarity about the basic sociological concepts
- Develop sociological imagination and apply to analyze the contemporary events
- explain major social processes of society
- analytical view about Indian social structure
- explicate major process of social change and can conceptualize the changing aspects of Indian society

Course Contents

Block-1 Basic Concepts and Processes

Unit-1 Emergence of Sociology-Factors and Early Thinkers-Sociological Imagination

Unit-2 Society, Community- Associations and Institutions- Culture and Socialization

Unit-3 Social System, Structure and Function

Unit-4 Social Processes-Cooperation, Competition, Conflict, Accommodation and Assimilation

Block-2 Social Organization and Social Change

Unit-5 Caste and Class System-Changes in Caste

Unit-6 Social Mobility and Types

Unit-7 Factors of Social Change

Unit-8 Process of Social Change in India (Sanskritization, Westernization,
Modernization and Globalization)

References

1. Berger, Peter L. 1978. An Invitation to Sociology, Allen and Unwin, London. Davis, Kingsley. Human Society, Macmilan, New Delhi.
2. Dumont, Louis, 1988, Homo Hierarchicus. Oxford University Press. Giddens, Anthony. 2009. Sociology. Politi Press, Malden.
3. Inkles, Alex. 2002. What is Sociology, Prentice Hall India, New Delhi. Jayaram, N, 1990, Introductory Sociology, Macmilan, New Delhi.
4. Johnson Harry M., 2011: Sociology: A Systematic Introduction: Allied Publishers, New Delhi.
5. MacIver, R.M and C.H. Page. Society - Introduction to Sociology, Macmilan, New Delhi
6. Samuel, Koenig. 1957. Sociology: An Introduction to Science of Society, Barnes & Nobel Books, London.
7. Singh, Yogendra. 1993: Social Change in India: Crisis and Resilience, Har-Anand, New Delhi.

DEPARTMENT – ANCIENT HISTORY AND ARCHEOLOGY

AHA
OE 1.1

World Heritage Sites of India

Block - 1

Introduction

Unit - 1 Nature - Scope - Criteria for incorporation of World Heritage sites

Unit - 2 Types of World Heritage sites in India

Block - 2

Archaeological and Cave Heritage sites

Unit - 3 Bimbetka - Sanchi- Nalanda – Champaner - Dholavira

Unit – 4 Ajanta – Ellora - Elephant

Block - 3

Unit – 5 Bodh Gaya — Kajuraho–Konarak–Rani kivav– Jaipur,

Unit – 6 Agra Fort – Red Fort - Fatehpur Sikri–Taj Mahal – Humayun’s Tomb –
Ahmadabad, Qutub Minar

Block - 4

Unit – 7 Mahabalipuram – Pattadakallu – Chola temples

Unit - 8 Monuments of Hampi – Churches and Convents of Old Goa – Ramappa Temple

References:

1. Marco Canneo, Jasmina: The world heritage sites of UNESCO – The Treasure of Art
2. ASI: World Heritage Sites Series
3. Individual guide: Books on respective city Individual

DEPARTMENT - EDUCATION

IDC – 1 FOUNDATIONS OF EDUCATION

BLOCK-1 FOUNDATIONS OF EDUCATION – I

Unit-1 Philosophical Foundations

Unit-2 Basic Concepts of Philosophy

Unit-3 Psychology as a Science

Unit-4 Basic Concept in Psychology related to Education

BLOCK-2 FOUNDATIONS OF LEARNING – II

Unit-5 Sociological bases of Education

Unit-6 Educational Issues in Indian Society

Unit-7 Cultural and Historical Foundations

Unit-8 Political and Economic bases of Education

References:

1. Harison and Myers (1970), Education, Manpower and Economic Growth, McGrothill, Oxfords, IBH Publishing Co., New Delhi.
2. Kamala Bhatia & Baldev Bhatia, (1974) The Philosophical and Sociological Foundations of Education, Doaba House, New Delhi.
3. Bhatia B.D, (1974), 'Theory and Principles of Education, Doaba House, Delhi'.
4. Sorokim .P, (1947) 'Society, Culture and Personality', Harper and Brothers Publishers, New York.

DEPARTMENT – COMMERCE

EL1.1: Personal Financial Planning

Objective: To enable the Students to understand about the different Investment Avenues, Saving Schemes designed by various agencies particularly for the individuals.

Pedagogy: A Combination of Lectures, Group Discussion, Assignments.

Credits: 2

Examination Duration: 1¹/₂ and Maximum Marks: 50

(Internal Assessment Marks = 10 and Semester-end Examination =40)

Course Inputs

Block I

- **Unit -1: Introduction to Financial Planning:** Introduction - The Process Financial Planning – Client Interactions – Time Value of Money Applications – Personal Financial Statements – Cash Flow and Debt Management – Planning to Finance Education.
- **Unit -2: Financial Planning Process:** Introduction - Setting Goals – Informal Budget Preparation – Investment Opportunities – Financial Vs Physical Investments – Role of a Financial Planner.
- **Unit -3: Savings Plans:** Introduction - Setting Goals – Savings Instruments – Savings Plan – Tax Savings Schemes.
- **Unit -4: Investment Planning:** Introduction - Risk Return Analysis – Mutual Fund – Derivatives – Asset Allocation – Investment Strategies and Portfolio Construction and Management.

Block II

- **Unit -5: Risk Analysis and Insurance Planning:** Introduction - Risk Management and Insurance Decision in Personal Financial Planning – Various Insurance Policies and Strategies for General Insurance – Life Insurance – Motor Insurance – Medical Insurance.
- **Unit -6: Retirement Planning and Benefits:** Introduction - Retirement Need Analysis Techniques – Savings and Investment Plans for Retirement –Employee Provident Fund – Public Provident Fund – Superannuation Fund – Gratuity – Annuity Plans.
- **Unit -7: Tax Planning:** Introduction - Income-tax Computation for Individuals – Companies - Trust and other bodies – Statutory Provisions Pertaining to Capital Gains and Indexation – House Property – Deduction and Allowances.
- **Unit -8:Health Financing:** Introduction - Health Financing Models – Financing of Health in India – National Rural Health Mission – Challenges of Access to Health Care and Service Quality – Health Insurance Mechanism & Financial Protection.

Books Recommended for Reference

01. Khan M.Y, Financial Services, Tata MacGraw Hill.
02. Singhanar V.K, Students' Guide to Income Tax, Taxmann.
03. Ranganathan and Madhuamathi, Investment Analysis and Portfolio Management, Pearson Publications.
04. Gordon and Natarajan, Emerging Scenario of Financial Services, Himalaya Publishing House.
05. George Rejda, Principles of Risk Management and Insurance, Pearson.

DEPARTMENT - MANAGEMENT

COURSE: OE-1 : Disaster Management - Credit: 2

MBAS 459: DISASTER MANAGEMENT

Objectives	: The course aims at familiarizing the students with the concepts of disaster management, need for disaster management and its relevance.
Pedagogy	: Lectures, assignments, Industrial visits and practical exercises, discussions.

1. Understanding Disasters · Meaning, nature, characteristics and types of Disasters, Causes and effects, Disaster: A Global View, Disaster Profile of India, The Disaster Management cycle.
2. Geological and Mountain Area Disasters · Earthquakes · Volcanic Eruption · Landslides Snow Avalanches, Wind and Water Related Natural Disaster · Floods and Flash Floods · Droughts ·

Cyclones · Tsunamis, Man Made Disasters · Understanding Man-Made Disasters · Fires and Forest Fires · Nuclear, Biological and Chemical disaster · Road Accidents

3. Introduction to disaster Preparedness · Disaster Management: Prevention, Preparedness and Mitigation · Disaster Preparedness: Concept & Nature · Disaster Preparedness Plan · Disaster Preparedness for People and Infrastructure · Community based Disaster Preparedness Plan
4. Roles & Responsibilities of Different Agencies and Govt. · Roll of Information, Education, Communication & Training · Role and Responsibilities of Central, State, District and local administration. · Role and Responsibilities of Armed Forces, Police, Para Military Forces. Role and Responsibilities of International Agencies, NGO's, Community Based Org. (CBO's)
5. Technologies for Disaster Management · Role of IT in Disaster Preparedness · Remote Sensing, GIS and GPS · Use and Application of Emerging Technologies · Application of Modern Technologies for the Emergency communication. · Application and use of ICST for different disasters.
6. Disaster Mitigation · Disaster Mitigation: meaning and concept · Disaster Mitigation Strategies · Emerging Trends in Disaster Mitigation · Mitigation management · Role of Team and Coordination
7. Disaster Management in India Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies. National Disaster management Authority.

References

1. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.
3. Central Water Commission, 1987, Flood Atlas of India, CWC, New Delhi.
4. Central Water Commission, 1989, Manual of Flood Forecasting, New Delhi.
5. Government of India, 1997, Vulnerability Atlas of India, New Delhi.
6. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.

DEPARTMENT - BIO CHEMISTRY

Basics of Bioinorganic and Biophysical chemistry for Biology graduates.

Bioinorganic chemistry

Coordination Compounds: Transition metals, properties (Colour, Oxidation states, Magnetic properties) Coordinate bond, double and complex salts– differences with examples.

Postulates of Warner's theory. Types of ligands: For examples: uni, bi, polydentate ligands. Coordination number, examples.

Porphyrin nucleus and their classification. Important metallo-porphyrins occurring in nature. Structure and biological importance of Heme, cytochrome, chlorophyll, Vitamin B₁₂.

Nitrogen, Fixation of atmospheric nitrogen – Symbiotic and non-symbiotic. Nitrogen cycle.

Environmental pollution by nitrogen compounds. Phosphorous: Importance of Phosphorous compounds in biological system, phosphorous cycle

Oxygen, Formation of ozone in atmosphere. Role of ozone in maintenance of life on earth. Effect of environmental pollutants on ozone layer.

Sulphur and Selenium, Importance of compounds of Sulphur and Selenium in biological systems. Effect of sulphur compounds on environmental pollution.

Biophysical chemistry.

Units in chemistry, Avogadro's number, Mole, Mole fraction, Molarity, Equivalent weight, Normality, Molality. Colligative Properties, Osmotic pressure and its measurements. Hypo-, Hyper- and isotonic solutions. Effect of osmotic pressure on living cells.

Donnan membrane equilibrium. Relative lowering of vapour pressure, Raoult's law. Elevation of boiling point, depression in freezing point.

Adsorption: Freundlich and Langmuir's adsorption isotherm. Applications of adsorption.

Viscosity: Definition, determination of viscosity of liquids & solutions by Ostwald's viscometer (solutions of gum and protein to be taken as examples).

Distribution law, Distribution law, partition coefficient, application of distribution law.

Acids, bases and buffers- Lewis concept of acids and bases. Ionic product of water. pH scale, buffers, Henderson- Hasselbach equation, buffer capacity Choice of buffers. Theory of acid base indicators. pH titration curve and iso-electric pH of amino acids.

