No. 6-38/2018 (Annual System-HPU (Acad.)
Himachal Pradesh University
(NAAC Accredited "A" Grade University)
Academic Branch, Summer Hill, Shimla-5

Dated:

To

1.The Dean, Faculty of Physical Sciences, HPU, Shimla-5
2.The Controller of Examinations, HPU, Shimla-5.
3.The A.R Exam (UG), HPU, Shimla-5.
4.The D.R/ A.R Eval./Re.Eval/Conduct/Exams, HPU, Shimla-5.
5.The D. R Secrecy, HPU, Shimla-5. with 2 spare copies.
6.The S.O.Exam (UG,I,II,III) HPU, Shimla-5.
7.The Incharge(ERP), Computer Centre, Examination Wing, HPU, Shimla-5.

Subject: *Restructure Scheme of B.Sc. (Computer Science) 3rd Year CBCS Annual Pattern effective from Academic Session 2018-19.*

Sir/Madam,

     I am sending herewith complimentary copy of syllabus *Restructure Scheme of B.Sc. (Computer Science) 3rd Year CBCS Annual Pattern effective from Academic Session 2018-19* duly approved by the Standing Committee of Academic Council in its meeting held on 25.10.2021 vide Item No.2, on the recommendations of the concerned Board of Studies/Faculty.

Yours faithfully,

Deputy Registrar (Acad)
HP University Shimla-5.
Dated: 1 2 JAN

Endst. No. Even
Copy forwarded for information and necessary action to:
1. The Chairman, Deptt. of **Computer Science**, HPU, Shimla -5
2. All the principal of the Govt./ Non- Govt. colleges in H.P. (affiliated with HPU)/ Regional Centre Dharamshala/ HPUCES the Mall, Shimla-1.
3. The Web Admin, HPU, Shimla-5,with the request to upload this letter on the website of HPU.
4. The Dealing Assistant Meeting (Acad), HPU, Shimla-5, for information.
5. Guard file.

Deputy Registrar (Acad)

Annexure C

Scheme for UG Syllabus
(Effective from 2018-19)

Under

CHOICE BASED CREDIT SYSTEM (CBCS)

In

Bachelor of Science (Computer Science)

Department of Computer Science
Himachal Pradesh University
Shimla-5

अध्यक्ष
संगणक विज्ञान विभाग
हि०प्र० विश्वविद्यालय, शिमला - 5

Bachelor of Science (Computer Science)

HIMACHAL PRADESH UNIVERSITY
SYLLABUS AND SCHEME OF EXAMINATION FOR
B.Sc. (COMPUTER SCIENCE) (Effective from 2018-19 onwards)

COURSETYPE	COURSECODE	TITLE OF PAPER	CREDITS	ESE	CCA	TOTALMARKS
3rd YEAR (Existing)						
DISCIPLINE SPECIFIC EFFECTIVES DSE: IA	COMP301TH	Operating System	6	70	30	100
DSE:2A	COMP302TH	Data Structure and File Processing	4	50	30	80
	COMP302PR	Data Structure and File Processing Lab	2	20	--	20
DSE:3A	COMP303TH	Project Work	6	70	30	100
DISCIPLINE SPECIFIC EFFECTIVES DSE: IB	COMP304TH	Web Technologies	6	70	30	100
DSE:2B	COMP305TH	Computer Graphics	6	70	30	100
DSE:3B	COMP306TH	Programming in Java	4	50	30	80
	COMP306PR	Programming in JavaLab	2	20	--	20
SEC 3	COMP307TH	Multimedia and Applications	4	70	30	100
SEC 4	COMP308TH	Software Engineering	4	70	30	100

B. Sc (Computer Science) 3rd Year

Course Type	Course Code	Title of Paper	Credits	ESE	CCA	Total
Discipline Specific Electives DSE:1A (Choose Any One from Given Three)	PHYS301TH PHYS301IA	Elements of Modern Physics Theory	4	50	30	80
	PHY301PR	Elements of Modern Physics Lab	2	20	-	20
	PHYS302TH PHYS302IA	Solid State Physics and Electronics Theory	4	50	30	80
	PHYS302PR	Solid State Physics and Electronics Lab	2	20	-	20
	PHYS303TH PHYS303IA	Astronomy and Astrophysics Theory	4	50	30	80
	PHYS303TU	Astronomy and Astrophysics Tutorials	2	20	-	20
Discipline Specific Elective DSE:2A (Choose Any One from Given Three)	COMP301TH	Operating System	6	70	30	100
	COMP305TH	Computer Graphics	6	70	30	100
	COMP306TH	Programming in Java	4	50	30	80
	COMP306PR	Programming in Java Lab	2	20	-	20
Discipline Specific Elective DSE:3A (Choose Any One from Given Three)	MATH301TH MATH301IA	Matrices	6	70	30	100
	MATH302TH MATH302IA	Mechanics	6	70	30	100
	MATH303TH MATH303IA	Linear Algebra	6	70	30	100
Discipline Specific Electives DSE:1B (Choose Any One from Given Three)	PHYS304TH PHYS304IA	Nuclear and Particle Physics Theory	4	50	30	80
	PHYS304TU	Nuclear and Particle Physics Tutorials	2	20	-	20
	PHYS305TH PHYS305IA	Quantum Mechanics Theory	4	50	30	80
	PHYS305PR	Quantum Mechanics Lab	2	20	-	20
	PHYS306TH PHYS306IA	Physics of Devices and Instruments Theory	4	50	30	80
	PHYS306PR	Physics of Devices and Instruments Lab	2	20	-	20
Discipline Specific Elective DSE:2B (Choose Any One from Given Three)	COMP302TH	Data Structure and File Processing	4	50	30	80
	COMP302PR	Data Structure and File Processing Lab	2	20	-	20
	COMP303TH	Project Work	6	70	30	100
	COMP304TH	Web Technologies	6	70	30	100
Discipline Specific Elective DSE:3B (Choose Any One from Given Three)	MATH304TH MATH304IA	Numerical Methods	6	70	30	100
	MATH305TH MATH305IA	Complex Analysis	6	70	30	100
	MATH306TH MATH306IA	Linear Programming	6	.70	30	100
SEC 3	COMP307TH	Multimedia and Applications	4	70	30	100
SEC 4	COMP308TH	Software Engineering	4	70	30	100

Structure of B.Sc. Life Sciences under CBCS

Year	Discipline Specific Courses (12)	Specific	Skill Enhancement Courses (SEC) (4)	Discipline Specific Elective DSE (6)
I	DSC-Botany I Biodiversity (Microbes, Algae, Fungi and Archegoniates) (BOTA 101)	i. Environment Science ENVS 1AECC 02 ii. English ENGL 103 /Hindi/SKT		
	DSC-Zoology I Animal Diversity ZOOL 101 TH ZOOL 101 PR			
	DSC-Chemistry I Atomic structure, Bonding, General Organic Chemistry and Aliphatic Hydrocarbons CHEM 101 TH CHEM 101 IA CHEM 101 PR			
	DSC-Botany II Plant Ecology and Taxonomy (BOTA 102)			
	DSC-Zoology II Comparative Anatomy & Developmental Biology of Vertebrates ZOOL 102 TH ZOOL 102 PR			
	DSC-Chemistry II States of Matter, Chemical Kinetics & Functional Organic Chemistry CHEM 102 TH, CHEM 102 IA, CHEM 102 PR			

Year	Discipline Specific Course (12)		Ability Enhancement Compulsory Courses (2)	Skill Enhancement Courses (SEC) (4)	Discipline Specific Elective DSE (6)
II	DSC-Botany III Plant Anatomy and Embryology BOTA 201			**SEC-I** Bio-Fertilizers (BOTA 203) OR Medical Diagnostics ZOOL 203 TH	
	DSC-Zoology III Physiology & Biochemistry ZOOL 201 TH ZOOL 201 PR				
	DSC-Chemistry III Solutions, Phase Equilibrium, Conductance, Electrochemistry & Organic Chemistry CHEM 201 TH CHEM 201 IA CHEM 201 PR			Basic Analytical Chemistry CHEM203TH CHEM203IA OR Fuel Chemistry and Chemistry of Cosmetics and Perfumes CHEM204TH; CHEM204IA	
	DSC-Botany IV Plant Physiology and Metabolism (BOTA202)				
	DSC-Zoology IV Genetics & Evolutionary Biology ZOOL 202 TH ZOOL 202 PR			**SEC-II** Gardening and Floriculture (BOT A 204) OR Apiculture ZOOL 204 TH	
	DSC-Chemistry IV Chemistry of main group elements, chemical Energetics and equilibria CHEM202TH; CHEM202IA;CHEM202PR				

		SEC-III Medicinal Botany and Ethnobotany (BOTA 306) OR Sericulture ZOOL 303 TH	**DSE-Botany I** Economic Botany & Biotechnology (BOT A301) or Analytical Techniques in Plant Sciences (BOTA 302) **DSE-Zoology I** 1.Applied Zoology ZOOL 301 (A) TH ZOOL 301 (A) TH OR 2. Animal Biotechnology ZOOL 301 (B) TH ZOOL 301 (B) PR OR 3. Aquatic Biology ZOOL 301 (C) TH ZOOL 301 (C) PR **DSE2A: Chemistry I** Polynuclear hydrocarbons, Dyes, Heterocyclic compounds and spectroscopy(UV,IR,NMR) CHEM301TH; CHEM301PR; CHEM 301IA OR Industrial Chemical And environment CHEM302TH; CHEM302IA; CHEM302PR OR Quantum Chemistry , Spectroscopy and Photochemistry CHEM 303TH; CHEM303IA; CHEM303PR
III			

		SEC-IV Mushroom Cultivation Technology (BOTA 307) OR Aquarium Fish Keeping ZOOL 304 (A)TH **OR** Research Methodology ZOOL 304 (B) TH Chemical Technology & Society and Business Skills for Chemistry CHEM307 **OR** Pesticide chemistry & Pharmaceutical chemistry CHEM308	DSE-Botany II Cell and Molecular Biology (BOTA303) OR 2. Bioinformatics (BOTA 304) OR **DSE-Zoology II** 1.Insect, Vector and Diseases ZOOL 302 (A) TH ZOOL 302 (A) PR OR 2 Immunology ZOOL 302 (B) TH ZOOL 302 (B) PR OR 4. Reproductive Biology ZOOL 302 (C) TH ZOOL 302 (C) PR **DSE2B: Chemistry II** Chemistry of Transition and inner transition elements, coordination chemistry, organomettalics, acids & Bases : CHEM 304 TH; CHEM304 IA CHEM 304 PR OR Polymer Chemistry CHEM305TH CHEM305IA; CHEM305PR OR Molecules of Life CHEM 306TH; CHEM306 IA; CHEM 306PR

Details of Courses
Discipline Specific Courses –Botany

1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)   BOTA 101
2. Plant Ecology and Taxonomy   BOTA 102
3. Plant Anatomy and Embryology   BOT A201
4. Plant Physiology and Metabolism   BOTA 202

Discipline Specific Electives-Botany (Any two)

1. Economic Botany and Biotechnology   BOTA 301
2. Analytical Techniques in Plant Sciences   BOTA 302
3. Cell and Molecular Biology   BOT A303
4. Bioinformatics   BOTA 304

Discipline Specific Courses: Zoology

1. Animal Diversity   ZOOL 101 TH ; OOL 101PR
2. Comparative Anatomy and Developmental Biology of Vertebrates   ZOOL 102 TH; ZOOL 102 PR
3. Physiology and Biochemistry   ZOOL 201 TH ;   ZOOL 201 PR
4. Genetics and Evolutionary Biology ZOOL 202 TH ; ZOOL 202 PR

Discipline Specific Electives: Zoology (Any two)

1. Applied Zoology   ZOOL 301 (A) TH; ZOOL 301 (A) PR
2. Animal Biotechnology   ZOOL 301 (B) TH; ZOOL 301 (B) PR
3. Aquatic Biology   ZOOL 301 (C) TH; ZOOL 301(C) PR
4. Insect, Vector and Diseases   ZOOL 302 (A) TH; ZOOL 302 (A) PR
5. Immunology   ZOOL 302 (B) TH; ZOOL 302 (B) PR
6. Reproductive Biology   ZOOL 302 (C) TH; ZOOL 302 (C) PR

Discipline Specific Courses -Chemistry

1. Atomic Structure, Bonding, General Organic Chemistry and Hydrocarbon
2. States of matter, Chemical Kinetics & Functional organic Chemistry
3. Solutions, Phase Equilibrium, conductance, Electrochemistry &   Organic Chemistry
4. Chemistry of main group elements, chemical energetics and equilibria.

Discipline Specific Electives-Chemistry (Any two)

1. Polynuclear hydrocarbons, Dyes, Heterocyclic compounds and spectroscopy (UV,IR, NMR) OR
2. Industrial chemical and Environment.OR
3. Quantum Chemistry, Spectroscopy & photochemistry
4. Chemistry of transition and inner transition elements, coordination chemistry, organometallics, acids and bases. OR
5. Polymer Chemistry OR
6. Molecules of Life

Ability Enhancement Compulsory Courses

1. Environment Science
2. English/Hindi/SKT

Skill Enhancement Courses (Any four) Botany

1. Biofertilizers   BOTA 203

2. Gardening and Floriculture   BOT A204

3. Medicinal Botany and Ethnobotany   BOTA 306

4. Mushroom Cultivation Technology   BOTA 307

Chemistry

1. Basic Analytical Chemistry   CHEM203

OR

2. Fuel Chemistry & Chemistry of Cosmetics and Perfumes CHEM 204

3. Chemical Technology & Society and Bus Skills for Chemistry CHEM 307

OR

4. Pesticide Chemistry and Pharmaceutical Chemistry   CHEM 308

Zoology

1. Medical Diagonistics   ZOOL 203 TH
2. Apiculture   ZOOL 204 TH
3 Sericulture   ZOOL 303 TH
4 Aquarium Fish Keeping   ZOOL 304 (A) TH
5. Research Methodology   ZOOOL

YEAR	COURSE OPTED	COURSE NAME	Credits
I	**Ability Enhancement Compulsory Course**	i. Environmental Science ii. English/Hindi/SKT	2×4 =8
	Discipline Specific Courses Botany I	Biodiversity (Microbes, Algae, Fungi and Archegoniate) (BOTA 101)	4
	Botany I Practical	Biodiversity (Microbes, Algae, Fungi and Archegoniate) (BOTA 101)	2
	Discipline Specific **Courses Zoology I**	Biodiversity- Animals ZOOL 101TH	4
	Discipline Specific **Courses Zoology I Practical**	Biodiversity- Animals ZOOL 101PR	2
	Discipline Specific **Courses Chemistry I**	Atomic Structure, bonding, General Organic Chemistry and Hydrocarbon CHEM CC 101	4
	Discipline Specific **Courses Chemistry I Practical**	Atomic Structure, bonding, General Organic Chemistry and Hydrocarbon CHEM CC 101	2

Discipline Specific Courses Botany -II	Plant Ecology and Taxonomy (BOTA 102)	4
Discipline Specific Courses Botany -II Practical	Plant Ecology and Taxonomy (BOTA 102)	2
Discipline Specific Courses Zoology II	Comparative Anatomy and Developmental Biology of Vertebrates ZOOL 102 TH	4
Discipline Specific Courses Zoology II Practical	Comparative Anatomy and Developmental Biology of Vertebrates ZOOL 102 PR	2
Discipline Specific Courses Chemistry II	Chemical Energetics, Equilibria & Functional Group Organic Chemistry CHEM CC	4
Discipline Specific CoursesChemistry Practical	Chemical Energetics, Equilibria & Functional Group Organic Chemistry Lab CHEM CC	2

	Discipline Specific **Courses** **Botany III**	Anatomy and Embryology of Angiosperms (BOTA 201)	4
	Discipline Specific Courses **Botany III Practical**	Anatomy and Embryology of Angiosperms (BOTA 201 PR)	2
	Discipline Specific Courses **Zoology III**	Physiology Biochemistry ZOOL 201 TH	4
	Discipline Specific Courses **Zoology III Practical**	Physiology Biochemistry ZOOL 201 PR	2
	Discipline Specific Courses **Chemistry III**	Solutions, Phase Equilibria, Conductance, Electrochemistry & Organic Chemistry CHEM CC	4
II	**Discipline** Specific **Courses Chemistry III** **Practical**	Solutions, Phase Equilibria, Conductance, Electrochemistry & Organic Chemistry CHEM CC	2

Skill Enhancement Course-I	**SEC-I**	4
Discipline Specific Courses Botany IV	Plant Physiology and Metabolism (BOTA 202 TH)	4
Discipline Specific Courses Botany IV Practical	Plant Physiology and Metabolism (BOTA 202 PR)	2
Discipline Specific Courses Zoology IV	Genetics and Evolutionary Biology ZOOL 202 TH	4
Discipline Specific Courses Zoology Practical IV	Genetics Evolutionary Biology ZOOL 202 PR	2
Discipline Specific Courses Chemistry IV	Coordination chemistry, states of matter & Chemical Kinetics CHEM CC	4
Discipline Specific Courses Chemistry Practical	Coordination chemis states of matter & Kinetics CHEM CC	2
Skill Enhancement Course-II	SEC-II	4

	Skill Enhancement Course-III	SEC-**III**	4
III	**Discipline Specific Elective** **Botany 1**	**DSE Botany 1** Economic Botany and Biotechnology (BOTA 301) OR Analytical Techniques in Plant Sciences (BOTA 302)	4
	Discipline Specific Elective **Botany 1 Practical**	**DSE Botany 1** Economic Botany and Biotechnology (BOTA 301) OR Analytical Techniques in Plant Sciences (BOTA 302)	2
	Discipline Specific Elective **Zoology 1**	**DSE-Zoology I** 1.Applied Zoology ZOOL 301(A) TH OR 2.Animal Biotechnology ZOOL 301 (B) TH OR 3.Aquatic Biology ZOOL 301 (C) TH	4
	Discipline Specific Elective **Zoology 1 Practical**	1.Applied Zoology ZOOL 301 (A) PR OR 2.Animal Biotechnology ZOOL 301 (B) PR OR 3.Aquatic Biology ZOOL 301 (C) PR	2

	Discipline Specific Elective
	
	Chemistry 1 Practical
		DSE-3 Chemistry I
		Polymer Chemistry
		CHEM DSE COURSE
		          OR
		Industrial Chemical And environment CHEM DSE COURSE
		          OR
		Quantum Chemistry , Spectroscopy and Photochemistry CHEM DSE COURSE
			4

	Discipline Specific Elective
	
	Chemistry 1
		DSE- Chemistry I
		Polymer Chemistry CHEM DSE COURSE
		            OR
		Industrial Chemical And environment CHEM DSE COURSE
		            OR
		Quantum Chemistry , Spectroscopy and Photochemistry CHEM DSE COURSE
			2

	Skill Enhancement Course- IV	**SEC- IV**	4
	Discipline Specific Elective **Botany 1I**	**DSE-Botany II** Cell and Molecular Biology (BOTA 303) OR Bioinformatics (BOTA 304)	4
	Discipline Specific Elective **Botany 1I Practical**	Cell and Molecular Biology (BOTA 303) OR Bioinformatics (BOTA 304)	2

	Discipline Specific Elective
	
	Zoology 1I
		1.Insect, Vector and Diseases ZOOL 302 (A) TH
		                 OR
		2. Immunology ZOOL 302 (B) TH
		                 OR
		   3.Reproductive Biology ZOOL 302 (C)TH
			4

	Discipline Specific Elective **Zoology 1I Practical**	1.Insect, Vector and Diseases ZOOL 302(A) PR OR 2. Immunology ZOOL 302 (B) PR OR 3.Reproductive Biology ZOOL 302 (C) PR	2
	Discipline Specific Elective **Chemistry 1I**	**DSE-3 Chemistry II** Chemistry of Main group elements, Theories of acids and Bases CHEM DSE COURSE OR Organometallic, Bioinorganic chemistry polynuclear hydrocarbons and UV, IR spectroscopy CHEM DSE COURSE OR Molecules of Life CHEM DSE COURSE	4
	Discipline Specific Elective **Chemistry 1I Practical**	**DSE-3 Chemistry II** Chemistry of Main group elements, Theories of acids and Bases CHEM DSE COURSE OR Organometallic, Bioinorganic chemistry polynuclear hydrocarbons and UV, IR spectroscopy CHEM DSE COURSE OR Molecules of Life CHEM DSE COURSE	2

HIMACHAL PRADESH UNIVERSITY

SUMMER-HILL, SHIMLA-171005

B.Sc. Life Sciences

GENERAL INSTRUCTIONS/ GUIDELINES FOR EXECUTION OF CURRICULUM

I.   The B.Sc. Life Sciences will be of three years duration annually based Choice Based Credit System [CBCS] course.

II.   There will be broadly three types of courses for B.Sc. Life Sciences degree program.

1. The **Core Courses** (12 courses for Life Sciences; and 6 discipline specific papers) will be of 6-credits each including 2 credits assigned to the practical component. Thus a candidate will have to pass 12 courses for earning 12 X 6 = 72 credits during six semesters. Each of the 6-credits courses will carry 100 marks. These 100 marks will be split into marks assigned for Theory [TH]: 50 marks; Practical [P]: 20 marks and Internal Assessment [IA]: 30.

2. The **Elective Courses** will be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/ subject/ domain or nurtures the candidate's proficiency / skill. The Elective Courses will include;

    Discipline Specific Elective [**DSE**] Courses: A total of 6 courses offered under the main discipline/ subject of study is referred to as Discipline Specific Elective. These courses are discipline related and/ or interdisciplinary in nature. A total of 4 X 6 = 24 credits could be accumulated under DSE courses during the Life Sciences degree program.

3. **Ability Enhancement Compulsory Courses [AECC]:** Ability Enhancement Courses are of two types; Ability Enhancement Compulsory Courses [AECC] and Skill Enhancement Courses [SEC]. A total of 4 X 4 = 16 credits could be accumulated under these courses during the Life Sciences degree program i.e. 4 X 2 = 8 credits for AECC, and 4 X 2 = 8 credits for SEC courses.

The AECC courses are the mandatory courses based upon the content that leads to knowledge enhancement; i. Environment Science and ii. English/ Hindi/ MIL Communication. All these are mandatory courses for obtaining a B.Sc. Life Sciences degree in the concerned subject. These courses are mandatory for all disciplines. SEC courses are value-based and/ or skill-based and are aimed at providing hands-on-training, competencies, skills *etc*. A minimum of two such courses for obtaining an Life Sciences degree are selected amongst the courses designed to provide value-based and/ or skill-based knowledge and may contain both theory and lab/ hands-on training. The main purpose of these courses is to provide students life-skills in hands-on mode so as to increase their employability.

III. Practical [P] component has been included in every core and discipline/ generic specific elective paper. The list of practicals to be conducted by the candidates has been provided alongside each of such courses. The marks (30 marks) for the practical examination will be split as follows;

Write up of Practical I:	4 marks
Write up of Practical II:	4 marks
Performance of any one of these practicals:	4 marks
Practical record/ notebook:	4 marks
Viva voce:	4 marks

IV. **Classroom Attendance Incentive**: Those candidates who have greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CCA marks as follows:

☐ 75% but < 80%	1 marks
☐ 80% but <85%	2 marks
☐ 85 but <90%	3 marks
☐ 90% but < 95%	4 marks
☐ 95% To 100%	5 marks

V. The admission to B.Sc. Life Sciences programme of Himachal Pradesh University will be as per guidelines of Himachal Pradesh University, Shimla from time to time.

   i. The candidate should have passed 10+2 (class XII) Examination or its equivalent from a recognized Board/University with any of the three subjects out of Physics, Chemistry and Biology or any other science subjects with 50% or equivalent grade (for SC/ST candidates marks of eligibility will be 45% or equivalent grade).

   ii. In case of candidates who are studying in University/ Board/ College/ Schools in any of the foreign countries the eligibility/ Qualifying marks will be the same as recognized/equivalent to 10+2 by the University or the association of the Indian University with 50% marks of equivalent grade (for SC/ST candidates, eligibility will be 45% marks or equivalent grade).

iii. The candidate who has appeared in the qualifying examination but whose result has so far not been declared can also apply but his/her eligibility for the entrance test will be purely provisional subject to the condition that he/she has to produced a passing certificate scoring at least the minimum percentage of marks as prescribed for the qualifying examination on the day and the specified time of counseling.

   iv. The candidate shall not be more than 22 years of age as on 01st July of the year of admission. Date of birth as recorded in the Secondary Education Board/ University Certificate Only will be considered as authentic.

I Year

DSC: Botany Paper I
Biodiversity (Microbes, Algae, Fungi and Archegoniates)
(BOTA 101) (Credits: Theory-4, Practicals-2)
THEORY Lectures: 60

Unit 1: Microbes (7 Lectures)

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae (12 Lectures)

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Brief account of classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Oedogonium*, *Vaucheria, Ectocarpus, Polysiphonia*. Economic importance of algae

Unit 3: Fungi (12 Lectures)

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition , nutrition, reproduction and classification; Morphology and life cycles of *Phytophthora*, *Rhizopus* (Zygomycota) *Penicillium, Venturia* (Ascomycota), *Puccinia, Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance.

Unit 4: Bryophytes (9 Lectures)

General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit 5: Pteridophytes (10 Lectures)

General characteristics, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Adiantum*. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance.

Unit 6: Gymnosperms **(10 Lectures)**
General characteristics, Classification (up to family), Morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included). Economic importance.
NOTE: The question paper will be divided into four sections as follows:
Section A: Algae, Section B- Fungi, Section C – Microbes and Bryophytes and Section D-Pteridophytes and Gymnosperms.

Practical   (BOTA 101)

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and LysogenicCycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs)*, Oedogonium, Vaucheria, Ectocarpus* and *Polysiphonia* through temporary preparations and permanent slides.
5. *Phytophthora, Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures throughpermanent slides.
6. *Venturia:* Specimens/photographs

7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves;section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of   *Agaricus*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)

11. ***Marchantia***- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup,w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).