Selected References:

1. Basic Principles of Organic Chemistry, Roberts and Caserio, W. A. Benjamin, Inc. (1964).
2. Organic Chemistry, Morrison and Boyd, Allyn and Bacon Inc (1992).
3. Principles of Inorganic chemistry by Cotton & Wilkinson, Wiley (1999).
4. Textbook of Organic chemistry by Ahluwalia V K & Madhuri G Narosa publications (2001).
5. Physical chemistry by Castellan G W, Narosa Publications (2004).
6. Physical chemistry by Chakraborty D K, Narosa Publications (2004).

DEPARTMENT - BIOTECHNOLOGY

MBT EL –I- Biotechnology and its Applications

Introduction to biotechnology. Principles of biotechnology, classification.

Recombinant DNA Technology

Introduction, outline of genetic engineering procedure, restriction endonucleases, cloning & expression vectors- plasmids, cloning in plasmid, transformation and detection of transformants- lacZ, genomic and cDNA libraries, gene analysis techniques-hybridization: Southern, Northern, Western, in situ, Polymerase chain reaction.

Microbial and food and environmental Biotechnology

Basics of fermentation technology: Types of microbial culture- batch, continuous and fed-batch. Microbial production: Use of microbes in production of vitamins, enzymes, organic acids, amino acids, polysaccharides, flavors, sweeteners, proteins and antibiotics.

Fermented food products- yogurt, cheese, tempeh, sauerkraut; beverages- wine and beer. Pre- and Pro-biotics, single cell proteins, Genetically modified foods, designer foods.

Current status of biotechnology in environment. Bioconservation, biofuels, gasohol, biogas. Bioremediation: Concepts and principles, bioremediation using microbes, in situ and ex situ bioremediation, biosorption and bioaccumulation of heavy metals.

Plant Biotechnology

Landmarks in Plant tissue culture. Types of cultures- embryo, organ, callus and cell cultures, Somatic embryogenesis, Haploid Production, Androgenesis, Protoplast culture and somatic hybridization. Micropropagation- Methods and stages, applications. Synthetic seeds, somaclonal variation. Production of secondary metabolites by plant cells, Biotransformation.

Plant transformation techniques: Direct and indirect methods of gene transfer in plants. Transgenic plants and crop improvement- herbicide tolerance, disease resistance, abiotic stress tolerance, delayed ripening, improvement of nutritional quality, molecular pharming.

ANIMAL BIOTECHNOLOGY

Basics of animal cell culture techniques, cell lines, physical conditions for culturing animal cells, equipments required, scale-up of culture methods.

Application of animal cell culture- Hybridomas, production of therapeutic antibodies, stem cell technology, cell and tissue engineering.

Genetic engineering of animals: Methods for gene transfer in animals, microinjection, nuclear transplantation, retrovirus-mediated gene transfer, gene knockdown techniques. Transgenic- animals- sheep, pigs, cattle, chickens; applications of transgenic animals.

DEPARTMENT - CHEMISTRY

Block-1	Title: Periodic Table and chemical Periodicity
Unit-1	Elements, atomic structure, atomic number, atomic mass, quantum numbers, electronic configuration,
Unit-2	Periodic properties of elements, State of Matter, their resources. Important periodic properties of the elements, covalent radii, ionic radii, ionization potential, electron affinity and electronegativity
Unit-3	Concepts of Acids and Bases: Review of acid base concepts. Lux-Flood and solvent system concepts. Hard-soft acids and bases. Applications.
Unit-4	Solutions: Concentration units, solutions of liquids in liquids, Raoult's law, ideal and non-ideal solutions.

Block-2	Title: Bonding and molecular structure
Unit-5	Calcification of matter: (elements, compounds, substance and mixture), The three states of matter, physical and chemical properties of matter, fundamental particles of atoms, atomic number, atomic mass, atomic structure of atom molecular formula, empirical formula, molecular mass.
Unit-6	Ions and ionic compounds, properties of ionic compounds, formation of ionic compounds, covalent compounds, properties of covalent compounds, properties of covalent compounds
Unit-7	Metals, properties of metals, theory of metallic bond formation, types of metals conductor, semiconductor and insulators, n-type semiconductors and p-type semiconductors, alloys and superconducting materials.
Unit-8	Acids and bases, general properties of acid and bases, Acid base reactions, oxidation reduction reactions, oxidation number, types of redox reactions, balancing oxidation-reduction equation, exothermic and endothermic reactions energy change in chemical reactions.

DEPARTMENT : CLINICAL NUTRITION

AND DIETETICS

OEL-1: HEALTHY LIFESTYLES AND NUTRITION

3 CREDITS

BLOCK 1: INTRODUCTION TO FOOD AND NUTRITION

Unit 1.- Factors affecting food habits, choices and dietary patterns – Definition of Food, Nutrition, Health, Fitness. Interrelationship between nutrition and health, concept of a desirable diet for optimum nutrition, health and fitness.

Unit 2.- A brief review of nutrients in general –

- Energy and macronutrients – Carbohydrates, Protein, Fat - functions, sources deficiency disorders and recommended intakes.
- Micronutrients: Minerals – calcium, Iron, Iodine, and other elements, Vitamins – Fat Soluble & Water Soluble.

Unit 3: Nutritional assessment- Anthropometric, biochemical, clinical, dietary and Biochemical assessments

Unit 4: Basic principles of planning diet –, RDA for Indians, Food groups, Dietary guides and balanced diets.

BLOCK 2: PLANNING OF DIET

Unit 5: Principles of planning a normal diet: characteristics of a normal diet, meeting nutrient requirements of individuals and family. Use of Dietary guidelines for Indians.

Unit 6: Objectives of diet therapy- Regular diet and rationale for modifications in energy and other nutrients, texture, fluid, soft diets etc.

Unit 7: Role of dietician in hospital- specific functions, team approach in patient care,

psychological consideration, interpersonal relationship with patients. Nutrition and medical ethics. Hospital dietary- scope and importance, types of food service, quality management.

Unit 8: Nutrition counseling: definition, concept, role of clinical dietician, the recipient and counseling environment and goals of counseling. An overview of systems approach to nutritional care and its components (planning, implementation and evaluation).

REFERENCES

- Srilakshmi B (2004) Nutrition Science. New Age International (P) Ltd, Publishers.
- Kango M (2005) Normal Nutrition, Curing diseases through diet. First Edition CBS Publications. Paul S (2003) Text Book of Bio-Nutrition, Fundamental and Management. RBSA Publishers.
- Williams SR (2000) Nutrition and Diet Therapy. Sixth Edition C.V. Melskey Co.
- Mudambi SR and Rajagopal MV (1997) Fundamentals of Foods and Nutrition. New Age International (P) Ltd, Publishers.

- Swaminathan M (1999) Essential of Food and Nutrition. Vol I and II, Bappco publications, Madras.
- Corinne, H. Robinson 2010– “Normal and Therapeutic nutrition”, Oxford and IBH publishing company, Bombay.
- B. Srilakshmi –
2012 “Dietetics”, 4th edition, New age international publisher, Chennai

DEPARTMENT - COMPUTER SCIENCE

ELMCS-01 Mobile App Development: Credit 2

Block – I

Unit-1: Introduction to Mobile Computing: applications, a simplified reference model, Wireless Transmission:

Unit-2: Frequencies of radio transmission, signals, antennas, signal propagation, multiplexing, modulation, spread spectrum, cellular system.

Unit-3 Media Access Control: motivation for a specialized MAC, SDMA, FDMA, TDMA, CDMA ,and Comparisons.

Unit-4: GSM, DECT, Wireless LAN: Infrared vs. radio transmission, Infrastructure and ad-hoc networks, IEEE 802.11, HPERLAN, Bluetooth.

Block – II

Unit-5: Mobile Network Layer: mobile IP, dynamic host configuration protocol,

Unit-6: ad-hoc networks. Mobile Transport Layer: Traditional TCP, classical TCP improvements,

Unit-7: TCP over 2.5/3G wireless networks. File Systems, World Wide Web,

Unit-8: Wireless Application Protocol (WAP) and WAP 2.0.

Text book:

1. Jochen H. Schiller, Mobile Communications(2e)

Reference

1. Raj Kamal, Mobile Computing
2. Asoke K. Talukder, Roopa R. Yavagal, Mobile Computing
3. Mazliza Othman, Principles of Mobile Computing and Communications
4. Prasant Kumar Pattnaik, Rajib Mall, Fundamentals of Mobile Computing

5. Ivan Stojmenovic, Handbook of Wireless Networks and Mobile Computer

6. David Taniar, Mobile Computing Concepts, Methodologies, Tools, and Applications

DEPARTMENT - ENVIRONMENTAL SCIENCE

ESOEL-1: Basics of Environmental Science

Block I: Ecology and Environment

Unit 1: Definition, Principles and Scope. Biotic and abiotic factors of environment. Ecosystems: pond, forest, river, grassland and estuary ecosystems

Unit 2: Ecosystem – trophic structure, energy flow, food chain, food web, Ecological pyramids.

Unit 3: Population dynamics: Definition, population density, Natality, Mortality, Age structure, Growth pattern, population dispersion.

Unit 4: Biogeochemical cycle – types, sedimentary and gaseous cycles, N, C, S, P, O cycles. Rock and hydrological cycles.

Block II: Biodiversity and Conservation

Unit 5: Biodiversity, Definition, Types of Biodiversity, importance and roles.

Unit 6: Needs and benefits of biodiversity, Loss of biodiversity- causes and consequences, Need for conservation of biodiversity

Unit 7: Conservation strategies, endemic and exotic species, Red Data book, National parks, wildlife sanctuaries, biosphere reserves, biodiversity hotspots, wildlife protection act, biodiversity act, wetland conservation and management, Hotspots of biodiversity.

Unit 8: Project Tiger, Project elephant, Ramsar site and other conservation projects. Experts Committee Reports on Environmental conservation

DEPARTMENT - GEOGRAPHY

ELMG –01, INTRODUCTION TO PHYSICAL GEOGRAPHY (CREDIT-2)

Block-1

Origin, Shape and Size of the Earth, Movement of the Earth- Rotation and Revolution, Effects of the movement of Earth, Coordinates -Latitude, Longitude and Time; Structure of the Earth, Rocks - types, significance, Weathering –types; Agents of Denudation - River, Glacier, Wind and Under Ground water; Structure and Composition of Atmosphere, Weather and Climate

BLOCK-2

Atmospheric Pressure, Winds and Precipitation; Distribution of Land and Sea, Submarine Relief of the Ocean, Temperature and Salinity of Sea Water; Ocean Tides and Oceanic Currents- Atlantic, Pacific and Indian Oceans; Biosphere- Elements, Ecology, Ecosystem, World's Biomes, Biodiversity – Importance, Types and Conservation

REFERENCES

1. B.S. Negi (1993) Physical Geography. S.J. Publication, Meerut
2. D.S.Lal (1998) Climatology. Chaitnya publishing house, Allahabad
3. K. Siddhartha (2001) Atmosphere, Weather and Climate. Kishalay publication, New Delhi
4. R.N. Tikka (2002) Physical Geography. Kedarnath Ramnath & Co, Meerut
5. William D. Thornbury (1997) Principle of Geomorphology. New Age International (Pvt Ltd.) New Delhi.