12. ***Funaria***- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.

13. *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).

14. *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).

15. *Adiantum*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).

16. **Cycas**- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).

17. **Pinus**- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarfshoot, t.s. needle, t.s. stem, , l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores(temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

18. **Field visits**

Suggested Readings

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.

2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.

4. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.

6. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.

7. Thakur, A.K. and Bassi, S.K. (2008). Diversity of Microbes and Cryptogams. S. Chand & Co., Delhi.

8. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.

9. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

DSC Botany –Paper II

Plant Ecology and Taxonomy
(BOTA 102)

(Credits: Theory-4, Practicals-2)

THEORY   **Lectures: 60**
Section A

Unit 1: Introduction   (2 Lecture)

Unit 2: Ecological Factors   (13 Lectures)

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature, Shelford law of tolerance. General account of adaptations in xerophytes and hydrophytes.

Section B

Unit 3: Plant communities   (5 Lectures)

Characters; Ecotone and edge effect; Succession; Processes and types (Hydrosere and Xerosere)

Unit 4: Ecosystem   (10 Lectures)

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling- Cycling of Nitrogen and Phosphoros.

Section C

Unit 5: Introduction to plant taxonomy   (3 Lectures)

Identification, Classification, Nomenclature.

Unit 6 : Identification   (5 Lectures)

Functions of Herbarium, important herbaria and botanical gardens of the world and
India; Documentation: Flora, Keys: single access and multi-access

Unit 7 : Taxonomic evidences from cytology, phytochemistry and molecular data. **6 Lectures**

Unit 8: Taxonomic hierarchy   (2 Lectures)

Ranks, categories and taxonomic groups

Section D

Unit 9: Botanical nomenclature (6 Lectures)

Principles and rules (ICN); ranks and names; binominal system, typification, author citation,
valid publication, rejection of names, principle of priority and its limitations

Unit 10: Classification (5 Lectures)

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker
(upto series), Engler and Prantl (upto series), Angiosperm Phylogeny Group
(APG) - general introduction

Unit 11: Biometrics, numerical taxonomy and cladistics   (3 Lectures)

Characters; variations; OTUs, character weighting and coding; cluster analysis;
phenograms, cladograms (definitions and differences).

Practical (BOTA 102 PR)

1.Study of instruments used to measure microclimatic variables: Soil thermometer,
maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain
gauge and lux meter.

2.Determination of pH, and analysis of two soil samples for carbonates, organic matter.

3.Comparison of bulk density, porosity and rate of infiltration of water in soil of three
habitats.

4.(a) Study of morphological adaptations of hydrophytes and xerophytes (four each).

    (b)Study of biotic interactions of the following: Stem parasite
    (*Cuscuta)*, Root parasite (Orobanche), Epiphytes, Predation
    (Insectivorous plants)

5.Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)

6.Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law

7.Study of vegetative and floral characters of the following flowers s(Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

     i. Ranunculacaceae: *Ranunculus/Delphinium*
     ii. Brassicaceae :*Brassica/Alyssum/Iberis*
     iii. Malavaceae: *Hibiscus/Abutilon*
     iv. Asteraceae: *Helianthus/sonchus*
     v. Fabaceae: *Lathyrus/Pisum*
     vi. Rosaceae: *Rosa/Prunus*
     vii. Apiaceae: *Coriandrum*
     viii. Apocynaceae: *Vinca/Nerium*
     ix. Solanaceae: *Solanum/ Petunia*
     x. Lamiaceae; *Ocimum/Salvia*
     xi. Lilliaceae: *Asparagus/Allium*
     xii. Poaceae: *Zea mays/Triticum aestivum*

8. Field visit/ Visit to nearby Botanical Garden
9. Mounting of a properly dried and pressed specimen of any wild angiosperm with herbarium label.

Suggested Readings

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.   2.Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India.

2. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA,

   U.S.A.

3. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

DSC Botany –Paper III
Plant Anatomy and Embryology
(BOTA 201)
(Credits: Theory-4, Practicals-2)
THEORY Lectures: 60

SECTION A

Unit 1: Meristematic and permanent tissues   **(7 Lectures)**
Root and shoot apical meristems; Simple and complex tissues.

Unit 2: Organs   **(7 Lectures)**
Structure of dicot and monocot root stem and leaf.

Unit 3: Adaptive and protective systems   **(4 Lectures)**
Epidermis, cuticle, stomata;

SECTION B

Unit 4: Secondary Growth   (8Lectures)
Vascular cambium – structure and function, seasonal activity. Secondary growth in
root and stem, Wood (heartwood and sapwood).
Unit 5: Anomalous Secondary Growth   **(4 Lectures)**
Boerhaavia (Dicot) and *Dracaena* (Monocot)

SECTION C

Unit 6: Structural organization of flower   (13 Lectures)
Flower- a modified shoot, Function of floral parts; Structure of anther and pollen;
Microsporogenesis, Male gametophyte, Structure and types of ovules;
gasporangium, Types of embryo sacs, organization and ultra structure of
mature embryo sac.
Unit 7:   Pollination   (4 Lectures)
Pollination mechanisms and adaptations.

SECTION D

Unit 8:   Fertilization   (7 Lectures)
Double fertilization; Seed-structure, appendages and dispersal mechanisms.

Unit 9: Embryo and endosperm   (6 Lectures)
Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-
endosperm relationship, polyembryony

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)

3. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).

7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).

8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.

9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.

11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Study of various types of pollen grains.

Suggested Readings

1.Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas th Publication House Pvt. Ltd. New Delhi. 5 edition.
2.Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

DSC Botany –Paper IV

Plant Physiology and Metabolism
(BOTA 202
(Credits: Theory-4, Practicals-2)
THEORY Lectures: 60

SECTION A

Unit 1: Introduction
Applications of plant physiology in agriculture & horticulture.
Plant-water relations   (8 Lectures)
Importance of water,Diffusion. Osmosis, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation, Mechanism of Stomatal movements.

Unit 2: Mineral nutrition (8 Lectures)
Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

SECTION B

Unit 3: Translocation in phloem   (4 Lectures)
Composition of phloem sap, girdling experiment; Pressure flow model; Phloem

loading and unloading.

Unit 4: Photosynthesis   (12 Lectures)
Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C_3, C_4 and CAM pathways of carbon fixation; Photorespiration.

SECTION C

Unit 5: Respiration   (8 Lectures)
Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 6: Enzymes   (4 Lectures)
Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Unit 7: Nitrogen metabolism(4 Lectures)
Biological nitrogen fixation; Nitrate and ammonia assimilation.

SECTION D

Unit 8:   Plant growth regulators(6 Lectures)
Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Unit 9: Plant response to light and temperature   **(6 Lectures)**

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization. Practical applications of vernalization and photoperiodism

Practical (BOTA 202)

1. Determination of osmotic potential of plant cell sap by plasmolytic method.

2. Demonstration of transpiration with the help of photometers.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of activity of catalase and study of effect of pH and enzyme concentration.
5. To study the effect of light intensity and bicarbonate concentration on O_2 evolution in photosynthesis.
6. Comparison of the rate of respiration in any two parts of a plant.

7. Separation of photosynthetic pigments by paper chromatography.

8. To determine the RQ of different respiratory substances.

<u>Demonstration experiments (any four)</u>

1. Bolting.

2. Effect of auxins on rooting.

3. Hydroponics

Suggested Readings

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

Discipline Specific Elective Botany
Economic Botany and Biotechnology

(BOTA 301)
(Credits: Theory-4, Practicals-2)
THEORY Lectures: 60

SECTION A

Unit 1: Cultivated Plants   (3Lectures)

Introduction, Research centres, Concept of centres of origin, their importance with reference to Vavilov's work

Unit 2: Cereals   **(5 Lectures)**

Wheat and Rice –(Origin, morphology, uses)

Unit 3: Pulses & Vegetables   (4 Lectures)

General account with special reference to Gram , soybean and   Potato

Unit 4: Spices   (3 Lectures)

General account with special reference to clove, black pepper, cinnamon, Ginger and Turmeric (Botanical name, family, part used, morphology and uses)

SECTION B

Unit 5: Beverages   **(4 Lectures)**

Tea and Coffee (morphology, processing, uses)

Unit 6: Oils and Sugar   **(4 Lectures)**

General description with special reference to groundnut and sugarcane

Unit 7: Fibre Yielding Plants   **(4 Lectures)**

General description with special reference to Cotton (Botanical name, family, partused, morphology and uses)

Unit 8: Medicinal Plants   **(3 Lecture)**

Brief account of *Ocimum, Tinospora, Aloe, Rauvolfia, Emblica* and *Cathranthus*

SECTION C

Unit 9: Introduction to Biotechnology   **(15 Lectures)**

Tissue culture techniques, Micropropagation; haploid production through androgenesis and gynogenesis; brief account of embryo & endosperm culture; Applications of plant tissue culture in agriculture, horticulture and forestry.

SECTION D

Unit 10: Biotechnological Techniques   (15 Lectures)

Introduction to r-DNA, Cloning vehicles, Gene transfer techniques in plants, Transgenic plants, Agarose electrophoresis, Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. ELISA, Hybridoma and monoclonal an tibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

Practical (BOTA 301)

1. Study of economically important plants : Wheat, Rice, Gram, Soybean, Potato, Black pepper, Clove, Cinnamon, Ginger, Turmeric, Tea, Coffee, Cotton, Groundnut, Sugarcane and Medicinal plants through specimens, sections and microchemical tests
2. Familiarization with basic equipment used in tissue culture through videos, images or visit to nearby research Institute.

3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of equipments used in PCR, Blotting techniques and PAGE with the help of photographs or videos.

Suggested Readings

1. Kochhar, S.L. (2017). Economic Botany, Cambridge University Press.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

Discipline Specific Elective
Analytical Techniques in Plant Sciences
(BOTA 302)
(Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

SECTION A

Unit 1: Imaging and related techniques   (15 Lectures)

Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

SECTION B

Unit 2: Cell fractionation   (5 Lectures)
Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$ gradient, analytical centrifugation, ultracentrifugation, marker enzymes. (

Unit 3: Radioisotopes
Use in biological research, auto-radiography, pulse chase experiment.   **(6 Lectures)**

Unit 4: Spectrophotometry

Principle and its application in biological research.   **(6 Lectures)**

SECTION C

Unit 5: Chromatography   (8 Lectures)

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ionexchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 6: Characterization of proteins and nucleic acids (6 Lectures)

Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

SECTION D

Unit 7: Biostatistics (15 Lectures)

Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Practicals (BOTA 302)

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.

3. To separate nitrogenous bases by paper chromatography.

4. To separate sugars by thin layer chromatography.

5. Isolation of chloroplasts by differential centrifugation.

6. To separate chloroplast pigments by column chromatography.

7. To estimate protein concentration through Lowry's methods.

8. To separate proteins using PAGE.

9. To separate DNA (marker) using AGE.

10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).

1.Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.

2.Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.

3.Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.

4.Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Discipline Specific Elective Botany
Cell and Molecular Biology
(BOTA 303)
(Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

SECTION A

Unit 1: Techniques in Biology (8 Lectures)
Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample ; X-ray diffraction analysis.

Unit 2: Cell as a unit of Life (2 Lectures)
The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.

Unit 3: Cell Organelles (20 Lectures)
Mitochondria: Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA.
Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA.

SECTION B

ER, Golgi body & Lysosomes: Structures and roles.
Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis.

Nucleus: Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 4: Cell Membrane and Cell Wall   (6 Lectures)

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall.

SECTION C

Unit 5: Cell Cycle   (6 Lectures)
Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

Unit 6: Genetic material   (6 Lectures)

DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material.

A replication   rokaryotes and eukaryotes   bidirectional replication, semi–conservative, semi discontinuous R A priming, Ǿ theta mode of replication, replication of linear, ds-A, replicating the   end of linear chromosome including replication enzymes.

SECTION D

Unit 7: Transcription (Prokaryotes and Eukaryotes)   (6 Lectures)
Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code.

Unit 8: Regulation of gene expression   (6 Lectures)
Prokaryotes:Lac operon and Tryptophan operon ; and in Eukaryotes.

Practical (BOTA 303)

1.To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2.Study of the photomicrographs of cell organelles
3.To study the structure of plant cell through temporary mounts.
 4.Study of mitosis and meiosis (temporary mounts and permanent slid
5.Study the effect of temperature, organic solvent on semi permeable membrane.
 6.Demonstration of dialysis of starch and simple sugar.
7.Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.

8..Measure the cell size (either length or breadth/diameter) by micrometry.

9.Study the structure of nuclear pore complex by photograph (from Gerald Karp)Study of special chromosomes (polytene & lampbrush) either by slides or photographs.

10.Study DNA packaging by micrographs.

11.Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

Suggested Readings

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Discipline Specific Elective Botany
Bioinformatics
(BOTA 304)
(Credits: Theory-4, Practicals-2)
THEORY Lectures: 60
SECTION A

Unit 1: Introduction to Bioinformatics   **(5 Lectures)**
Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 2: Databases in Bioinformatics   (5 Lectures)
Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

SECTION B

Unit 3 : Biological Sequence Databases   (25 Lectures)
National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.

EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.

DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.

Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR.

Swiss-Prot: Introduction and Salient Features.

SECTION C

Unit 4: Sequence Alignments   (10 Lectures)

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

Unit 5: Molecular Phylogeny   (8 Lectures)

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

SECTION D

Unit 6: Applications of Bioinformatics   (7 Lectures)

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.

Practical (BOTA 304)

1.Nucleic acid and protein databases.

2.Sequence retrieval from databases.

3.Sequence alignment.

4.Sequence homology and Gene annotation.

5.Construction of phylogenetic tree.

Suggested Readings

1.Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

2.Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. WileyBlackwell.

3.Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

Discipline Specific Elective Botany

Genetics and Plant Breeding

(BOTA 305)

(Credits: Theory-4, Practical-2)

THEORY Lectures: 60

SECTION A

Unit 1: Heredity   (20 Lectures)

Brief life history of Mendel

1.Terminologies

2.Laws of Inheritance

3.Modified Mandelian Ratios: 2:1- lethal Genes; 1:2:1- Co- dominance, incomplete dominance; 9:7; 9:4:3; 13:3; 12:3:1.

1.Chi Square

2.Pedigree Analysis

3.Cytoplasmic Inheritance: Shell Coiling in Snail, Kappa particles in Paramecium, leaf variegation in Mirabilis jalapa, Male sterility.

4.Multiple allelism

5.Pleiotropism

6.Chromosome theory of Inheritance.

SECTION B

Unit 2: Sex-determination and Sex-linked Inheritance   (4 Lectures)

Unit 3: Linkage and Crossing over   (8 Lectures)

Linkage: concept & history, complete & incomplete linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps based on two and three factor crosses. Crossing over: concept and significance, cytological proof of crossing over.

Unit 4: Mutations and Chromosomal Aberrations   (4 Lectures)

Types of mutations, effects of physical & chemical mutagens. Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy ; Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations.

SECTION C

Unit 5: Plant Breeding   (4 lectures)
Introduction and objectives. Breeding systems: modes of reproduction in crop plants.
Important achievements and undesirable consequences of plant breeding.

Unit 6: Methods of crop improvement   (8 lectures)
Introduction: Centres of origin and domestication of crop plants, plant genetic
resources; Acclimatization; Selection methods: For self pollinated, cross pollinated
and vegetatively propagated plants; Hybridization: For self, cross and vegetatively
propagated plants – Procedure, advantages and limitations.

Unit 7: Quantitative inheritance   (4 lectures)

Concept, mechanism, examples. Monogenic vs polygenic Inheritance.

SECTION D

Unit 8: Inbreeding depression and heterosis   (4 lectures)
History, genetic basis of inbreeding depression and heterosis; Applications.

Unit 9: Crop improvement and breeding   (4 lectures)
Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop
improvement.

Practical (BOTA 305)

1.Mendel's laws through seed ratios. Laboratory exercises in probability and
chisquare.
2.Chromosome mapping using point test cross data.
3.Pedigree analysis for dominant and recessive autosomal and sex linked traits.
4.Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3,
15:1, 12:3:1, 9:3:4).

5.Study of aneuploidy   own's, Klinefelter's and Turner's syndromes through
photographs.
6.Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion
Bridge.
7.Hybridization techniques - Emasculation, Bagging (For demonstration only).
8.Induction of polyploidy conditions in plants (For demonstration only).

Suggested Readings

1.Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed.
        Wiley-India.
2.Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley &th
Sons Inc., India. 5 edition.
3.Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed.,
Benjamin Cummings

4.Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to th
Genetic Analysis. W. H. Freeman and Co., U.S.A. 10   edition.

5. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher
Education Learning

6.Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers.

7th edition.

7.Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH.
2nd edition.

COURSE ZOOLOGY I
ANIMAL DIVERSITY
ZOOL 101 TH

Section A

THEORY (CREDITS 4)

Unit 1: Kingdom Protista 4

General characters and classification up to classes; Locomotory Organelles and
locomotion in Protozoa

Unit 2: Phylum Porifera 3

General characters and classification up to classes; Canal System in *Sycon*

Unit 3: Phylum Cnidaria 3

General characters and classification up to classes; Polymorphism in Hydrozoa

Unit 4: Phylum Platyhelminthes 3

General characters and classification up to classes; Life history of *Taenia solium*

Unit 5: Phylum Nemathelminthes 5

General characters and classification up to classes; Life history of
Ascaris lumbricoides and its parasitic adaptations

Section B

Unit 6: Phylum Annelida 3

General characters and classification up to classes; Metamerism in Annelida

Unit 7: Phylum Arthropoda **5**

General characters and classification up to classes; Vision in Arthropoda,
Metamorphosis in Insects

Unit 8: Phylum Mollusca **4**
General characters and classification up to classes; Torsion in gastropods

Unit 9: Phylum Echinodermata **4**
General characters and classification up to classes; Water-vascular system in Asteroidea

Section C

Unit 10: Protochordates **2**
General features and Phylogeny of Protochordata

Unit 11: Agnatha **2**
General features of Agnatha and classification of cyclostomes up to classes

Unit 12: Pisces **4** General features and Classification up to orders;
Osmoregulation in Fishes

Unit 13: Amphibia **4**
General features and Classification up to orders; Parental care

Section D

Unit 14: Reptiles **4**
General features and Classification up to orders; Poisonous and non-poisonous
snakes, Biting mechanism in snakes

Unit 15: Aves **5**
General features and Classification up to orders; Flight adaptations in birds

Unit 17: Mammals   **5**

Classification up to orders; Origin of mammals

 Note: Classification of Unit 1-9 to be followed from "Barnes, R. . 1982). *Invertebrate Zoology*, V Edition"   **ANIMAL DIVERSITY**

ZOOL 101 PR

PRACTICAL   **(CREDITS 2)**

1. Study of the following specimens:

Amoeba, *Euglena, Plasmodium, Paramecium, Sycon*, *Hyalonema,* and *Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium,* Male and female *Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus*, *Palamnaeus, Scolopendra*, *Julus*, *Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria* and *Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis,* Any six common birds from different orders, *Sorex*, Bat, *Funambulus, Loris*

2. Study of the following permanent slides:

T.S. and L.S. of *Sycon*, Study of life history stages of *Taenia,* T.S. of Male

and female *Ascaris*

3. Key for Identification of poisonous and non-poisonous snakes

 An "**animal album**" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

SUGGESTED READINGS

 Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.

• Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The* *Invertebrates: A New Synthesis*, III Edition, Blackwell Science

• Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.

• Pough H. *Vertebrate life,* VIII Edition, Pearson International.

- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

DSC ZOOLOGY II
COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES
ZOOL 102 TH

THEORY   **Section A**   **(CREDITS 4)**

Unit 1: Integumentary System   **4**
Derivatives of integument w.r.t. glands and digital tips

Unit 2: Skeletal System   **3**
Evolution of visceral arches

Unit 3: Digestive System   **4**
Brief account of alimentary canal and digestive glands

Unit 4: Respiratory System   **5**
Brief account of Gills, lungs, air sacs and swim bladder

Section B

Unit 5: Circulatory System   **4**
Evolution of heart and aortic arches
 Unit 6: Urinogenital System   **4**
Succession of kidney, Evolution of urinogenital ducts

Unit 7: Nervous System   **3**
Comparative account of brain

Unit 8: Sense Organs   **3**
Types of receptors

Section C

Unit 9: Early Embryonic Development   12

Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog and humans (structure of mature egg and its membranes, patterns of

cleavage, fate map, up to formation of gastrula);types of morphogenetic movements; Fate of germ layers; Neurulation in frog embryo.

<div align="center">**Section D**</div>

Unit 10: Late Embryonic Development   **10**

Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.

Unit 11: Control of Development   **8**

Fundamental processes in development (brief idea) – Gene activation, determination, induction, Differentiation, morphogenesis, intercellular communication, cell movements and cell death.

<div align="center">**COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES**

ZOOL 201 PR</div>

PRACTICAL   **(CREDITS 2)**

1 . Osteology:

a) Disarticulated skeleton of fowl and rabbit

b) Carapace and plastron of turtle /tortoise

c) Mammalian skulls: One herbivorous and one carnivorous animal.

2.   Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.

3.   Study of the different types of placenta- histological sections through permanent slides or photomicrographs.

 3   . Study of placental development in humans by ultrasound scans.

 4   Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

SUGGESTED READINGS

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition.
- The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.
- Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.

Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.   Carlson, Bruce M 1996). Patten's Foundations of Embryology, McGraw Hill, Inc.

DSC ZOOLOGY III

PHYSIOLOGY AND BIOCHEMISTRY
ZOOL 201 TH
THEORY   (CREDITS 4)
Section A

Unit 1: Nerve and muscle   8

Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction

Unit 2: Digestion   5
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

Unit 3: Respiration   5
Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

Section B
Unit 4: Excretion   5

Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit 5: Cardiovascular system 6

Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle

Unit 6: Reproduction and Endocrine Glands 7

Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle

Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal

Section C

Unit 7: Carbohydrate Metabolism 8

Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain

Unit 8: Lipid Metabolism 5

Biosynthesis and β oxidation of palmitic acid

Section D

Unit 9: Protein metabolism 5

T ransamination, Deamination and Urea Cycle

Unit 10: Enzymes 6

Introduction, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation

PHYSIOLOGY AND BIOCHEMISTRY
ZOOL 201 PR
PRACTICAL (CREDITS 2)

1 . Preparation of hemin and hemochromogen crystals

2. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland

3. Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage

4. Qualitative tests to identify functional groups of carbohydrates in given solutions

   (Glucose, Fructose, Sucrose, Lactose)

5   Estimation of total protein in given solutions by Lowry's method

6   Study of activity of salivary amylase under optimum conditions

SUGGESTED READINGS

- Tortora, G.J. and Derrickson, B.H. (2009). *Principles of Anatomy and Physiology*, XII Edition, John Wiley & Sons, Inc.

- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) *Vander's Human Physiology*, XI Edition., McGraw Hill

- Guyton, A.C. and Hall, J.E. (2011). T*extbook of Medical Physiology*, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company

- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). *Biochemistry*. VI Edition. W.H Freeman and Co.

- Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). *Principles of Biochemistry*. IV Edition. W.H. Freeman and Co.

- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). *Harper's Illustrated Biochemistry*. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.

DSC ZOOLOGY IV GENETICS AND EVOLUTIONARY BIOLOGY
ZOOL 202 TH

THEORY   **(CREDITS 4)**

Section A

Unit 1: Introduction to Genetics   **3**

Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

Unit 2: Mendelian Genetics and its Extension   **8**

Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

Section B

Unit 3: Linkage, Crossing Over and Chromosomal Mapping   **9**

Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics - an alternative approach to gene mapping

Unit   4: Mutations   7

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations,

Unit 5: Sex Determination   **2**
Chromosomal mechanisms, dosage compensation

Section C

Unit 6: History of Life   **2**
Major Events in History of Life

Unit 7: Introduction to Evolutionary Theories   **4**
Lamarckism, Darwinism, Neo-Darwinism

Unit 8: Direct Evidences of Evolution   **4**
Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

Unit 9: Processes of Evolutionary Change   8
Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection

Section D

Unit 10: Species Concept   **5**
Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)

Unit 11: Macro-evolution   **4**
Macro-evolutionary Principles example: arwin's Finches)

Unit 12: Extinction   **4**
Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution

GENETICS AND EVOLUTIONARY BIOLOGY
ZOOL 202 PR
PRACTICAL   **(CREDITS 2)**

1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.

2. Study of Linkage, recombination, gene mapping using the data.

3. Study of Human Karyotypes (normal and abnormal).

4. Study of fossil evidences from plaster cast models and pictures 5 . Study of homology and analogy from suitable specimens/ pictures 6 . Charts:

   a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors

   b) arwin's Finches with diagrams/ cut outs of beaks of different species

7. Visit to Natural History Museum and submission of report

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India. □
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc. □
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X □ Edition. Benjamin Cummings. □
- Russell, P. J. (2009). *Genetics- A Molecular Approach.* III Edition. Benjamin Cummings. □
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co. □
- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing □
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). □ *Evolution*. Cold Spring, Harbour Laboratory Press. □
- Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett

□ Publishers □

- Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings. □
- Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates. □

DSE 2 APPLIED ZOOLOGY
ZOOL 301(A)TH
THEORY (CREDITS 4)

Unit 1: Introduction to Host -parasite Relationship 3
Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis

Unit 2: Epidemiology of Diseases 7
Transmission, Prevention and control of diseases: Tuberculosis, typhoid

Unit 3: Rickettsiae and Spirochaetes 6
Brief account of *Rickettsia prowazekii, Borrelia recurrentis* and *Treponema pallidum*

Unit 4: Parasitic Protozoa 8
Life history and pathogenicity of *Entamoeba histolytica, Plasmodium vivax* and *Trypanosoma gambiense*

Unit 5: Parasitic Helminthes 5
Life history and pathogenicity of *Ancylostoma duodenale* and *Wuchereria bancrofti*

Unit 6: Insects of Economic Importance 8
Biology, Control and damage caused by *Helicoverpa armigera*, *Pyrilla perpusilla* and *Papilio demoleus, Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*

Unit 7: Insects of Medical Importance 8
Medical importance and control of *Pediculus humanus corporis*, *Anopheles, Culex, Aedes, Xenopsylla cheopis*

Unit 8: Animal Husbandry 5
Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle

Unit 9: Poultry Farming 5
Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs

Unit 10: Fish Technology 5

Genetic improvements in aquaculture industry; Induced breeding and transportation of fish seed

APPLIED ZOOLOGY
ZOOL 301 (A) PR

PRACTICAL   (CREDITS 2)

1.Study of *Plasmodium vivax*, *Entamoeba histolytica*, *Trypanosoma gambiense, Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.