DEPARTMENT -MATHEMATICS

ELMM –01 - FUNDAMENTALS OF MATHEMATICS

(2 Credits)

Block-I: Number Theory: Natural numbers, integers, Real numbers, GCD, LCM, Prime numbers. Surds, Indices, Logarithms, Progressions, Arithmetic Progression, Geometric Progression, Harmonic Progression,

Block-II: Set Theory: Operations of Union, Intersection, Complementation. Relations & Functions: Types of relations One-one, onto, Many-one functions, graphs of functions.

Mathematical Logic: Propositions, logical connectives, Methods of proofs.

Books for Reference:

1. Kolman and Busby: Discrete Mathematics, PHI.
2. S. L. Loney: The Elements of Coordinate Geometry, London Macmillan & Co.
3. B. S. Grewal: Higher Engineering Mathematics, 36th Ed., Khanna Pub.
4. S. Lipschutz and M. Lipson: Theory and Problems of Discrete Mathematics. Schaum Series. 2nd Ed. Tata McGraw Hill.

DEPARTMENT -PHYSICS

MP-EL1: MECHANICS

BLOCK-A

Unit-1: Laws of Motion: Frames of reference, Newton's Laws of motion, Dynamics of a system of particles, Centre of Mass.

Unit-2: Momentum and Energy: Conservation of momentum, Work and energy, Conservation of energy, Motion of rockets.

Unit-3: Rotational Motion: Angular velocity and angular momentum, Torque, Conservation of angular momentum.

Unit-4: Gravitation: Kepler's Laws (statement only), Newton's Law of gravitation, motion of a particle in a central force field, satellite in circular orbit and applications, geosynchronous orbits, weightlessness, basic idea of global positioning system (GPS).

BLOCK-B:

Unit-5: Oscillations: Simple harmonic motion, differential equation of SHM and its solutions, kinetic and potential energy, total energy and their time averages, damped oscillations.

Unit-6: Elasticity-1: Hooke's law, stress-strain diagram, elastic moduli-relation between elastic constants, Poisson's ratio, expression for Poisson's ratio in terms of elastic constants, work done in stretching and work done in twisting a wire.

Unit-7: Elasticity-2: Twisting couple on a cylinder - determination of rigidity modulus by static torsion, torsional pendulum-determination of rigidity modulus and moment of inertia - η and θ by Searles method.

Unit-8: Special Theory of Relativity: constancy of speed of light, postulates of special theory of relativity, length contraction, time dilation.

DEPARTMENT -PSYCHOLOGY

EL-1 Introduction to Psychology 2 Credits

Block 1: Introduction to Psychology-I

Unit 1: Introducing Psychology -Definition, Scope, and goals

Unit 2: Branches of Psychology

Unit 3: Motivation

Unit 4: Emotions

Block 2: Introduction to Psychology-II

Unit 5: Sensation, Attention and Perception

Unit 6: Learning, Memory and Forgetting

Unit 7: Intelligence

Unit 8: Personality

References:

1. Charles G.Morris. Albert A. Maisto Psychology an Introduction , Prentice Hall. New Jersey.
2. Feldman, A. R., Understanding Psychology IV th Ed, 1996, McGraw Hill, New Delhi.
3. Morgan, King, Weisz & Schopler, Introduction to Psychology-V11 Ed, 1993, Tata McGraw Hill, New Delhi.
4. Ernest R Hilgard, Richard C Atkinson , Rita L Atkinson Introduction to Psychology Oxford Publication, New Delhi.

DEPARTMENT : INFORMATION TECHNOLOGY

ELMIT –01: Green Computing

(2 Credits)

Course Objective: Study the concepts related to Green IT, Green devices and hardware along with software methods, green enterprise activities, managing the green IT and various laws, standards, protocols along with outlook of green IT.

BLOCK 1: Overview of Green Computing

Unit 1: Green IT Introduction, Overview and issues, Initiatives and standards, Pathways of Green computing, Benefits of Green IT, Environmental Impacts of IT

Unit 2: Green devices and hardware Environmental issues arising from electronic devices, life cycle of electronic devices, Hazards and E-waste Recycling, Going paperless, Hardware considerations, Greening information systems, Managing Green IT, 3Rs of Green IT, Thinking About Money-Saving Efforts

Unit 3: Green Data Centres and Associated Energy Challenges, Data Centre IT Infrastructure, Data Centre Facility Infrastructure: Implications for Energy Efficiency, IT Infrastructure Management, Green Data Storage, Storage Media Power Characteristics,

Unit 4: Green network and communications, objectives and challenges of green networking, Enterprise Green IT strategy, Approaching Green IT strategies, Business drivers and dimensions for Green IT strategies, Steps in Developing a Green IT Strategy, Metrics and Measurements in Green Strategies

BLOCK 2: Management of Green Computing

Unit 5: Sustainable Information Systems and Green Metrics, Sustainable IT Services, Sustainable IT Roadmap, Enterprise, Green IT Readiness, Readiness and Capability

Green Enterprises and the Role of IT, Organizational and Enterprise Greening, Information Systems in Greening Enterprises, Greening the Enterprise: IT Usage and Hardware,

Unit 6: Managing Green IT, Strategizing Green Initiatives, Implementation of Green IT, Regulating Green IT: Laws, Standards and Protocols,

Unit 7: Green Cloud Computing and Environmental Sustainability, Cloud Computing and Energy Usage Model: A Typical Example, Features of Clouds Enabling Green Computing, Green Cloud Architecture

Unit 8: Green IT: An Outlook, Awareness to Implementation, Green IT Trends, Greening by IT, A Seven-Step Approach to Creating Green IT Strategy

Text Books:

1. Gangadharan, G. R., & Murugesan, S. (2012). Harnessing Green IT: Principles and practices. Wiley Publication, ISBN: 9788126539680.
2. Smith, B. E. (2013). Green Computing: Tools and Techniques for Saving Energy, Money, and Resources. CRC Press.

DEPARTMENT -BOTANY

Plant-Microbe Interactions

Overview of plant microbes interactions,

Introduction, beneficial microbes, Rhizobium bacterium and nitrogen fixation, mycorrhizal fungi.

Plant pathogens, Agrobacterium tumefaciens and crown gall disease,

Mechanisms of plant disease mechanism, some bacterial plant diseases,

Plant viruses and mechanism of plant against viruses attacks.

Fungal pathogen- mechanism of plant disease,

Oomycete pathogens, Fungal mediated plant.

General concept of plant immunity,

PAMP-triggered immunity (PTI) and effectors-triggered immunity (ETI).

Transcription activator like effector and their role in virulence and disease resistance.

References

1. Lautenberg, B. (2015). Principles of Plant-Microbes Interactions: Microbes for sustainable Agriculture, Springer.
2. Stacey, G. and Keen, N. T. (1997). Plant-Microbes Interactions, Vol 4, . Springer.
3. Ramasamy, K, (2015). Plant Microbes Interactions, New India Publishing Agency.

4. Martin, F. and Kamoun, S. (2014). Effectors in Plant-Microbes Interactions 1st Edition, Wiley Blackwell.

DEPARTMENT -ZOOLOGY

MZO-IE-1: Parasites, Vectors & Communicable Diseases

Introduction to parasites.

Distribution, types, origin and evolution of parasites. Parasitism.

Types: Ecto-parasites, Endo-parasites and their adaptations.

Pathogenic micro-organisms, brief outline and classification of parasitic protozoan's: Entamoeba, Balantidium, Giardia, Trichomonus, Plasmodium, Leishmania and Trypanosoma and their diseases.

Control measures, diagnosis and therapy.

Pathogenic helminthes and vectors.

Etiology, epidemiology, pathogenesis, diagnosis, prevention and control of disease due to *Trichinella spiralis*, *Ancylostoma duodenale*, *Fasciola hepatica*, Schistosoma species.

Pathogenic Cestodes: Life cycle, treatment of diseases caused by Echinococcus, Hymenolepis and Diphylobothrium. Scope and importance of vectors. Origin and evolution of vectors. Habitat, life cycle, pathogenicity of fleas, mites, ticks, lice's and mosquitoes.

Historical perspectives and scientists involved in the discovery of vectors and communicable Diseases.

Epidemiology, bio-ecology, life cycle of biological and mechanical Vectors. Vector-host-parasites interactions, Host-pathogen interaction, insects transmitting Bacteria and viruses.

Control and management of vectors and vector borne diseases

Control measures: cultural, chemical, biological, genetic and environmental Methods of vectors. Management of biological and mechanical vectors during Different seasons. Integrated Vector Control and Management.

Insecticide resistance in vectors, Drug resistance in pathogens.

Importance of education, awareness among public on communicable diseases and community participation. Covid-19 pandemics. Epidemiology of corona virus and its mutants. Vaccination against corona virus in India and other parts of the world.

DEPARTMENT –FOOD AND NUTRITION SCIENCE

ELMFNS- 01 FOOD PSYCHOLOGY

Credits: 2

BLOCK 1: FOOD: PREFERENCES AND CHOICES

Unit 1: Food: Physiological definition and significance, meaning of food, food classification, Food as statement of self-identity, Social interaction, Cultural identity

Unit 2: The Role of Food and Eating on Personality and Social Development: Psychology of eating, Food and emotion regulation, Food in daily living, Food Socialization, Food and control of others

Unit 3: Food Preferences and Fluctuations: Developmental Models, Cognitive Models & Psychophysiological Models, Physiology of food choice, Likes and Dislikes, acquired food preferences, Attitudes towards change, Food and sensory stimulus, Factors influencing eating behavior – (biological, environmental, individual, food characteristics, culture etc., Effect of eating on food selection and preferences, Understanding of the body and self – selection of the diet.

Unit 4: Food choices across lifespan and influence of society: The changing role of the senses in food choice and food intake across lifespan, Food in security and health across lifespan, Influence of media and advertisements, Digital platform and influence on food choices

BLOCK 2: EATING DISORDERS AND TREATMENTS

Unit 5: Mood, Emotions, food cravings and addictions: relation with food preferences, Connection between mood and eating, Biological and physiological aspects of food cravings, Stress and eating behavior, Food addiction - description, neurobiology of food addiction

Unit 6: Eating disorders and treatment: Anorexia nervosa, Bulimia nervosa and binge eating Disorder-Definition, Symptoms, believed causes, Classification, Risk factors, Common myths of eating disorders, Treatment & dietary management

Unit 7: Overeating, Obesity and Weight management: Definition, Prevalence, Classification of Body Mass Index, Types & patterns, Etiology, Physiological component, Fad diets, Risk factors, Treatment - Weight management (Behavior & Cognitive), Lifestyle modifications, Dietary modification - (calorie restricted diet)

Unit 8: You are what you eat- Approaches to change the dietary behavior: Multidisciplinary approach, Strategies to support healthy dietary behavior: Encouraging healthy eating, Selection of food, Meal & portion size, developing education materials, Motivation & economics, Benefits of exercise, Stage classification for change, Barriers affecting the clinical outcome

REFERENCES:

1. [Smith John L.](#) (2002), The Psychology of Food and Eating (English, Hardcover, Smith John , Publisher: Palgrave MacmillanL.), ISBN: 9780333800201, 0333800206.