2.Study of arthropod vectors associated with human diseases: *Pediculus, Culex, Anopheles, Aedes* and *Xenopsylla.*

3.Study of insect damage to different plant parts/stored grains through damaged products/photographs.

4.Identifying feature and economic importance of *Helicoverpa* (*Heliothis*) *armigera*, *Papilio demoleus*, *Pyrilla perpusilla, Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*

5.Visit to poultry farm or animal breeding centre. Submission of visit report

6.Maintenance of freshwater aquarium

SUGGESTED READINGS

Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers. ꙮ

Arora, D. R and Arora, B. (2001). *Medical Parasitology*. II Edition. CBS Publications and Distributors. ꙮ

Kumar and Corton. *Pathological Basis of Diseases*. ꙮ

Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani ꙮ

Publishers. Dennis, H. (2009). *Agricultural Entomology.* Timber Press (OR). ꙮ

Hafez, E. S. E. (1962). *Reproduction in Farm Animals*. Lea & Fabiger Publisher ꙮ

Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approache*s. CABI publications, U.K. ꙮ

Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall. ꙮ

DISCIPLINE CENTRIC ELECTIVE COURSES
DSE 1 ANIMAL BIOTECHNOLOGY
ZOOL 301(B) TH

THEORY (Credits 4)

Unit 1: Introduction 8

Concept and scope of biotechnology
Unit 2: Molecular Techniques in Gene manipulation
 Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics)
 Restriction enzymes: Nomenclature, detailed study of Type II.
Transformation techniques: Calcium chloride method and electroporation.
 Construction of genomic and cDNA libraries and screening by colony and plaque hybridization Southern, Northern and Western blotting; DNA sequencing: Sanger method Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

Unit 3: Genetically Modified Organisms 18

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection

 Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice.

Production of transgenic plants: *Agrobacterium* mediated transformation.

Applications of transgenic plants: insect and herbicide resistant plants.

Unit 4: Culture Techniques and Applications 10

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)
 Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy

ANIMAL BIOTECHNOLOGY
ZOOL 301(B) PR

PRACTICAL

1. Genomic DNA isolation from *E. coli*

2. Plasmid DNA isolation (pUC 18/19) from *E. coli*

3. Restriction digestion of plasmid DNA.

4. Construction of circular and linear restriction map from the data provided.

5. Calculation of transformation efficiency from the data provided.

6. To study following techniques through photographs

    a) Southern Blotting

    b) Northern Blotting

    c) Western Blotting

    d) DNA Sequencing (Sanger's Method)

    e) PCR

    f) DNA fingerprinting

7. Project report on animal cell culture

SUGGESTED READINGS

- Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis*. II Edition, Academic Press, California, USA.
- Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
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- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). ☐ *An Introduction to Genetic Analysis*. IX Edition. Freeman and Co., N.Y., USA. ☐

- Snustad, D.P. and Simmons, M.J. (2009). *Principles of Genetics.* V Edition, John Wiley and Sons Inc. ☐

Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). *Recombinant DNA-*

☐ *Genes and Genomes- A Short Course*. III Edition, Freeman and Co., N.Y., USA. ☐

- Beauchamp, T.I. and Childress, J.F. (2008). *Principles of Biomedical Ethics.* VI Edition, Oxford University Press. ☐

DCE 1 AQUATIC BIOLOGY
ZOOL 301(C) TH

THEORY (Credits 4)

UNIT 1: Aquatic Biomes   15

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT 2: Freshwater Biology   20

Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico–chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.

Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

UNIT 3: Marine Biology   10

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

UNIT 4: Management of Aquatic Resources   15

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

ZOOL 301 (C) PR PRACTICAL   (Credits 2)

1.Determine the area of a lake using graphimetric and gravimetric method.

2.Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.

3.Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.

4.Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.

5.A Project Report on a visit to a Sewage treatment plant/Marine bioreserve/Fisheries Institutes.

SUGGESTED READINGS

Anathakrishnan : Bioresources Ecology 3rd Edition

Goldman : Limnology, 2nd Edition

Odum and Barrett : Fundamentals of Ecology, 5th Edition

Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1st Edition
Wetzel : Limnology, 3rd edition

Trivedi and Goyal : Chemical and biological methods for water pollution studies
Welch : Limnology Vols. I-II

DSE II
INSECT, VECTORS AND DISEASES
ZOOL 302 (A) TH
THEORY   **(Credits 4)**

Unit I: Introduction to Insects   6

General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits

Unit II: Concept of Vectors 6

Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity

Unit III: Insects as Vectors   8

Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

Unit IV: Dipteran as Disease Vectors   24

Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies;

Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes

Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly

Study of house fly as important mechanical vector, Myiasis, Control of house fly

Unit IV: Siphonaptera as Disease Vectors   6

Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases –Plague, Typhus fever; Control of fleas

Unit V: Siphunculata as Disease Vectors 4

Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Vagabond's disease, Phthiriasis; Control of human louse

Unit VI: Hempitera as Disease Vectors 6

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

INSECT VECTORS AND DISEASES
ZOOL 302(A) PR

PRACTICAL **(CREDITS 2)**

1. Study of different kinds of mouth parts of insects

2.Study of following insect vectors through permanent slides/ photographs: *Aedes, Culex, Anopheles*, *Pediculus humanus capitis, Pediculus humanus corporis, Phithirus pubis, Xenopsylla cheopis, Cimex lectularius, Phlebotomus argentipes, Musca domestica,* through permanent slides/ photographs

3. Study of different diseases transmitted by above insect vectors

Submission of a project report on any one of the insect vectors and disease transmitted

SUGGESTED READINGS

Imms, A.D. (1977). *A General Text Book of Entomology*. Chapman & Hall, UK

Chapman, R.F. (1998). *The Insects: Structure and Function.* IV Edition, Cambridge University Press, UK

Pedigo L.P. (2002). *Entomology and Pest Management.* Prentice Hall Publication

Mathews, G. (2011). *Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases*. Wiley-Blackwell

DSE II   IMMUNOLOGY
ZOOL 302 (B) TH
THEORY   **(CREDITS 4)**

Unit 1 : **Overview of the Immune System**   **10**
Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system

Unit 2 : **Cells and Organs of the Immune System**   **8**
Haematopoeisis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system

Unit 3: Antigens   **8**
Basic properties of antigens, B and T cell epitopes, haptens and adjuvants

Unit 4   : Antibodies   **8**
Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis

Unit 5 : **Working of the immune system**   **12**
Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Basic properties and functions of cytokines, Complement system: Components and pathways.

Unit 6 : **Immune system in health and disease**   **10**
Gell and Coombs' classification and brief description of various types of hypersensitivities, Introduction to concepts of autoimmunity and immunodeficiency,

Unit 7: Vaccines   **4**

General introduction to vaccines, Various types of vaccines

IMMUNOLOGY
ZOOL 302 PR
PRACTICAL   **(CREDITS 2)**

  1*. Demonstration of lymphoid organs

2. Histological study of spleen, thymus and lymph nodes through slides/ photographs

2 . Preparation of stained blood film to study various types of blood cells.

4.Ouchterlony's double immuno-diffusion method.

5 ABO blood group determination.

6 Cell counting and viability test from splenocytes of farm bred animals/cell lines.

7Demonstration of   a) EISA   b) Immunoelectrophoresis

(*Subject to UGC guidelines)

SUGGESTED READINGS

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.

- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology,* VII Edition, Mosby, Elsevier Publication.

- Abbas, K. Abul and Lechtman H. Andrew (2003.) *Cellular and Molecular Immunology.* V Edition. Saunders Publication.

DSE II REPRODUCTIVE BIOLOGY

ZOOL 302 (C) TH

THEORY   (CREDITS 4)

Unit 1: Reproductive Endocrinology   15

Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation.

Unit 2: Functional anatomy of male reproduction   **15**

Outline and histological of male reproductive system in rat and human; Testis: Cellular functions, germ cell, system cell renewal; Spermatogenesis: kinetics and hormonal regulation; Androgen synthesis and metabolism; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract

Unit 3: Functional anatomy of female reproduction   **20**

Outline and histological of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

Unit 4: Reproductive Health   **10**

Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning

<div align="center">

REPRODUCTIVE BIOLOGY
ZOOL 302(C) PR

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PRACTICAL   **(CREDITS 2)**

1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.

2. Examination of vaginal smear rats from live animals.

3. Surgical techniques: principles of surgery in endocrinology. Ovarectomy, hysterectorny, castration and vasectomy in rats.

4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems;
   Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.

5. Human vaginal exfoliate cytology.

6. Sperm count and sperm motility in rat

7. Study of modern contraceptive devices

SUGGESTED READINGS

•   Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press.

- Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company.

- Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.

- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

SKILL ENHANCEMENT COURSES
Biofertilizers (BOTA 203)

(Credits 4)   Lectures: 45

SECTION A

Unit 1: Fertilizers:

Introduction, Types of fertilizers and their advantages and disadvantages, Brief account of microbes used as biofertilizer, Marketable forms of biofertilizers.   **(5 Lectures)**

Unit 2. *Rhizobium*: General account, Isolation, Identification, Mass multiplication, Carrier based inoculants, Application, Crop response   **(5 Lectures)**

Unit 3. Actinorrhizal Symbiosis- *Frankia*, Host-microsymbiont relationship, Isolation, Culture, Application and Advantages   **(2 Lectures)**

SECTION B

Unit 4: *Azospirillum:* Isolation and mass multiplication, Carrier based inoculant, Crop response **(4 Lectures)**

Unit 5: *Azotobacter*: Characteristics, Isolation and mass multiplication, Application and Crop response.   **(4 Lectures)**

Unit 6: Phosphate Solubilizing Organisms (Microorganism): Introduction, Isolation, Culture and Applications.   **(3 Lectures)**

SECTION C

Unit 7: Cyanobacteria (Blue Green Algae): *Azolla* and *Anabaena azollae* association, Nitrogen fixation, Factors affecting growth, Blue green algae and *Azolla* in rice cultivation. **(6 Lectures)**

Unit 8: Mycorrhizal Association: Types of mycorrhizal association, Taxonomy, Occurrence and distribution, Phosphorus nutrition, Growth and yield; VAM – Isolation and inoculum production, Influence on growth and yield of crop plants.

(6 Lectures)

SECTION D

Unit 9: Organic Farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes; Biocompost making methods, Types and method of vermicomposting, field Application.   **(10 Lectures)**

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S. Chand& Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Thakur, A.K., Bassi, S.K. and Singh, K.J. 2017. Biofertilizers. S. Dinesh & Co., Jalandhar.
7. Vayas, S.C, Vayas, S. and Modi, H.A. 1998. Biofertilizers and Organic Farming Akta Prakashan, Nadiad

Gardening and Floriculture

(BOTA 204)

(Credits 4)   **Lectures: 45**

SECTION A

Unit 1: Landscape Gardening and Floriculture: Definitions of Landscape Gardening and Floriculture, history of gardening, importance, status and scope of Floriculture and Landscaping; landscaping   of homes, educational institutions, highways and public parks.   **(6 Lectures)**

Unit 2: Gardening operations: Soil laying, Manuring, Watering, Management of pests and diseases; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Mulching; Pruning, Topiary making.   (**4 Lectures)**

SECTION B

Unit 3: Garden Designs, Principles, Types and Features:

Principles and Elements of Garden Designs, Formal and Informal gardens, English, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Rock garden, Water garden. Some Famous gardens of India.

                                                                                 (7 Lectures)Unit

4: Propagation of Garden Plants: Sexual and vegetative methods of propagation; Role of plant growth regulators.   **(5 Lectures)**

SECTION C

Unit 5: Ornamental Plants: Flowering annuals; Herbaceous perennials; Shrubs, Climbers; Ornamental trees; Ornamental bulbous plants; Palms and Cycads; Potted plants and indoor gardening; Bonsai.   (**10 Lectures)**

SECTION D

Unit 6: Commercial Floriculture: Factors affecting growth and flower production of ornamentals; Cultivation of Important flower crops (Carnation, Chrysanthemum, Gerbera, Gladiolus, Marigold, Rose, Lilium) (**9 Lectures)**

Unit 7. Post Harvest Management: Post- harvest handling of important flower crops, methods to prolong vase life, packaging, storage and transport of flower crops, Flower arrangements and other floral crafts.   (**4 lectures)**

Suggested Readings

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.

2. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.

3. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

4. Hartmann and Kester, 2010. Plant Propagation: Principles and Practices. Pearson Publisher.

5. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

6. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.

7. Thakur, A.K., Kashyap, B., Bassi, S.K. and Sharma, M. 2018. Floriculture. S. Dinesh & Co., Jalandhar.

Medicinal Botany and Ethnobotany

(BOTA 306)

(Credits 4)   **Lectures 45**

SECTION A

Unit 1: Traditional Systems of Medicine:

Brief history of use of medicinal herbs; Introduction to indigenous systems of medicines- Ayurveda, Unani and Siddha system of medicine.   **(5 Lectures)**

Unit 2: Ethnobotany:

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles.   (**5 Lectures**)

SECTION B

Unit 3: **Plants Used by the Tribals:** a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses. d Sacred plants   **(4 Lectures)**

Unit 4: Methodology of Ethnobotanical Studies: a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places. **(7 Lectures)**

SECTION C

Unit 5: Role of ethnobotany in modern Medicine

Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b)*Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina, Taxus wallichiana, Trichopus zeylanicus, Artemisia, Withania*.

(13 Lectures)

SECTION D

Unit 6: Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management). **(3 Lectures)**

Unit 7: Ethnobotany and Legal Aspects: Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge. (**8 Lectures**)

Suggested Readings

1. Abdin, M.Z. and Y.P. Abrol, Y.P. 2006. Traditional Systems of Medicine. Narosa Publishing House, New Delhi.

2. Balick, M.J. and Cox, P.A. 1996. Plants, People and Culture: The Science of Ethnobotany. Scientific American Library.

3. Bera, S., Mukherji , D. and D'Rozario, A. 2004. A Hand Book of Ethnobotany. Kalyani Publishers.

4. Colton C.M. 1997. Ethnobotany: Principles and Applications. John Wiley and Sons.

5. Jain, S.K. (ed.) 1981. Glimpses of Indian. Ethnobotany. Oxford and I B H, New Delhi.

6. Jain, S.K. (ed.). 1989. Methods and Approaches in Ethnobotany. Society of Ethnobotanists, Lucknow.

7. Jain, S.K. 1990. Contributions to Indian Ethnobotany. Scientific publishers, Jodhpur.

8. Jain, S.K. 1995. Manual of Ethnobotany, Scientific Publishers, Jodhpur

9. Martin, G.J. 2008. Ethnobotany: A Methods Manual. Chapman and Hall

Mushroom Cultivation Technology
(BOTA 307)

(Credits 4)   **Lectures: 45**

SECTION A

Unit 1: Introduction, history. Nutritional and medicinal value of edible mushrooms; Nutrition and nutraceuticals – Proteins, amino acids, mineral elements nutrition, carbohydrates, crude fibre content , vitamins; Poisonous mushrooms.   **(10 Lectures)**

SECTION B

Unit 2: Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag,vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, Sterilization, Preparation of spawn, Multiplication.   **(12 Lectures)**

SECTION C

Unit 3: Cultivation practices of *Agaricus bisporus*, *Pleurotus* sp. and *Volvoriella volvacea*. Composting technology in mushroom production, Low cost technology, Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation.   **(12 Lectures)**

SECTION D

Unit 4: Storage: Short-term storage (Refrigeration - upto 24 hours) Long termStorage
(canning, pickels, papads), drying, storage in salt solutions.   **(4 Lectures)**

Unit 5: Food Preparation: Types of foods prepared from mushroom. Research Centres -National level and Regional level. Cost benefit ratio - Marketing in India and abroad,
Export Value   **(4 Lectures)**
Unit: 6 Diseases and Pests of Mushrooms   **(3 Lectures)**

Suggested Readings

1.   Biswas, S., Datta, M. and Ngachan, S.V. 2012. Mushrooms: A Manual for Cultivation. PHI Learning Private Limited, New Delhi.

2. Kapoor, J.N. 2010. Mushroom Cultivation. ICAR, New Delhi.

3. Nita Bahl (2000) Hand book of Mushrooms. Oxford & IBH Publishing Co. Pvt. Ltd.

4. Singh, M., Vijay, B., Kamal, S. and Wakchaure (Eds.) 2011. Mushrooms: Cultivation, Marketting and Consumption. Directi\orate of Mushroom Reseaerch (ICAR), Solan

5. Tewari, Pankaj and Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.

SKILL ENHANCEMENT COURSES

Zoology
SEC 1 MEDICAL DIAGNOSTICS
Code: ZOOL 203 TH

THEORY   **(Credits 4)**

Unit 1: Introduction to Medical Diagnostics and its Importance   **2**

Unit 2: Diagnostics Methods Used for Analysis of Blood   **15**

Blood composition, Preparation of blood smear and Differential Leucocyte
Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer,
Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)

Unit 3: Diagnostic Methods Used for Urine Analysis   **6**
Urine Analysis: Physical characteristics; Abnormal constituents

Unit 4:Non -infectious Diseases   **10**
Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I
and Type II), Hypertension (Primary and secondary), Testing of blood glucose using
Glucometer/Kit

Unit 5: Infectious Diseases   **6**
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis

Unit 6: Tumours   **6**
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone
fracture, PET, MRI and CT Scan (using photographs).

SUGGESTED READINGS

Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers ⬚

- Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, ⬚ II Edition, Bhalani Publishing House ⬚

- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A*

⬚   *Basis for Training Courses* ⬚

- Guyton A.C. and Hall J.E. T*extbook of Medical Physiology*, Saunders ⬚

- Robbins and Cortan, *Pathologic Basis of Disease*, VIIIEdition, Saunders ⬚

- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd. ⬚

Skill Enhancement Course II Zoology
Apiculture   ZOOL 204 TH   (CREDITS 4)

Unit 1: Biology of Bees   **(10)**
History, Classification and Biology of Honey Bees
Social Organization of Bee Colony

Unit 2: Rearing of Bees   **(15)**
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth
Bee Pasturage
Selection of Bee Species for Apiculture
Bee Keeping Equipment
Methods of Extraction of Honey (Indigenous and Modern)

Unit 3: Diseases and Enemies   **(8)**
Bee Diseases and Enemies
Control and Preventive measures

Unit 4: Bee Economy   (6)
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

Unit 5: Entrepreneurship in Apiculture   (6)
Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

SUGGESTED READINGS

- Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.

- Bisht D.S., *Apiculture*, ICAR Publication.

Singh S., *Beekeeping in India*, Indian council of Agricultural Research, NewDelhi.

SEC - III

SERICULTURE
Code: ZOOL 303 TH   (CREDITS 4)

Unit 1: Introduction   **(8)**

Sericulture: Definition, history and present status; Silk route
Types of silkworms, Distribution and Races
Exotic and indigenous races
Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm   **(6)**
Life cycle of *Bombyx mori*
Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms   **(15)**
Selection of mulberry variety and establishment of mulberry garden
Rearing house and rearing appliances
Disinfectants: Formalin, bleaching powder, RKO
Silkworm rearing technology: Early age and Late age rearing
Types of mountages
Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases   **(10)**
Pests of silkworm: Uzi fly, dermestid beetles and vertebrates
Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial
Control and prevention of pests and diseases

Unit 5: Entrepreneurship in Sericulture   **(6)**
Prospectus of Sericulture in India: Sericulture industry in different states,
employment, potential in mulberry and non-mulberry sericulture. Visit to various
sericulture centres.

SUGGESTED READINGS

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore. ⬚ ⬚ Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi

⬚   Pub. Co. Ltd., Tokyo, Japan1972. ⬚

- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988. ⬚
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988. ⬚
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989. ⬚
- Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986. ⬚

Skill Enhancement Course Zoology
AQUARIUM FISH KEEPING
ZOOL 304 (A) TH
(CREDITS 4)

Unit1: Introduction to Aquarium Fish Keeping   **10**

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic andEndemic species of Aquarium Fishes

Unit 2: Biology of Aquarium Fishes   **15**

Common characters and sexual dimorphism of Fresh water and Marine Aquariumfishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes   **6**

Use of live fish feed organisms. Preparation and composition of formulated fish feeds

Unit 4: Fish Transportation   8

Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium   **6**

General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

SUGGESTED READINGS

Mary Bailey, Gina Sandford; *The Complete Guide to Aquarium Fish Keeping (Practical Handbook)* Publishers: Lorenz Books

- Mills, Dick; *Keeping Aquarium Fish (Teach Yourself General)* Publisher : Teach Yourself

OR
RESEARCH METHODOLOGY
ZOOL 304 (B)TH

CREDITS 4

Unit 1: Foundations of Research   **5**

Meaning, Objectives, Motivation: Research Methods *vs* Methodology, Types of Research: Analytical *vs* Descriptive, Quantitative *vs* Qualitative, Basic *vs* Applied

Unit 2: Research Design   **8**

Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

Unit 3: Data Collection, Analysis and Report Writing   **12**

Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology

Unit 4: Ethical Issues   **5**

Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

SUGGESTED READINGS

Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.

- Walliman, N. 2011.Research Methods- The Basics. Taylor and Francis, London, New York.
- Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing
- C.R.Kothari: Research Methodology, New Age International, 2009 Coley, S.M. and Scheinberg, C.A. 1990, "Proposal writing". Stage Publications

END SEMESTER EXAMINATION (ESE) OF LIFESCIENCES IN B.Sc. PROGRAMME
THEORY EXAMINATION
SCHEME OF EXAMINATION

1. English shall be the medium of instruction and examination.
2. Examinations shall be conducted at the end of each semester as per the Academic Calendar notified by Himachal Pradesh University.
3. Each course will carry **100 marks** and will have following components

1.	**Theory Paper End-Semester examination**	**50 Marks**
2.	**Practicals**	**20 Marks**
3.	**Internal Assessment**	**30 Marks**

Theory Paper + Practicals + Internal Assessment   **(50+20+ 30) =100 Marks**

Distribution of Internal Assessment /CCA:

(i)   Class Attendance = 5 Marks
(ii)   Class test to be taken on completion of 40% syllabus by the class teacher   = 5 Marks
(iii)   House test to be taken on completion of 75 % of Syllabus   = 10 Marks
(iv)   Assignment, tutorials, general behavior of students   = 10 Marks

Marks for Class attendance

☐ 75% but < 80%	1 marks
☐ 80% but <85%	2 marks
☐ 85 but <90%	3 marks
☐ 90% but < 95%	4 marks
☐ 95% To 100%	5 marks

Scheme of Examination for every course (Core Course, Discipline Specific Elective Course, Generic Elective Course):

End Semester Examination	50 Marks	Time 3 hrs
Practical for every course	20 Marks	Time 3 hrs
Internal Assessment	30 Marks	

Skill Enhancement Course & Ability Enhancement Compulsory Course: 100 Marks

Skill Enhancement Course = 100 Marks   (Theory 70 + CCA 30)

Ability Enhancement Compulsory Course 1. Environment Science = 100 Marks 2. English/Hindi/SKT = 100 Marks (Theory 70 +CCA 30)

Instructions for Setting of Question Papers

I. Discipline Specific Courses and Discipline Specific Electives (Theory Papers)   **Max Marks: 50**

1. Each question paper will contain 9 questions (divided into five parts A, B, C, D and E) of 10 marks each.
2. Question number 1 in Part A will be compulsory and will contain ten fill in the blanks, multiple choice questions, definitions or terms of one mark each.
3. Rest of the eight questions will be divided into four Parts (B, C, D and E containing questions from Section A, B, C and D of the syllabus) with each Part containing two questions. Students will be required to attempt only one question from each Part. Each question may be divided into 2 parts.
4. Questions should be taken from the whole syllabus.

II. Skill Enhancement Courses (SEC)   **Max Marks: 70**

1. Each question paper will contain 9 questions (divided into five Parts- A, B, C, D and E) of 14 marks each.
2. Question number 1 in Part A will be compulsory and will contain ten fill in the blanks, multiple choice questions, definitions or terms of one mark each.
3. Rest of the eight questions will be divided into four Parts (B, C, D and E containing questions from Section A, B, C and D of the syllabus) with each Part containing two questions. Students will be required to attempt only one question from each Part.
4. Questions should be taken from the whole syllabus.