Alexandra W. Logue Oct 2017, The Psychology of Eating and Drinking Fourth Edition.

Annexure II

INTER- DISCIPLINARY COURSE

(Open Elective) for Second Semester

ವಿಭಾಗ- ಕನ್ನಡ

ಪತ್ರಿಕೆ-೬: ಪ್ರಾಚೀನ ಕನ್ನಡ ಸಾಹಿತ್ಯದ ಇತಿಹಾಸ

EL-2.1 (ಕ್ರೆಡಿಟ್-೨)

ಬ್ಲಾಕ್-೨೮: ಸಾಹಿತ್ಯ ಚರಿತ್ರೆಯ ಉಗಮ ಮತ್ತು ವಿಕಾಸ

ಘಟಕ-೧೪೯: ಸಾಹಿತ್ಯದ ಉಗಮ, ಬೆಳವಣಿಗೆ, ಉದ್ದೇಶ.

ಘಟಕ-೧೫೦: ಪ್ರಾಚೀನ ಪೂರ್ವ ಶಾಸನಸಾಹಿತ್ಯ.

ಘಟಕ-೧೫೧: ಪಂಪ ಪೂರ್ವ ಯುಗದ ಸಾಹಿತ್ಯ.

ಘಟಕ-೧೫೨: ಕನ್ನಡ ಸಾಹಿತ್ಯ ಚರಿತ್ರೆಯ ವಿಭಾಗಕ್ರಮ.

ಬ್ಲಾಕ್-೨೯: ಪ್ರಾಚೀನ ಕನ್ನಡ ಸಾಹಿತ್ಯ

ಘಟಕ-೧೫೩: ಪ್ರಾಚೀನ ಕನ್ನಡ ಸಾಹಿತ್ಯ ರೂಪಗಳು; ಚಂಪೂ, ವಚನ, ರಗಳೆ, ಷಟ್ಪದಿ, ಸಾಂಗತ್ಯ ಇತ್ಯಾದಿ.

ಘಟಕ-೧೫೪: ಪ್ರಾಚೀನ ಕನ್ನಡ ಸಾಹಿತ್ಯದ ಪರಿಕಲ್ಪನೆಗಳು;

ಚರಿತ್ರೆ-ಪುರಾಣ, ಧರ್ಮ-ಕಾವ್ಯಧರ್ಮ, ಹಿಂಸೆ-ಅಹಿಂಸೆ, ಮಾರ್ಗ-ದೇಶಿ, ಲೌಕಿಕ-ಆಗಮಿಕ, ವಸ್ತುಕ-ವರ್ಣಕ, ಪ್ರಭುತ್ವ-ಪ್ರತಿರೋಧ.

ಘಟಕ-೧೫೫: ಪ್ರಾಚೀನ ಕನ್ನಡ ಕವಿ-ಕೃತಿ-ಕಾಲ-ದೇಶ-ಭಾಗ ೧.

ಪಂಪ, ರನ್ನ, ಪೊನ್ನ, ೧ನೆ ಚಾವುಂಡರಾಯ, ನಾಗವರ್ಮ ೨ನೆಯ ಚಾವುಂಡರಾಯ, ನಾಗಚಂದ್ರ, ನಯಸೇನ, ದುರ್ಗಸಿಂಹ, ಬ್ರಹ್ಮಶಿವ, ಕರ್ಣಪಾರ್ಯ, ಜನ್ನ.

ಘಟಕ-೧೫೬: ಪ್ರಾಚೀನ ಕನ್ನಡ ಕವಿ-ಕೃತಿ-ಕಾಲ-ದೇಶ-ಭಾಗ ೨.

ಆಂಡಯ್ಯ, ನೇಮಿಚಂದ್ರ, ರುದ್ರಭಟ್ಟ ಪ್ರಮುಖ ವಚನಕಾರರು - ಜೇಡರ ದಾಸಿಮಯ್ಯ, ಬಸವಣ್ಣ, ಅಕ್ಕ ಮಹಾದೇವಿ, ಅಲ್ಲಮಪ್ರಭು, ಚನ್ನಬಸವಣ್ಣ, ಹರಿಹರ, ರಾಘವಾಂಕ, ಕುಮಾರವ್ಯಾಸ, ಲಕ್ಷ್ಮೀಶ, ಪ್ರಮುಖ ಕೀರ್ತನಕಾರರು, ಚಾಮರಸ, ಕುಮಾರವಾಲ್ಮೀಕಿ, ಸರ್ವಜ್ಞ, ಷಡಕ್ಷರಿ, ಸಂಚಿ ಹೊನ್ನಮ್ಮ, ನಂಜುಂಡ, ರತ್ನಾಕರವರ್ಣಿ, ಮುದ್ದಣ, ಕೆಂಪುನಾರಾಯಣ.

ಪರಾಮರ್ಶನ ಗ್ರಂಥಗಳು

೧. ಗತಿಬಿಂಬ : ಜಿ.ಎಸ್. ಶಿವರುದ್ರಪ್ಪ, ಬೆಂಗಳೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಬೆಂಗಳೂರು
೨. ಕಾವ್ಯ ವಿಹಾರ : ಕುವೆಂಪು, ಉದಯರವಿ ಪ್ರಕಾಶನ, ಮೈಸೂರು, ೧೯೬೯
೩. ಸಮಗ್ರ ಕನ್ನಡ ಸಾಹಿತ್ಯ ಚರಿತ್ರೆ : ಬೆಂಗಳೂರು, ವಿಶ್ವವಿದ್ಯಾನಿಲಯ ಬೆಂಗಳೂರು, ೨೦೦೨
೪. ಕನ್ನಡ ಸಾಹಿತ್ಯ ಚರಿತ್ರೆ : ಕೆ. ವೆಂಕಟರಾಮಪ್ಪ, ಪ್ರಸಾರಾಂಗ, ಮೈಸೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಮೈಸೂರು
೫. ಕರ್ನಾಟಕ ಸಂಸ್ಕೃತಿ: ದೇವುಡು, ಶಾರದಾ ಪ್ರಕಾಶನ, ಮೈಸೂರು, ೧೯೩೫
೬. ಕನ್ನಡ ಸಾಹಿತ್ಯ ಸಂಗಾತಿ : ಕೀರ್ತಿನಾಥ ಕುರ್ತಕೋಟಿ, ಮನೋಹರ ಗ್ರಂಥಮಾಲೆ, ಧಾರವಾಡ
೭. ಶೈಲಿ : ಎಸ್.ವಿ.ರಂಗಣ್ಣ, ಮೈಸೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಮೈಸೂರು, ೧೯೭೬
೮. ಶತಮಾನದ ಕನ್ನಡ ಸಾಹಿತ್ಯ : ಸಂಪಾದಕರು, ಜಿ.ಎಸ್. ನಾಯಕ, ಕನ್ನಡ ಸಾಹಿತ್ಯ ಅಕಾಡೆಮಿ, ಬೆಂಗಳೂರು
೯. ಕನ್ನಡ ಸಾಹಿತ್ಯದ ಇತಿಹಾಸ : ರಂ. ಶ್ರೀ. ಮುಗಳಿ, ಕೇಂದ್ರ ಸಾಹಿತ್ಯ ಅಕಾಡೆಮಿ, ನವದೆಹಲಿ, ೧೯೬೩
೧೦. ಕನ್ನಡ ಸಾಹಿತ್ಯ ಚರಿತ್ರೆ : ರಂ.ಶ್ರೀ. ಮುಗಳಿ, ಉಷಾ ಸಾಹಿತ್ಯ ಮಾಲೆ, ಮೈಸೂರು, ೧೯೭೧
೧೧. ಬಿಂಬ: ಚದುರಂಗ, ಸಂವಹನ ಪ್ರಕಾಶನ, ಮೈಸೂರು
೧೨. ಕನ್ನಡ ಸಾಹಿತ್ಯ ಚರಿತ್ರೆ ಸಂಪುಟಗಳು : ಕುವೆಂಪು ಕನ್ನಡ ಅಧ್ಯಯನ ಸಂಸ್ಥೆ, ಮೈಸೂರು. ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಮೈಸೂರು, ೧೯೮೨
೧೩. ಕನ್ನಡ ಸಾಹಿತ್ಯದ ಪ್ರಾಚೀನತೆ: ಪ್ರಧಾನ ಸಂಪಾದಕರು, ಎ. ರಂಗಸ್ವಾಮಿ, ಲೇ. ಎಚ್.ಪಿ. ಗೀತಾ, ಜನಪ್ರಿಯ ಕನ್ನಡ ಮಾಲೆ, ಕನ್ನಡ ಅಧ್ಯಯನ ಮತ್ತು ಸಂಶೋಧನಾ ವಿಭಾಗ, ಕರಾಮುವಿ, ಮೈಸೂರು, ೨೦೧೧
೧೪. ಪ್ರಾಚೀನ ಕನ್ನಡ ಕಾವ್ಯ ಸ್ಥಿರತೆ ಮತ್ತು ಚಲನ ಶೀಲತೆ : ಪ್ರಧಾನ ಸಂಪಾದಕರು, ಎ. ರಂಗಸ್ವಾಮಿ, ಲೇ. ಶಿವರಾಮಯ್ಯ, ಜನಪ್ರಿಯ ಕನ್ನಡ ಮಾಲೆ, ಕನ್ನಡ ಅಧ್ಯಯನ ಮತ್ತು ಸಂಶೋಧನಾ ವಿಭಾಗ, ಕರಾಮುವಿ, ಮೈಸೂರು, ೨೦೧೨
೧೫. ಕನ್ನಡ ಕೃಷಿ: ಸಂಪುಟ ೨, ಪ್ರಸಾರಂಗ, ಮೈಸೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಮೈಸೂರು, ೨೦೦೭

DEPARTMENT - ENGLISH

EL-2.1: INDIAN LITERATURE-II

OBJECTIVES

- To appreciate artistic values in *Hayavadana* and the use of myth
- To know the importance of Indian English historical plays
- To appreciate Sri Aurobindo as a poet and critic
- To comprehend the different theories of aesthetic experience of art

BLOCK -I

Girish Karnad: Hayavadana

Gurucharan Das: Larin Sahib

BLOCK –II

M. Hiriyanna: Art Experience

Sri Aurobindo: Selections: The Poets of the Dawn and The Poets of the Dawn 3 (The Future Poetry)

Suggested Reading:

- **K.R.Srinivas Iyengar:** Indian Writing in English .Macmillan, 1979.
- **M.K.Naik:** Critical Essays on Indian Writing in English.Sahitya Akademi, 1969.
- **Narasimhaiah C.D:** The Swan and the Eagle. Indian Institute of Advanced Study, 1987.
- **Meenakshi Mukherjee:** The Twice Born Fiction. Heinemann Educational Publishers, 1972.

DEPARTMENT - HINDI

हिंदी सिनेमा

- सिनेमा का उद्भव और विकास
- मूक चलचित्र और दादा साहब फाल्के युग
- दूसरा पढ़ाव, सवाक चलचित्र अथवा आलमआरा
- रंगीन सिनेमा का युग
- सामाजिक सिनेमा एक विवेचन
- धर्म एवं सांस्कृतिक सिनेमा एक विवेचन
- राजनैतिक सिनेमा एक विवेचन
- आर्थिक सिनेमा एक विवेचन
- हास्य एवं व्यंग्य सिनेमा एक विवेचन
- बाल सिनेमा
- सिनेमा एवं संवेदना
- सिनेमा एवं भाषा-शिल्प सिनेमा एवं गायन
- सिनेमा एवं पात्र संयोजना
- सिनेमा एवं नैतिक मूल्य
- अनूदित सिनेमा
- सिनेमा का तुलनात्मक अध्ययन
- फिल्म समीक्षा.....आदि

□□□□□□ □□□□□□

- सिनेमा साहित्य और समाज- प्रहलाद अग्रवाल, अनामिका प्रकाशन, नई दिल्ली
- कथाकार कमलेश्वर और हिंदी सिनेमा- उज्ज्वल अग्रवाल, राजकमल प्रकाशन, नई दिल्ली
- बॉलिवुड पाठ विमर्श के संदर्भ- ललित जोशी, वाणी प्रकाशन, नई दिल्ली
- फ्लैशबैक, प्रभुनाथ आजमी, शिल्पायन, नई दिल्ली

- नाटक के सौ बरस, हरिश्चंद्र अग्रवाल और अजित पुष्कल, शिल्पायन, नई दिल्ली

DEPARTMENT - TELUGU

E. L. 2.1 TELUGU SAMSKRUTHI - SAMAJAM

Block - 1: ANDHRULA CHARITHRA - SAMSKRUTHI

Unit - 1: Samskruthi Vaisistyam

Unit - 2: Andhrula Charithra - Samskruthi Paraspara Prabhavam

Unit - 3: Andhrula kalalu

Unit - 4: Andhrula basha - samajam

Block - 2: ANDHRULA AACHARALU - SAMPRADHAYALU

Unit - 1: Andhrula Pandugalu

Unit - 2: Sthrela Nomulu - Vrathalu

Unit - 3: Andhrula Sangikaacharalu

Unit - 4: Andhrula Sampradhayalu

DEPARTMENT - HISTORY

OEL2.1 Social Reform Movements in Modern India

Objective: The course aims to trace the causes for the division of society in various sections and need for reformation. Further it explains age old social evils which crippled Indian society.

Pedagogy: personal contact programmes, audio video programmes, online lectures
Assignments, etc

Credits: 2. Examination Duration: 1 1/2 hours and Maximum Marks: 40

Course outcomes

After completing this course the students should be able to

- Understanding the contributions of the Raja ram Mohan Roy Dayananda Sarawathi towards the Indian modernity
- Analyse the Jyothibai pule Savithribai Pule Ambedkar's contributions to Indian social reform movements
- Evaluate the works of Sahu Maharaj and Krishna raja wadiyar IV patronage to social Justice.

Block-I

Unit : 1

Colonial Discovery of India : Orientalism, Anglicism, Evangelism-Understanding Indian Society, Meaning of Social Reform. The Concept of Modernity : Western Impact – Indian Response.

Unit : 2

Rajaram Mohan Roy and Brahmo Samaj, Dayananda Sarawathi and Arya Samaj-Nationalism and Society – Prarthana Samaj.

Unit : 3

Jyothi Ba- Phle and Savithri Ba Pule, Social and education reforms.

Unit : 4

Communalism, Eradication of Communalism, Muslim League, Wahhabi and Pan Islamism-Syed Ahmed and Aligarh Movement.

Block-II

Unit : 5

The debate over the interpretation of Shastras – Ishwar Chandra Vidya Sagar - B.M.Malabari – Vivekananda –M.G. Ranade—Bal Gangadhar Tilak.

Unit :6

Dr. B.R.Ambedkar-, His views on Society, A caste and its annihilation, Religion and Economy, M.K.Gandhi- E.V.Ramswamy Periyar and Sri.Narayanguru, Ayyan kali.

Unit :7

The reformers – Kandukuri Veereshalingam – Pandit Shivanatha Shastry – Gopal Ganesh Agarkar-K.T.Telang-Maharma.

Unit :8

D.K.Karve, Maharaj Saiyyaji Rao Gaekwad of Baroda – Chatrapathi Shahu Maharaj of Kolhapur and Maharaja Krishnaraja Wodeyar IV of Mysore.

Suggested readings:

1. Nararajan : A Century of Social Reform in Indian.
2. Seetharam Singh : Nationalism and Social Reform in India
3. Dhananjaya Keer : Ambedkar, Life and Mission
4. Dhananjaya Keer :Mahatma Jyoti Rao Phule : Father of Social Revolution in India
5. Charless Heimsath R : Indian Nationalism and Hindu social Reform
6. A.S.Altekar : Position of Women In Hindu Civilization.
7. Gail Omvedt : Cultural Revolt in a Colonial Society – The Non – Brahmin Movements in Western India.
8. Gail Omvedt : Dalits and Democratic Revolution.
9. Ravindrakumar : Selected Documents of B.G.Tilak.
10. S. Ramkrishna : Social Reform Movements in Andhra

11. M.K.Gandhi : Women and Social Injustice.

ವಿಜಯ ಪೊಣಚ್ಚು ತಂಬಂಡ (ಸಂ), ಭಾರತ ಉಪಖಂಡದ ಆಧುನಿಕ ಪೂರ್ವ ಚರಿತ್ರೆ ವಿವಿಧ ಆಯಾಮಗಳು - ಸಂಪುಟ-03, ಪ್ರಸಾರಾಂಗ, ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಹಂಪಿ.

DEPARTMENT - ECONOMICS

EL2.1: Institutions for International Development

- **Objective:** To enable the Students to understand the need and importance of various International Institutions.
- **Pedagogy:** A Combination of Lectures, Group Discussion, Assignments.
- **Credits:** 2 ; Examination Duration: 1½ and Maximum Marks: 50 (Internal Assessment Marks = 10 and Semester-end Examination =40)

Course Inputs

Block – I Economic Issues at Global and National Level

Unit – 1 Globalisation

Globalisation – Forces Driving Globalisation – Income Inequality – National Integrity – Impact on Labour – Multinational corporations – Global Business Environment – National Business Environment.

Unit – 2 Legal Issues of Business at Global and National Level

Political Risks – Legal System – Business Ethics – Centrally Planned Economy – Mixed Economy – Market Economy – Human Development

Unit – 3 International Trade

Importance – Volume – Direction – Composition – Trends – Theories of Trade - Mercantilism – Absolute Advantage – Comparative Advantage – International Product Life Cycle – Political, Economic and Cultural Motives behind Government Intervention.

Unit – 4 GATT and WTO

Importance – objectives – Functions - GATT and W.T.O – India and WTO.

Block – II Economic Integration and International Business Issues

Unit – 5 Regional Economic Integration

Meaning – Effects – Integration in Europe: European Union – Integration in Americas : North American Free Trade Agreement (NAFTA) – Latin American Integration Association (LAIA) – Free Trade Area of Americas (FTAA) and Transatlantic Economic Partnership.

Unit – 6 Integration in Asia

Association of Southern East Asian Nations (ASEAN) - Asia Pacific Economic Cooperation (APEC) – Integration in middle East : Gulf Cooperation Council (GCC) – BRICS – SAARC.

Unit – 7 International Financial Markets

International capital markets – Foreign Exchange markets – Currency Convertibility – International Monetary System.

Unit – 8 Issues in International Business

Trade War – Balance of Payment – Terrorism – Oil Crisis – Smuggling – Dumping – Environmental Degradation – Exhibit of Nuclear power – Covid 19 and other pandemics.

References:

01. Apte A.N. (2011) International Financial Management, Tata McGraw Hill Pub., Co. Ltd., New Delhi.
02. Bhambari C.P, (1980) The World Bank and India, Vikas Publishing House, New Delhi.
03. International Development Association, Annual Reports.
04. International Finance Corporation, Annual Reports.
05. International Monetary Fund, Annual Reports.
06. World Bank, (1995) The Evolving Role of the World Bank in the First Half Century, Washington D.C.
07. World Bank, World Bank in India, Washington, D.C. USA
08. World Bank, World Development Reports, and Annual Reports.

Palle Krishna Rao, (2005) WTO, Text and Cases, PSG Excel Series, New Delhi.

DEPARTMENT - POLITICAL SCIENCE

(OEL-I) Indian Constitution

Block-I

- | | |
|--------|---|
| Unit:1 | Framing of the Indian Constitution. |
| Unit:2 | Preamble and Salient Features of the Indian Constitution. |
| Unit:3 | Fundamental Rights and Duties. |
| Unit:4 | Directive Principles of the State Policy. |

Block-II

Unit:5	Union Legislature : Composition, Powers and Functions.
Unit:6	Union Executive : President and Vice-President - Election, Powers and Functions, Prime ministers and Council of Minister - Powers and Functions.
Unit:7	State Legislature : Composition, Powers and Functions, State Executive - Governor and Chief Minister.
Unit:8	The Judiciary : Supreme Court and High Court - Composition, Jurisdiction and Functions.

References:

1. Andre Beteille, 1965. Caste, class, and Power. Berkley: University of California Press.
2. Appadorai, A 1968. India: Studies In Social And Political Development 1947-1967. New Delhi: Aisa Publishing House.
3. Desai, A R. 2016. Social Background of Indian Nationalism. Los Angeles: Popular Prakashan.
4. Granville Austin, 2000. The Indian Constitution: Cornerstone of a Nation. Melbourne: Oxford University Press.
5. Hanson and Douglas, 1972. India's Democracy. New York city: W W Norton & Co Inc.
6. Johari J C 1974. Indian Government and Politics. New Delhi: Vishal Publications.
7. Karunakaran, K.P 1964. Continuity and Change in Indian Politics. New Delhi: People's Pub. House.
8. Kochanek. A. 1968. The Congress Party of India: the Dynamics of a One-Party Democracy. New Jersey: Princeton University Press.
9. Morris Jones, 1967. The Government and Politics of India. London: Hutchinson University Library.
10. Myron Weiner, 1957. Party Politics in India. New Jersey: Princeton University Press.
11. Myron Weiner, 1967. Party Building in New Nation. Chicago: University of Chicago Press.
12. Palmer, N D 1971. The Indian Political System. Boston: Houghton Mifflin.
13. Partha Chatterjee, 1998. State and Politics in India. University of Michigan: Oxford University Press.
14. Pylee, M V 1960. Constitutional government in India. Bombay: Asia Pub. House.
15. Rajni Kothari, 1970. Politics in India. The University Of Michigan: Little Brown
16. Rajni Kothari, 1995. Caste in Indian Politics. Telangana: Orient Blackswan.
17. Venkatarangaiya: M Shiviah, 1975. Indian Federalism. New Delhi: Arnold-heinemann Publishers.
18. Zoya Hasan, 2000. The State in Indian Politics. London: Sage publication.