Himachal Pradesh University

Summer Hill, Shimla-171005

Syllabus and Scheme of Examination

For

B. Sc. Physical Sciences

(Physics, Chemistry & Mathematics)

&

B.Sc. Physical Sciences

(Physics, Computer Science & Mathematics)

&

B. Sc. with Mathematics

&

B.A. with Mathematics

Courses

under the

Choice Based Credit System

(ANNUAL SYSTEM) *w.e.f.*

Session   2018 -19 onwards

Details of Courses Under B.Sc. Physical Sciences (Physics, Chemistry/Computer Science, Mathematics)

Course	*Credits	
	Theory+ Practical	Theory +Tutorials
I. Core Course	12X4= 48	12X5=60
(12 Papers)		
04 Courses from each of the 03 disciplines of choice		
Core Course Practical / Tutorial*	12X2=24	12X1=12
(12 Practical/ Tutorials*)		
04 Courses from each of the 03 Disciplines of choice		
II. Discipline Specific Course Elective Course	6x4=24	6X5=30
(6 Papers)		
Two papers from each discipline of choice including paper of interdisciplinary nature.		
Discipline Specific Course Practical / Tutorials*	6 X 2=12	6X1=6
(6 Practical / Tutorials*)		
Two Papers from each discipline of choice including paper of interdisciplinary nature		

• **Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 3rd year**

•

III. Ability Enhancement Courses

1**. Ability Enhancement Compulsory** 2 X 4=8   2X4=8

(2 Papers of 4 credits each)
Environmental Science English/MIL Communication

2**. Skill Enhancement Course**   4 X 4=16 4 X 4=16

(Skill Based)

(4 Papers of 4 credits each)

        _____ _____

        Total credit= 132 **Total credit= 132**

College should evolve a system/policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.

*wherever there is practical there will be no tutorials and vice –versa.

Details of Courses under B.Sc. with Mathematics

Course	*Credits	
	Theory + Practical	**Theory + Tutorials**
I. Core Course	$12\times4 = 48$	$12\times5 = 60$
(12 Papers) 04 Courses from each of the 03 disciplines of choice		
Core Course Practical / Tutorial*	$12\times2 = 24$	$12\times1 = 12$

(12 Practical/ Tutorials*)

04 Courses from each of the
03 Disciplines of choice

II. Elective Course	$6\times4 = 24$	$6\times5 = 30$
(6 Papers)		
Two papers from each discipline of choice including paper of interdisciplinary nature.		
Elective Course Practical / Tutorials*	$6\times2 = 12$	$6\times1 = 6$

(6 Practical / Tutorials*)
Two Papers from each discipline of choice
 including paper of interdisciplinary nature

• **Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 3rd Year**

III. Ability Enhancement Courses		
1.**Ability Enhancement Compulsory**	$2\times4 = 8$	$2\times4 = 8$
(2 Papers of 4 credits each) **Environmental Science English/MIL Communication**		
2. **Skill Enhancement Course**	$4\times4 = 16$	$4\times4 = 16$
(Skill Based) (4 Papers of 4 credits each)		
	Total credit = 132	**Total credit = 132**

*wherever there is practical there will be no tutorials and vice -versa

Details of Courses under B.A. with Mathematics

Course		*Credits
	Theory + Practical	**Theory + Tutorials**
I. Core Course	12×4 = 48	12×5 = 60

   (12 Papers)
   Two Papers- English
   Two Papers- MIL
   Four Papers- Discipline 1 specific
   Four Papers- Discipline 2 specific

Core Course Practical / Tutorial*	12×2 = 24	12×1 = 12
(12 **Practical/Tutorials***)		
II. Elective Course	6×4 = 24	6×5 = 30

 (6 Papers)
 Two papers –Discipline 1 specific
 Two papers –Discipline 2 specific
 Two papers – Generic Elective (Interdisciplinary)

Two Papers from each discipline of choice and
*Two Papers of Interdisciplinary nature.(**GE**)*

Elective Course Practical / Tutorials*	6×2 =12	6x1=6

(6 Practical / Tutorials*)
Two papers –Discipline 1 specific
Two papers –Discipline 2 specific
Two papers – Generic Elective (Interdisciplinary)

Two Papers from each discipline of choice
including paper of interdisciplinary nature

  III.   Ability Enhancement Courses

1. Ability Enhancement Compulsory Courses(AECC)	2×4 = 8	2×4 = 8

(2 Papers of 4 credits each)
Environmental Science
English/MIL Communication

2. **Skill Enhancement Course(SEC)   4×4 = 16**   **4×4 = 16**
   (4 Papers of 4 credits each)
   _____   _____

                       Total credit = 132   **Total credit = 132**

*wherever there is practical there will be no tutorials and vice −versa

Scheme for Choice Based Credit System (CBCS) in Bachelor of Science Physical Science and Bachelor of Science with Mathematics Annual Pattern

Year	Core Course (12)	Ability Enhancement Compulsory Course AECC (2)	Skill Enhancement Courses SEC (4)	Elective Course Discipline Specific Elective DSE (6)	Total Credits
I	DSC-1A = 6 Credit DSC-1B = 6 Credit DSC-2A = 6 Credit DSC-2B = 6 Credit DSC-3A = 6 Credit DSC-3B = 6 Credit **Credits = 36**	Eng/MIL Communi/EVS = 4 Credit Eng/MIL Communi/EVS = 4 Credit **Credits = 08**	NIL	NIL	**44**
II	DSC-1C = 6 Credit DSC-1D = 6 Credit DSC-2C = 6 Credit DSC-2D = 6 Credit DSC-3C = 6 Credit DSC-3D = 6 Credit **Credits = 36**	NIL	SEC-1 = 4 Credit SEC-2 = 4 Credit **Credits = 08**	NIL	**44**
III	NIL	NIL	SEC-3 = 4 Credit SEC-4 = 4 Credit **Credits = 08**	DSE-1A = 6 Credit DSE-1B = 6 Credit DSE-2A = 6 Credit DSE-2B = 6 Credit DSE-3A = 6 Credit DSE-3B = 6 Credit **Credits = 36**	**44**
Total Credits in B.Sc. Physical Science and B.Sc. with Mathematics Degree Courses = 44 × 3					**132**

Credits Split:

Theory = 04   **Theory = 05**

Practical = 02   **Tutorial = 01**

For SEC:

Theory = 03

Skill Exam (SE) = 01

Scheme for Choice Based Credit System (CBCS) in Bachelor of Science Physical Science and Bachelor of Arts with Mathematics Annual Pattern

Year	Core Course (12)	Ability Enhancement Compulsory Course AECC (2)	Skill Enhancement Courses SEC (4)	Elective Course Discipline Specific Elective DSE (6)	Generic Elective (GE)	Total Credits
I	Eng-1 = 6 Credit Skt/Hindi-1 = 6 Credit DSC-1A = 6 Credit DSC-1B = 6 Credit DSC-2A = 6 Credit DSC-2B = 6 Credit **Credits = 36**	Env. Studies = 4 Credit Hindi/Eng/Skt = 4 Credit **Credits = 08**	NIL	NIL	NIL	44
II	Eng-2 = 6 Credit Skt/Hindi-2 = 6 Credit DSC-1C = 6 Credit DSC-1D = 6 Credit DSC-2C = 6 Credit DSC-2D = 6 Credit **Credits = 36**	NIL	SEC-1 = 4 Credit SEC-2 = 4 Credit **Credits = 08**	NIL	NIL	44
III	NIL	NIL	SEC-3 = 4 Credit SEC-4 = 4 Credit **Credits = 08**	DSE-1A = 6 Credit DSE-1B = 6 Credit DSE-2A = 6 Credit DSE-2B = 6 Credit **Credits = 24**	GE-1 =6 Credit GE-2 =6 Credit **Credits = 12**	44
				Total Credits in B.A Degree Courses = 44 × 3		**132**

Credits Split:

Theory = 04   Theory = 05

Practical = 02   Tutorial = 01

For SEC:

Theory = 03,   Skill Exam (SE) = 01

Details of CBCS Scheme for Undergraduate Three Year Degree Course: B.Sc. Physical Science and B.Sc. with Mathematics: Teaching Hours and Credits Plan in Annual System for Three years

S. No.	Name of Course (6 Credits)	Teaching Hrs.		Credits as per annual Plan				
				Non Practical Course (2Weeks Teaching Hours)		Practical Course (2Weeks Teaching Hours)		Total Credits in a Year
1	Core Courses (12)	1st Week	2nd Week	Theory	Tutorial	Theory	Practical	
a	Discipline Specific Courses (4+4+4 =12)							
i	DSC-1A	03	06	05	01	04	02	06
	DSC-1B	03	06	05	01	04	02	06
	DSC-1C	03	06	05	01	04	02	06
	DCS-1D	03	06	05	01	04	02	06
ii	DSC-2A	03	06	05	01	04	02	06
	DSC-2B	03	06	05	01	04	02	06
	DSC-2C	03	06	05	01	04	02	06
	DCS-2D	03	06	05	01	04	02	06
iii	DSC-3A	03	06	05	01	04	02	06
	DSC-3B	03	06	05	01	04	02	06
	DSC-3C	03	06	05	01	04	02	06
	DCS-3D	03	06	05	01	04	02	06
	Total Credits of Core Courses							**72**
2	Ability Enhancement Courses (6)							
a	Ability Enhancement Compulsory Courses (2)							
i	Eng/MIL Communication/EVS	02	04	03	01	--	--	04
	Eng/MIL Communication/EVS	02	04	03	01	--	--	04
	Total Credits of Ability Enhancement Compulsory Courses (AECC)							**08**
b	Skill Enhancement Courses (4)					Theory	Practical Skill Exam	
	SEC-1	02	04	04	--	03	01	04
	SEC-2	02	04	04	--	03	01	04
	SEC-3	02	04	04	--	03	01	04
	SEC-4	02	04	04	--	03	01	04
	Total Credits of Skill Enhancement Courses (SEC)							**16**

							Theory	Practical	
	Total Credits of Ability Enhancement Courses (AEC) = 08 + 16								**24**
3	**Elective Courses (6)**								
a	**Discipline Specific Elective Courses**						Theory	Practical	
i	DSE-1A	03	06	05	01		04	02	06
	DSE-1B	03	06	05	01		04	02	06
	DSE-2A	03	06	05	01		04	02	06
	DSE-2B	03	06	05	01		04	02	06
	DSE-3A	03	06	05	01		04	02	06
	DSE-3B	03	06	05	01		04	02	06
Total Credits of Discipline Specific Elective (DSE) Courses									**36**
Grand Total Credits in Three Year Degree Course: B.Sc. Physical Science and B.Sc. with Mathematics: 72 + 24 +36									**132**

Annual Examination (A.E.) and Internal Assessment (I.A.) Scheme of Three years Degree of

B.Sc. Physical Sciences/ B.Sc. Mathematics /B.A Mathematics

Scheme for Examination for each course

⑩ The medium of instructions and Examinations shall be English only.

⑩ AE & Practical Examinations shall be conducted at the end of each year as per the Academic Calendar notified by H.P. University, Shimla-5, time to time.

⑩ Each course of 4/6 credits (theory + Practicals) will carry 100 marks and will have following components:

(FOR COURSES WITHOUT PRACTICALS)

I.	Theory	marks
	Annual Examination (AE)	70 marks
II.	Internal Assessment (IA)	30 marks
	a) Assignment/Class Test/Quiz/Seminar/Model	10 marks
	a) Mid-Term Examination (One Test)	15 marks
	b) Attendance	05

(FOR COURSES WITH PRACTICALS)

III.	Theory	marks
	Annual Examination (AE)	50 marks
IV.	Internal Assessment (IA)	30 marks
	a) Assignment/Class Test/Quiz/Seminar/Model	10 marks
	c) Mid-Term Examination (One Test)	15 marks
	d) Attendance	05

V.   Practical   20 marks

❖ **Minimum Pass Percentage in each component (AE, IA & Practical) shall be 40%, separately**

❖ **Criterion for Class-room attendance (05 marks)**

   75% Attendance is minimum eligibility condition.

i)   **Attendance 75% to 80% 1 mark**
ii)   **Attendance above 80% to 85% 2 marks**
iii)   **Attendance above 85% to 90% 3 marks**
iv)   **Attendance above 90% to 95% 4 marks**
 v)   **Attendance above 95%   5 marks**

HIMACHAL PRADESH UNIVERSITY
SYLLABUS AND SCHEME OF EXAMINATIONFOR B.SC. PHYSICAL SCIENCE
(PHYSICS, CHEMISTRY AND MATHEMATICS) W.E.F. 2018-19

Year	Course Type	Course Code	Title of Paper	Credits
1	CORE COURSE-1	PHYS101TH PHYS101IA	MECHANICS THEORY	4
		PHYS101PR	MECHANICS LAB	2
	CORE COURSE-II	CHEM101TH CHEM101IA CHEM101PR	ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS	6
	CORE COURSE-III	MATH101TH MATH101IA	DIFFERENTIAL CALCULUS	6
	A.E.C. COURSE-I		ENVIRONMENTAL SCIENCE	4
	CORE COURSE-IV	PHYS102TH PHYS102IA	ELECTRICITY, MAGNETISIM AND EMT THEORY	4
		PHYS102PR	ELECTRICITY, MAGNETISIM AND EMT LAB	2
	CORE COURSE-V	CHEM102TH CHEM102IA CHEM102PR	STATES OF MATTER, CHEMICAL KINETICS & FUNCTIONAL ORGANIC CHEMISTRY	6
	CORE COURSE-VI	MATH102TH MATH102IA	DIFFERENTIAL EQUATIONS	6
	A.E.C. COURSE-II		ENGLISH/MIL COMMNICATION	4
II	CORE COURSE-VII	PHYS201TH PHYS201IA	STATISTICAL AND THERMAL PHYSICS THEORY	4
		PHYS201PR	STATISTICAL AND THERMAL PHYSICS LAB	2
	CORE COURSE-VIII	CHEM201TH CHEM201IA CHEM201PR	SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & ORAGANIC CHEMISTRY	6
	CORE COURSE-IX	MATH201TH MATH201IA	REAL ANALYSIS	6
	CORE COURSE-X	PHYS202TH PHYS202IA	WAVES AND OPTICS THEORY	4
		PHYS202PR	WAVES AND OPTICS LAB	2
	CORE COURSE-XI	CHEM202TH CHEM202IA CHEM202PR	CHEMISTRY OF MAIN GROUP ELEMENTS, CHEMICAL ENERGETICS AND EQUILIBRIA	6
	CORE COURSE-XII	MATH202TH MATH202IA	ALGEBRA	6
	SEC 1 (CHOOSE ANY ONE FROM GIVEN THREE)	PHYS203TH PHYS203IA	PHYSICS WORKSHOP SKILLS THEORY	3 + 1=4 (TH+IA=3 SE=1)
		PHYS203SE	PHYSICS WORKSHOP SKILLS SKILL EXAM	
		PHYS204TH PHYS204IA	COMPUTATIONAL PHYSICS THEORY	
		PHYS204SE	COMPUTATIONAL PHYSICS SKILL EXAM	