DEPARTMENT - SOCIOLOGY

Study of Indian Society -02 Credits

Course Description

Every science has its own classical theories, which stand as eternal in their explanatory power and prowess to transcend the time and region. This course intends to introduce the learners to the classical period of sociology which is not just a bundle of theories but a consistent tradition and formative period,

even contemporary theories cannot eschew from being inspired. After studying this course, following learning outcomes can be expected.

Course Objectives

1. To appreciate the organizational framework of Indian society
2. To appreciate the aspects unity and diversity of Indian society
3. Examine the social issues in contemporary India

Learning Outcomes

Following outcomes are expected from the learners after successfully completing the course. Learner can/has

LOC-1: sociological insights about the social structural and organizational aspects of Indian society

LOC-2: present the changes in institutional framework of Indian society

LOC-3: recognize the causes for major social issues and present realistic remedies

Course Content

Block-1 Social Organizations

Unit-1 Unity and Diversity-Problem of Integration

Unit-2 Caste-Characteristics and Recent Changes

Unit-3 Marginalization-SC, ST, OBC and Minorities

Unit-4 Changes in Family and Concerns of the Aged

Block-2 Social Issues in Contemporary India

Unit-5 Environmental Sanitation and Ecological Degradation

Unit-6 Educated Unemployment and Employability

Unit-7 Social Unrest-Terrorism, Naxalism, Communalism and Corruption

Unit-8 Child Rights and Right to Education (RTE)

References

- Ahuja, Ram. 2002. Study of Social Problems. Jaipur & New Delhi: Rawat Publications
- Atal, Yogesh. 1979. The Changing Frontiers of Caste. National Publishing House: Delhi
- Beteille, Andre. 1971. Caste, Class and power. Berkeley: University of California.
- Beteille, Andre. 1974. Social Inequality, New Delhi: Oxford University Press.
- Beteille, Andre. 1992. Backward Classes in Contemporary India. New Delhi: Oxford University Press.
- Berreman, G.D. 1979. Caste and Other Inequalities: Essays in Inequality. Meerut: Folklore Institute.
- Dube, Leela. 1997. Women and Kinship, Comparative Perspectives on Gender Southern South Asia.
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- Jha, Hetukar. 2015. Sanitation in India. Delhi: Gyan Books.

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- Pathak, Bindeshwar. 2015. Sociology of Sanitation. Delhi: Kalpaz Publications.
- Singer, Milton & Cohen, Bernards. 1996. Structure and change in Indian Society. Jaipur: Rawat
- Singh, Yogendra, Modernization of Indian Tradition. Jaipur & New Delhi: Rawat
- Srinivas, M N. 1995. Social Change in Modern India: Orient Blackswan
- Srinivas, M. N. 1962. Caste in Modern India and Other Essays. Asia Publishing House: Delhi

DEPARTMENT – ANCIENT HISTORY AND ARCHEOLOGY

AHA
OE 2.1

Cultural History of Hoysalas (OE)

Block - 1

Early Kings

Unit - 1 Archeological and Literary Sources

Unit - 2 Theories of Origin of Hoysalas – Sala – Nripakama – Ereyanga

Block - 2

Important Rulers

Unit - 3 Vishnuvardhana - VeeraNarasimha – I

Unit - 4 Ballala – II - Narasimha – II - Narasimha III and Ballala – III

Block - 3

Cultural Contributions

Unit - 5 Hoysala polity - Economy

Unit –6 Hoysala Society – Religion – Education - literature

Block - 4

Art and Architecture

Unit - 7 Hoysala Architecture

Unit – 8 Hoysala Art

References:

1. Epigraphia Carnatica: Relevant Volumes
2. Derrett Duncan, M.J: The Hoysalas, 1957
3. Dhakey M.A: Encyclopedia of Indian Temple Architecture
4. Desai P.B: History of Karnataka
5. Foekema Gerard: A Complete Guide to Hoysala Temples
6. Gopinatha Rao T.A: Elements of Hindu Iconography, Vols

7. Kelleeson Collyer: The Hoysala Artists – Their Identity Style
8. Krishna Murthy M.S: The Hoysala Art, Kuppam, 2007
9. Padmnabha K: Hoysala Sculptures : A cultural Study
10. Sheik Ali B (Ed): The Hoysala Dynasty , 1972
11. William Cohelo: The Hoysala Vamsha, 1950
12. Annual Reports of the Department of Archaeology, Mysore 1939 – 46
13. Settar S: Hoysala Temples
14. Marg: In Praise of Hoysala Art
15. Narasimhachar R; Lakshmidēvi Temple at Doddagaddhavalī
16. Shastri KAN: The Cholas, 17. Shastri KAN: History of South India

DEPARTMENT - EDUCATION

IDC - 2 HIGHER EDUCATION

BLOCK - 1 HIGHER EDUCATION – ORGANIZATION AND TEACHING – LEARNING

Unit-1 Higher Education

Unit-2 Teaching Learning in Higher Education – I

Unit-3 Teaching-Learning in Higher Education – II

Unit-4 Problems and Innovations in Higher Education

BLOCK - 2 HIGHER EDUCATION – SOCIO-PSYCHOLOGICAL AND MANAGEMENT DIMENSIONS

Unit-5 Socio-Psychological Background of College Students

Unit-6 Problems of College Students

Unit-7 Higher Education – Management Dimensions

Unit-8 Higher Education Teacher

References:

1. Shills Edward (1989) 'The modern university Liberal Democracy'.
2. Abraham, Abu (1988) The Penguin, Book of Indian cartoons, New Delhi.
3. Chandra, Bipan (1984) Communalism Modern India, New Delhi.
4. Chauhan S.S (1989) Innovations in Teaching Learning Process, New Delhi, Vikas.
5. Srivastva A.B and Sharma K.K (1985) Elementary Statistics in Psychology and Education, New Delhi, Sterling Publishers Pvt. Ltd.,

DEPARTMENT - COMMERCE

Elective Course – EL2.1: Entrepreneurship Development

- **Objective:** To enable the Students to understand about the different aspects of Entrepreneurship Development.
- **Pedagogy:** A Combination of Lectures, Group Discussion, Assignments.
- **Credits:** 2 ; Examination Duration: 1½ and Maximum Marks: 50 (Internal Assessment Marks = 10 and Semester-end Examination =40)

Course Inputs

Block I

- **Unit -1: Entrepreneur and Entrepreneurship:** Introduction - Evolution – Characteristics – Distinction between Entrepreneur and Manager – Functions – Types – Entrepreneur - Concept of Entrepreneurship – Growth of Entrepreneurship in India – Role of Entrepreneurship in Economic Development
- **Unit – 2: Women Entrepreneurship:** Introduction - Concept – Statistical Evidence – New Age Women – Functions – Growth - Problems – Recent trends in Development of Women Entrepreneurship.
- **Unit -3: Rural Entrepreneurship:** Introduction - Meaning – Need – Rural Industrialisation in Retrospect – Problems – Development of Rural Entrepreneurship – NGOs and Rural Entrepreneurship.
- **Unit -4: Conceptual Models of Entrepreneurship:** Introduction - Models of John Kao – Udai Pareek and Nadakarni– NISIET.

Block II

- **Unit – 5: Factors Affecting Entrepreneurial Growth And Competencies:** Introduction - Economic Factors – Non-Economic Factor – Government Actions - Entrepreneurial Competencies: Meaning – Major Entrepreneurial Competencies – Developing Competencies.
- **Unit -6: Entrepreneurial Motivation and Mobility:** Introduction - Motivation – Motivation Theories – Motivating Factors – Achievement Motivation – Factors Influencing Mobility – Occupational Mobility – Locational Mobility.
- **Unit – 7: Entrepreneurship Development Programmes:** Introduction - Need for EDPs - Objectives of EDPs – Course Contents and Curriculum of EDPs – Phases of EDPs – Evaluation of EDPs.
- **Unit -8: Institutional Support System for Entrepreneurship:** Introduction - DICs – SISIs – SIDCOs – NISIET – EDIT – NIESBU – TCOs- A Broad Overview of Central and State Level Financing Institutions.

Books Recommended for Reference

- a. Vasanth Desai, The Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House.
- b. A. N Desai, Entrepreneurship Management, Ashish Publishing House.
- c. Chandra Prasanna, Project Preparation, Appraisal and Implementation, Tata McGraw Hill.
- d. Khanka, S.S, Entrepreneurial Development, S. Chand Publications.
- e. Prasanna Chandra, Projects: Planning, Analysis, Selection, Implementation and Review, Tata McGraw Hill.

DEPARTMENT - MANAGEMENT

E-COMMERCE

Credits: 2

Module 1: E-commerce and its Technological Aspects:

Overview of developments in Information Technology and Defining E-Commerce: The scope of E commerce, Electronic Market, Electronic Data Interchange, Internet Commerce, Benefits and limitations of E-Commerce, Produce a generic framework for E-Commerce, Architectural framework of Electronic Commerce, Web based E Commerce Architecture.

Module 2: Electronic Data Interchange: Benefits of EDI, EDI technology, EDI standards, EDI communications, EDI Implementation, EDI Agreements, EDI Security. Electronic Payment Systems, Need of Electronic Payment System: Study and examine the use of Electronic Payment system and the protocols used, Study Electronic Fund Transfer and secure electronic transaction protocol for credit card payment. Digital economy: Identify the methods of payments on the net – Electronic Cash, cheques and credit cards on the Internet.

References:

1. Elias. M. Awad, " Electronic Commerce", Prentice-Hall of India Pvt Ltd.
2. Ravi Kalakota, Andrew B. Whinston, "Electronic Commerce-A Manager's guide", Addison-Wesley.
3. Efraim Turban, Jae Lee, David King, H.Michael Chung, "Electronic Commerce–A Managerial Perspective", Addison-Wesley.
4. Elias M Award, "Electronic Commerce from Vision to Fulfilment", 3rd Edition, PHI, Judy Strauss, Adel El-Ansary, Raymond Frost, "E-Marketing", 3RDEdition, Pearson Education

DEPARTMENT - BIO CHEMISTRY

Basics of Bioorganic chemistry for Biology graduates.

Introduction to Organic chemistry: Classification of organic compounds, unique characteristics, IUPAC nomenclature of organic compounds (including bifunctional).

Reaction mechanisms: Classification of organic reactions: substitution, addition, elimination and rearrangement with one example for each. Concepts of the following – carbon anions, carbon cations, free radicals, carbenes, nucleophiles and electrophiles.

Cycloalkanes: Reactivities and relative stability, Bayer's strain theory. Sachse-Mohr theory. Boat and chair form of cycloalkanes. Axial and equatorial bonds.

Arenes: Structure of Benzene—resonance and molecular orbital theories. Aromaticity. Mechanism of Nitration and Friedel-Craft's reaction. Electronic interpretation of the orienting influence of substituents in the electrophilic substitution of Toluene, Chlorobenzene, Nitrobenzene and Phenol. Polynuclear hydrocarbons—Resonance structures of Naphthalene, Anthracene and phenanthrene.

S_N1 and S_N2 reactions, mechanism with an example for each. Concept of elimination reactions. Example –n-butyl chloride.

Alcohols: Classification, monohydric, alcohols-distinguishing reactions for primary, secondary and tertiary alcohols.

Trihydric alcohols: Glycerol, Properties, (KHSO₄, HNO₃, Oxalic acid and HI)

Phenols: Acidity of phenols, Effect of substitution on acidity

Stereochemistry: Stereoisomerism, types, Fischer-projection formulae, asymmetric carbon atom, molecular dissymmetry, chirality, optical isomerism: ex. Glyceraldehyde, Lactic acid, Tartaric acid. Nomenclature of enantiomers. D- and L- system, Racemisation and resolution.

Heterogeneous and Homogeneous hydrogenation of oils.

Selected References:

1. Basic Principles of Organic Chemistry, Roberts and Caserio, W. A. Benjamin, Inc. (1964).
2. Organic Chemistry, Morrison and Boyd, Allyn and Bacon Inc (1992).
3. Principles of Inorganic chemistry by Cotton & Wilkinson, Wiley (1999).
4. Textbook of Organic chemistry by Ahluwalia V K & Madhuri G Narosa publications (2001).
5. Physical chemistry by Castellan G W, Narosa Publications (2004).
6. Physical chemistry by Chakraborty D K, Narosa Publications (2004).

DEPARTMENT - BIOTECHNOLOGY

MBT EL-2 FUNDAMENTAL OF BIOTECHNOLOGY

Scope and Introduction to Biotechnology History & Introduction to Biotechnology What is Biotechnology? Definition of Biotechnology, Traditional and Modern Biotechnology, Branches of Biotechnology

Plant, Animal Biotechnology, Marine Biotechnology, Agriculture, Healthcare, Industrial Biotechnology, Pharmaceutical Biotechnology, Environmental Biotechnology.

Applications Biotechnology Applications of Biotechnology in Agriculture : GM Food, GM Papaya, GM Tomato, Fungal and Insect Resistant Plants BT Crops, BT Cotton and BT Brinjal Pros and Cons

Biotechnological applications in Crop and Livestock Improvements Modifications in Plant Quality Golden Rice, Molecular Pharming, Plant Based Vaccines Ethics in Biotechnology and IPR 15 lectures

Food and Fermentation Biotechnology Food Biotechnology Biotechnological applications in enhancement of Food Quality Unit Operation in Food Processing Quality Factors in Pre processed Food Deterioration and its Control Rheology of Food Products Microbial role in food products Yeast, Bacterial and other Microorganisms based process and products Fermentation Technology Definition, Applications of Fermentation Technology Microbial Fermentations Overview of Industrial Production of Chemicals (Acetic Acid, Citric Acid and Ethanol), Antibiotics, Enzymes and Beverages

Molecular Biology - Replication DNA Replication in Prokaryotes and Eukaryotes Semi-conservative DNA replication, DNA Polymerases and its role, E.coli Chromosome Replication, Bidirectional Replication of Circular DNA molecules. Rolling Circle Replication, DNA Replication in Eukaryotes DNA Recombination – Holliday Model for Recombination Transformation

Mutation and DNA Repair Definition and Types of Mutations. Mutagenesis and Mutagens. (Examples of Physical, Chemical and Biological Mutagens) Types of Point Mutations, DNA REPAIR Photo reversal, Base Excision Repair, Nucleotide Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair.

Genetic Engineering Experimental evidences for DNA and RNA as Genetic Material. Genetic Engineering in Ecoli and other Prokaryotes, Yeast, Fungi and Mammalian Cells Cloning Vectors- Plasmids (pBR 322, pUC) Vectors for Plant and Animal Cells, Shuttle Vectors, YAC Vectors, Expression Vectors Enzymes- DNA Polymerases, Restriction Endonucleases, Ligases, Reverse Transcriptase's, Nucleases, Terminal Transferees, Phosphatases Isolation and Purification of DNA (Genomic, Plasmid) and RNA,, Identification of Recombinant Clones

DEPARTMENT - CHEMISTRY

Block-1	Title: Physical parameters of molecules
Unit-1	Thermodynamics: First and second laws of thermodynamics. Concept of entropy and free energy, entropy as a measure of unavailable energy. Entropy and free energy changes and spontaneity of process.
Unit-2	Chemical kinetics: Rate and order of reaction. Factor affecting the rate of reaction. And determination Order of reaction. Energy of activation and its determination. Brief account of collision and activated complex theories.
Unit-3	Ionic equilibria: pH scale, buffer solutions, calculation of pH of buffer solutions, buffer capacity and buffer index, buffer mixtures.
Unit-4	Electrochemistry: Electrolytic conductance, specific, equivalent and molar conductance, ionic mobility and transference number, factors affecting the electrolytic conductance, Arrhenius theory of strong and weak electrolytes, assumptions of DebyeHuckel theory of strong electrolytes.

Block-2	Title: Organic molecules
Unit-5	Introduction to organic chemistry, atomic orbitals, sigma and pi bond formation-molecular orbital (MO) method, sp, sp ² and sp ³ hybridization, bond length, bond dissociation energies and bond angles
Unit-6	Electronegativity and polarity of the bonds. Classifications and reactions of organic compounds (with examples).
Unit-7	Biological importance of natural products: Amino acids, proteins, carbohydrates (cellulose, starch, glycogen), lipids (fats and oils, phospholipids), nucleic acids, steroids, alkaloids, vitamins, flavonoids.
Unit-8	Applications of synthetic products: Dyes, drugs, polymers (plastics), soaps and detergents, pesticides and pheromones.

DEPARTMENT – CLINICAL NUTRITION AND DIETETICS

OEL - 2: NUTRACEUTICALS AND HEALTH FOODS

2 CREDITS

BLOCK 1. NUTRACEUTICALS:

Unit - 1: Introduction to Nutraceutical

Unit - 2: Use of Nutraceuticals in Traditional Health Sciences

Unit – 3: Functional Foods

Unit – 4: Development of Nutraceutical and Functional Foods

BLOCK 2: FUNCTIONAL FOODS AND NUTRACEUTICALS OF PLANT, ANIMAL AND MIRCIBIAL ORIGIN

Unit - 5: Prebiotics and Probiotics

Unit - 6: Bio Active Peptides and Phyto- Chemicals

Unit - 7: Fats and Oils- Omega 3 Fatty Acids:

Unit - 8: Sugar Substitutes / Sweeteners

REFERENCES:

- Tai Hu Guan, (2018), text book of Nutraceuticals and Health, Scitus Academics Publisher, Wilmington DE 19804, United States of America.
- Wildman REC, (2016), Handbook of Nutraceuticals and Functional Foods, 2nd edition, CRC Press publishers, Boca Raton, Florida (USA).
- Athapol Noomhorm, Imran Ahmad, Anil Kumar Anal (2014), Functional Foods and Dietary Supplements Processing, Effects and Health Benefits, first edition, published by John Wiley & Sons, Ltd. UK 111 River Street, Hoboken, NJ 07030-5774, USA
- Wildman REC, (2001) Handbook of Nutraceutical and Functional Foods, CRC Press, USA. Ghosh D et al, (2012) Innovations in Healthy and Functional Foods, CRC Press, USA. Pathak YV (2011) Handbook of nutraceuticals Volume 2, CRC Press, USA.

DEPARTMENT - COMPUTER SCIENCE

ELMCS- 02: E -Commerce

BLOCK-1

UNIT-1: Overview of developments in Information Technology and Defining E-Commerce: The scope of E commerce, Electronic Market, Electronic Data Interchange, Internet Commerce, Benefits and limitations of E-Commerce, Produce a generic framework for E-Commerce,

UNIT-2: Architectural framework of Electronic Commerce, Web based E Commerce Architecture. Consumer Oriented E Commerce E-Retailing: Traditional retailing and e retailing, Benefits of e retailing,

UNIT-3: Key success factors, Models of e retailing, Features of e retailing. E services: Categories of e-services, Web-enabled services, matchmaking services,

UNIT-4: Information-selling on the web, e entertainment, Auctions and other specialized services. Business to Business Electronic Commerce

BLOCK-2

UNIT-5: Electronic Data Interchange: Benefits of EDI, EDI technology, EDI standards, EDI communications, EDI Implementation, EDI Agreements, EDI Security. Electronic Payment Systems, Need of Electronic Payment System:

UNIT-6: Study and examine the use of Electronic Payment system and the protocols used, Study Electronic Fund Transfer and secure electronic transaction protocol for credit card payment. Digital economy: Identify the methods of payments on the net – Electronic Cash, cheques and credit cards on the Internet.

UNIT-7: Security in E Commerce Threats in Computer Systems: Virus, Cyber Crime Network Security: Encryption, Protecting Web server with a Firewall, Firewall and the Security Policy, Network Firewalls and Application Firewalls, Proxy Server. Issues in E Commerce Understanding Ethical,

UNIT-8: Social and Political issues in E-Commerce: A model for Organizing the issues, Basic Ethical Concepts, Analyzing Ethical Dilemmas, Candidate Ethical Principles Privacy and Information Rights: Information collected at E-Commerce Websites, The Concept of Privacy, Legal protections Intellectual Property Rights: Types of Intellectual Property protection, Governance.

References:

1. Elias. M. Awad, " Electronic Commerce", Prentice-Hall of India Pvt Ltd.
2. RaviKalakota, Andrew B. Whinston, "Electronic Commerce-A Manager's guide", Addison-Wesley.
3. Efraim Turban, Jae Lee, David King, H.Michael Chung, "Electronic Commerce–A ManagerialPerspective", Addison-Wesley.
4. Elias M Award, "Electronic Commerce from Vision to Fulfilment", 3rd Edition, PHI, Judy Strauss, Adel
5. El-Ansary, Raymond Frost, "E-Marketing", 3RDEdition, Pearson Education.

DEPARTMENT - GEOGRAPHY

ELMG –02 Regional Geography of Karnataka (Credits – 2)

Block-1

Physical setting - Location, Administrative divisions, Geology, Physiographic divisions of the Karnataka; Climate and Rivers; Soils and Vegetation; Irrigation in Karnataka, Major Multipurpose River Valley Projects, Major water problems and Issues - Yetthinahole, Linganamakki, Mekedatu, Krishna-Cauvery valley-linking Rivers.

BLOCK-2

Agriculture - Major of Crops: Rice, Jowar, Ragi, Wheat, Oil seeds, Sugarcane, Cotton, Tobacco and Coffee; Minerals Resources - Iron ore, Manganese, Bauxite, Copper, Gold; Major Power Projects - Hydel, Thermal and Atomic Energy power plants; Industries - Cotton Textile, Silk Textile, Sugar, Iron and Steel, Cement and Paper industries, Industrial Regions of Karnataka; Transportation - Roads, Railway, Water way, Ports/Harbors and Airways; Population - growth, distribution and density

REFERENCES:

1. Directorate of Information and Tourism, Government of KarnatakaKarnataka State Gazetteer
2. Mallappa, P., (2014) Geography of Karnataka, Chethana book publishers, Mysuru
3. N.B.K Reddy & G.S. Murthy, (1967) Regional Geography of Mysore State
4. R.P. Misra, (1973) Geography of Mysore
5. Ranganath, (2018) Geography of Karnataka, Mysore Book House, Mysuru

DEPARTMENT - MATHEMATICS

Combinatorics and Graph Theory (ELMM –02) 2 Credits

Block-I: Permutations and Combinations, Pigeon-hole principle, Principle of inclusion and exclusion.

Block-II: Graphs, Vertices of graphs, Walks and connectedness, Degrees, Operations on graphs, Blocks – Cutpoints, bridges, Block graphs and Cutpoint graphs. Trees - Elementary properties of trees,

Books for Reference:

1. C. L. Liu – Elements of Discrete Mathematics, McGraw-Hill, 1986.
2. Kenneth H. Rosen – Discrete Mathematics and its Applications, McGraw-Hill, 2002.
3. F. Harary – Graph Theory, Addition Wesley Reading Mass, 1969.
4. N. Deo – Graph Theory With Applications to Engineering and Computer Science, Prentice Hall of India, 1987.
5. K. R. Parthasarathy – Basic Graph Theory, Tata McGraw-Hill, New Delhi, 1994.
6. G. Chartand and L. Lesniak – Graphs and Diagraphs, wadsworth and Brooks, 2nd Ed.,
7. Clark and D. A. Holton – A First Look at Graph Theory, Allied publishers.
8. D. B. West – Introduction to Graph Theory, Pearson Education Inc.,2001, 2nd Ed.,
9. J. A. Bondy and U. S. R. Murthy – Graph Theory with applications, Elsevier, 1976.

DEPARTMENT - PHYSICS

MP-EL2: WAVES AND OPTICS

BLOCK-A:

Unit-1: Superposition of Two Collinear Harmonic oscillations: linearity & superposition principle. (i) Oscillations having equal frequencies and (ii) oscillations having different frequencies (Beats).

Unit-2: Waves Motion- General: Transverse waves on a string, travelling and standing waves on a string, normal modes of a string, group velocity, phase velocity, plane waves, Spherical waves, wave intensity.

Unit-3: Fluids: Surface tension: synclastic and anticlastic surface - excess of pressure - application to spherical and cylindrical drops and bubbles. viscosity - rate flow of liquid in a capillary tube - Poiseuille's formula - determination of coefficient of viscosity of a liquid.

Unit-4: Sound: Simple harmonic motion - forced vibrations and resonance intensity and loudness of sound, intensity levels, musical notes, musical scale, acoustics of buildings: reverberation and time of reverberation, absorption coefficient, Sabine's formula - measurement of reverberation time.

BLOCK-B:

Unit-5: Wave Optics: electromagnetic nature of light, definition and properties of wave front, Huygen's Principle.

Unit-6: Interference: Interference: division of amplitude and division of wavefront. Young's double slit experiment, interference in thin films: parallel and wedge-shaped films, Newton's Rings: measurement of wavelength and refractive index.

Unit-7: Diffraction: Fraunhofer diffraction- single slit and double Slit, multiple slits and diffraction grating, Fresnel diffraction: half-period zones, zone plate, Fresnel diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.

Unit-8: Polarization: Transverse nature of light waves, plane polarized light – production and analysis, circular and elliptical polarization.

DEPARTMENT -PSYCHOLOGY

EL-2 Psychology in Everyday Life 2 Credits

Block 1: Applications of Psychology-I

Unit 1: Psychology as a Profession

Unit 2: Memory Improving Techniques

Unit 3: Stress and Emotional Management

Unit 4: Personality Development

Block 2: Applications of Psychology-II

Unit 5: Psychology in Educational Settings

Unit 6: Psychology in Health Setting

Unit 7: Psychology in Organizational Setting

Unit 8: Adjustment to Family and Work Place

References:

1. Charles G.Morris, Albert A. Maisto Psychology an Introduction , Prentice Hall. New Jersey.
2. Feldman, A. R., Understanding Psychology IV th Ed, 1996, McGraw Hill, New Delhi.
3. Morgan, King, Weisz & Schopler, Introduction to Psychology-V11 Ed, 1993, Tata McGraw Hill, New Delhi.
4. Ernest R Hilgard, Richard C Atkinson , Rita L Atkinson Introduction to Psychology Oxford Publication, New Delhi.

DEPARTMENT -INFORMATION TECHNOLOGY

ELMIT –02 E-Commerce (2 Credits)

Block 1: Fundamentals of E-commerce

Unit 1 : Introduction to E-commerce

What Is E-commerce? The Difference Between E-commerce and E-business, Technological Building Blocks Underlying E-commerce: the Internet, Web, and Mobile Platform, Major Trends in E-commerce, Unique Features of E-commerce Technology

Unit 2 : Types of E-commerce:

Business-to-Consumer (B2C) E-commerce, Business-to-Business (B2B) E-commerce. Consumer-to-Consumer (C2C) E-commerce, Mobile E-commerce (M-commerce), Social E-commerce, Local E-commerce E-commerce: A Brief History, Understanding E-commerce: Organizing Themes, Academic Disciplines Concerned with E-commerce

Unit 3 : E-Commerce Infrastructure

The Internet, Technology Background , Internet – Key Technology concepts, TCP/IP, IP addresses, Domain names, DNS and URLs, Client Server Computing, Cloud computing model, Mobile platform

Unit 4 : Internet and Web

Hypertext, HTML, XML, Web servers and clients, Web browsers, Communication tools – E mail, messaging apps, online message boards, Internet Telephony

Block 2: Construction of E-commerce presence

Unit 5: E-commerce presence – Building an e-commerce idea, Systematic approach, Choosing software and hardware, E-commerce site tools

Unit 6: E-commerce security E-commerce System environment, Security threats, Technology solutions

Unit 7: E-commerce payment systems : Management policies, E-commerce payment systems, Electronic billing presentment and payment

Unit 8: E-commerce Business Strategies : E-commerce business models, Major B2C Business models, B2B Business models,

References:

1. Laudon, Kenneth C., and Carol Guercio Traver. *E-Commerce 2020-2021*. Pearson, 2020.
2. Laudon, Kenneth C., and Carol Guercio Traver. *E-commerce Essentials*. Pearson, 2014

DEPARTMENT - BOTANY

Plant Diversity and Human Welfare

Plant Diversity and its Scope Levels of biodiversity: Genetic, Species and Ecosystem; Agrobiodiversity and cultivated plant taxa and related wild taxa.

Values and uses of Biodiversity, Methodologies for valuation, Ethical and aesthetic values, Uses of plants; Ecosystem services.

Loss of Biodiversity Loss of biodiversity- causes and implications, Hot spots of biodiversity, extinction of species, projected scenario for biodiversity loss.

Management of Plant Biodiversity Organizations associated with biodiversity management, IUCN, UNEP, WWF, UNESCO, NBPGR; Methodology for execution;

Biodiversity legislation; Information management and communication.

Conservation of Biodiversity, Role of Plants in Relation to Human Welfare Conservation of genetic, species and ecosystem diversity,

In situ and ex situ conservation strategies, India's biodiversity and its conservation Social approaches to conservation,

Biodiversity awareness programmes, Sustainable development.

Importance of forestry their utilization and commercial aspects; Avenue trees; Ornamental plants of India; Alcoholic beverages; Fruits and nuts; Wood and its uses; their commercial importance.

References

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
2. Singh, J.S., Singh, S.P. and Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Reddy, K.V. and Veeraiah, S. (2010). Biodiversity and Plant Resources. Aavishkar publication, New Delhi.
4. Heywood, V. H. and Watson, R. T. (1995). Global biodiversity and Assessment. Cambridge University Press.

DEPARTMENT –FOOD AND NUTRITION SCIENCE

OEL-2: NUTRITIONAL MANAGEMENT IN DISASTER CONDITIONS

BLOCK- I: NATURAL / MANMADE DISASTERS

Unit-1: Emergency Situations-Famine, Drought, Flood, Earthquake, Cyclone, War, Civil and Political Emergencies.

Unit-2: Nutrition in Emergencies, Nutritional Problems and Communicable Diseases.

Unit-3: Feeding Programs during Emergencies.

Unit-4: Assessment and monitoring of Nutritional Status and relief measures during emergencies.

BLOCK- I: NUTRITIONAL RELIEF AND REHABILITATION

Unit-5: Assessment of Food needs in emergency situations, Food Distribution Strategy, Local food rehabilitation.

Unit-6: Special Foods/ Rations for Nutritional Relief, Organizations for Mass Feeding/ Food Distribution, and Supplementary Feeding.

Unit-7: Transportation, Storage, Feeding Centres, Sanitation, Hygiene and Identifying Reaching the Vulnerable Group.

Unit-8: Public Nutrition Approach to Tackle Nutritional and Health Problems in Emergencies, food security.

REFERENCES:

Jaspars, S. & Young, H. (1996), General Food Distribution in Emergencies: from Nutritional Needs to Political Priorities. Good Practice Review 3. 1996. Relief and Rehabilitation Network, Overseas Development Institute. London.

Young H., Jaspars S., Brown R., Frize J. & Khogali H (2001), Food Security and Assessments in Emergencies: A Livelihoods Approach. Humanitarian Practice Network, Overseas Development Institute. London

Annexure - III

I Semester, M.Sc. in Biotechnology Examination May 2014Biomolecules

TIME: 3 HOURS

MAX. MARKS: 80

Instruction: Answer all the sections.

SECTION A

Answer any **FOUR** questions from the following
20

4 × 5 =

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

SECTION B

Answer any **THREE** questions from the following
30

3 × 10 =

- 7.
- 8.
- 9.
- 10.
- 11.

SECTION C

Answer any **TWO** questions from the following
30

2 × 15 =

- 12.
1. 13.
2. 14.
3. 15.