		PHYS205TH PHYS205IA	ELECTRICAL CIRCUITS AND NETWORK SKILL THEORY	
		PHYS205SE	ELECTRICAL CIRCUITS AND NETWORK SKILLS SKILL EXAM	
	SEC2 (CHOOSE ANY ONE FROM GIVEN TWO)	CHEM203TH CHEM203IA	BASIC ANALYTICAL CHEMISTRY	4
		CHEM204TH CHEM204IA	FUEL CHEMISTRY & CHEMISTRY OF COSMETICS & PERFUMES	
III	DISCIPLINE SPECIFIC ELECTIVES DSE:1A (CHOOSE ANY ONE FROM GIVEN THREE)	PHYS301TH PHYS301IA	ELEMENTS OF MODERN PHYSICS THEORY	4+2 =6 (TH+IA=4 PR=2)
		PHY301PR	ELEMENTS OF MODERN PHYSICS LAB	
		PHYS302TH PHYS302IA	SOLID STATE PHYSCS AND ELECTRONICS THEORY	
		PHYS302PR	SOLID STATE PHYSCS AND ELECTRONICS LAB	
		PHYS303TH PHYS303IA	ASTRONOMY AND ASTROPHYSICS THEORY	
		PHYS303TU	ASTRONOMY AND ASTROPHYSICS TUTORIALS	
	DISCIPLINE SPECIFIC ELECTIVES DSE:2A (CHOOSE ANY ONE FROM GIVEN THREE)	CHEM301TH CHEM301IA CHEM301PR	POLYNUCLEAR HYDROCARBONS DYES, HETROCYCLIC COMPOUNDS AND SPECTROSCOPY (UV, IR, NMR)	6
		CHEM302TH CHEM302IA CHEM302PR	INDUSTRIAL CHEMICALS AND ENVIRONMENT	
		CHEM303TH CHEM303IA CHEM303PR	QUANTUM CHEMISTRY, SPECTROSCOPY AND PHOTOCHEMISTRY	
	DISCIPLINE SPECIFIC ELECTIVE DSE:3A (CHOOSE ANY ONE FROM GIVEN THREE)	MATH301TH MATH301IA	MATRICES	4+2 =6 (TH+IA=6
		MATH302TH MATH302IA	MECHANICS	
		MATH303TH MATH303IA	LINEAR ALGEBRA	
	DISCIPLINE SPECIFIC ELECTIVES DSE: 1B (CHOOSE ANY ONE FROM GIVEN THREE)	PHYS304TH PHYS304IA	NUCLEAR AND PARTICLE PHYSICS THEORY	5+1 (TH+IA=5 TU=1) OR 4+2 (TH+IA=4 PR=2)
		PHYS304TU	NUCLEAR AND PARTICLE PHYSICS TUTORIALS	
		PHYS305TH PHYS305IA	QUANTUM MECHANICS THEORY	
		PHYS305PR	QUANTUM MECHANICS LAB	
		PHYS306TH PHYS306IA	PHYSICS OF DEVICES AND INSTRUMENTS THEORY	
		PHYS306PR	PHYSICS OF DEVICES AND INSTRUMENTS LAB	

DISCIPLINE SPECIFIC ELECTIVE DSE: 2B (CHOOSE ANY ONE FROM GIVEN THREE)	CHEM304TH CHEM304IA CHEM304PR	CHEMISTRY OF TRANSITION AND INNER TRANSITION ELEMENTS, COORDINATION CHEMISTRY, ORGANOMETTALICS, ACIDS AND BASES	6
	CHEM305TH CHEM305IA CHEM305PR	POLYMER CHEMISTRY	
	CHEM306TH CHEM306IA CHEM306PR	MOLECULES OF LIFE	
DISCIPLINE SPECIFIC ELECTIVE DSE: 3B (CHOOSE ANY ONE FROM GIVEN THREE)	MATH304TH MATH304IA	NUMERICAL METHODS	4+2 =6 (TH+IA=6
	MATH305TH MATH305IA	COMPLEX ANALYSIS	
	MATH306TH MATH306IA	LINEAR PROGRAMMING	
SKILL ENHANCEMENT COURSE SEC3 (CHOOSE ANY ONE FROM GIVEN TWELVE))	MATH307TH MATH307IA	LOGIC AND SETS	4
	MATH308TH MATH308IA	ANALYTIC GEOMETRY	
	MATH309TH MATH309IA	INTEGRAL CALCULUS	
	MATH310TH MATH310IA	VECTOR CALCULUS	
	MATH311TH MATH311IA	BOOLEAN ALGEBRA	
	MATH312TH MATH312IA	NUMBER THEORY	
	MATH313TH MATH313IA	PROBABILITY AND STATISTICS	
	MATH314TH MATH314IA	MATHEMATICAL FINANCE	
	MATH315TH MATH315IA	MATHEMATICAL MODELING	
	MATH316TH MATH316IA	THEORY OF EQUATIONS	
	MATH317TH MATH317IA	TRANSPORTATION AND GAME THEORY	
	MATH318TH MATH318IA	GRAPH THEORY	
SEC4 (IN CASE OF CHEMISTRY CHOSE ANY ONE FROM GIVEN TWO)	CHOOSE ONE COURSE OUT OF THE LIST OF SEC COURSES OF PHYSICS/MATHEMATICS, BUT NOT CHOSEN EARLIER IN SEC1 AND SEC3.		4
	CHEM307TH	CHEMICAL TECHNOLOGY & SOCIETY AND BUSINESS SKILLS FOR CHEMISTRY	
	CHEM308TH	PESTICIDE CHEMISTRY & PHARMACEUTICAL CHEMISTRY	

TH= Theory, IA=Internal Assessment, PR= Practical, TU= Tutorial, SE= Skill Exam

HIMACHAL PRADESH UNIVERSITY
SYLLABUS AND SCHEME OF EXAMINATIONFOR B.SC. PHYSICAL SCIENCE
(PHYSICS, COMPUTER SCIENCE AND MATHEMATICS) W.E.F. 2018-19

Year	Course Type	Course Code	Title of Paper	Credits
1	CORE COURSE-1	PHYS101TH PHYS101IA	MECHANICS THEORY	4
		PHYS101PR	MECHANICS LAB	2
	CORE COURSE-II	COMP101TH COMP101IA	PROBLEM SOLVING USING COMPUTER	4
		COMP101PR	SOFTWARE LAB USING PYTHON	2
	CORE COURSE-III	MATH101TH MATH101IA	DIFFERENTIAL CALCULUS	6
	A.E.C. COURSE-I		ENVIRONMENTAL SCIENCE	4
	CORE COURSE-IV	PHYS102TH PHYS102IA	ELECTRICITY, MAGNETISIM AND EMT THEORY	4
		PHYS102PR	ELECTRICITY, MAGNETISIM AND EMT LAB	2
	CORE COURSE-V	COMP102TH COMP102IA	OFFICE AUTOMATION TOOLS	4
		COMP102PR	OFFICE AUTOMATION TOOLS LAB	2
	CORE COURSE-VI	MATH102TH MATH102IA	DIFFERENTIAL EQUATIONS	6
	A.E.C. COURSE-II		ENGLISH/MIL COMMNICATION	4
II	CORE COURSE-VII	PHYS201TH PHYS201IA	STATISTICAL AND THERMAL PHYSICS THEORY	4
		PHYS201PR	STATISTICAL AND THERMAL PHYSICS LAB	2
	CORE COURSE-VIII	COMP201TH COMP201IA	COMPUTER SYSTEM ARCHITECTURE	6
	CORE COURSE-IX	MATH201TH MATH201IA	REAL ANALYSIS	6
	CORE COURSE-X	PHYS202TH PHYS202IA	WAVES AND OPTICS THEORY	4
		PHYS202PR	WAVES AND OPTICS LAB	2
	CORE COURSE-XI	COMP202TH COMP 202IA	DATABASE MANAGEMENT SYSTEM	4
		COMP202PR	DATABASE MANAGEMENT SYSTEM LAB	2
	CORE COURSE-XII	MATH202TH MATH202IA	ALGEBRA	6
	SEC 1 (CHOOSE ANY ONE FROM GIVEN THREE)	PHYS203TH PHYS203IA	PHYSICS WORKSHOP SKILLS THEORY	3 + 1=4 (TH+IA=3 SE=1)
		PHYS203SE	PHYSICS WORKSHOP SKILLS SKILL EXAM	
		PHYS204TH PHYS204IA	COMPUTATIONAL PHYSICS THEORY	
		PHYS204SE	COMPUTATIONAL PHYSICS	

			SKILL EXAM	
		PHYS205TH PHYS205IA	ELECTRICAL CIRCUITS AND NETWORK SKILL THEORY	
		PHYS205SE	ELECTRICAL CIRCUITS AND NETWORK SKILLS SKILL EXAM	
	SEC2	COMP203TH COMP203IA	PHP PROGRAMMING	4
III	DISCIPLINE SPECIFIC ELECTIVES DSE:1A (CHOOSE ANY ONE FROM GIVEN THREE)	PHYS301TH PHYS301IA	ELEMENTS OF MODERN PHYSICS THEORY	4+2 =6 (TH+IA=4 PR=2)
		PHY301PR	ELEMENTS OF MODERN PHYSICS LAB	
		PHYS302TH PHYS302IA	SOLID STATE PHYSCS AND ELECTRONICS THEORY	
		PHYS302PR	SOLID STATE PHYSCS AND ELECTRONICS LAB	
		PHYS303TH PHYS303IA	ASTRONOMY AND ASTROPHYSICS THEORY	
		PHYS303TU	ASTRONOMY AND ASTROPHYSICS TUTORIALS	
	DSE: 2A	COMP301TH COMP301IA	OPERATING SYSTEM	6
	DISCIPLINE SPECIFIC ELECTIVE DSE:3A (CHOOSE ANY ONE FROM GIVEN THREE)	MATH301TH MATH301IA	MATRICES	4+2 =6 (TH+IA=6
		MATH302TH MATH302IA	MECHANICS	
		MATH303TH MATH303IA	LINEAR ALGEBRA	
	DISCIPLINE SPECIFIC ELECTIVES DSE: 1B (CHOOSE ANY ONE FROM GIVEN THREE)	PHYS304TH PHYS304IA	NUCLEAR AND PARTICLE PHYSICS THEORY	5+1 (TH+IA=5 TU=1) OR 4+2 (TH+IA=4 PR=2)
		PHYS304TU	NUCLEAR AND PARTICLE PHYSICS TUTORIALS	
		PHYS305TH PHYS305IA	QUANTUM MECHANICS THEORY	
		PHYS305PR	QUANTUM MECHANICS LAB	
		PHYS306TH PHYS306IA	PHYSICS OF DEVICES AND INSTRUMENTS THEORY	
		PHYS306PR	PHYSICS OF DEVICES AND INSTRUMENTS LAB	

	DSE: 2B	COMP302TH COMP302IA	DATA STRUCTURE AND FILE PROCESSING	4
		COMP302PR	DATA STRUCTURE AND FILE PROCESSING LAB	2
	DISCIPLINE SPECIFIC ELECTIVE DSE: 3B (CHOOSE ANY ONE FROM GIVEN THREE)	MATH304TH MATH304IA	NUMERICAL METHODS	4+2 =6 (TH+IA=6
		MATH305TH MATH305IA	COMPLEX ANALYSIS	
		MATH306TH MATH306IA	LINEAR PROGRAMMING	
	SKILL ENHANCEMENT COURSE SEC3 (CHOOSE ANY ONE FROM GIVEN TWELVE)	MATH307TH MATH307IA	LOGIC AND SETS	4
		MATH308TH MATH308IA	ANALYTIC GEOMETRY	
		MATH309TH MATH309IA	INTEGRAL CALCULUS	
		MATH310TH MATH310IA	VECTOR CALCULUS	
		MATH311TH MATH311IA	BOOLEAN ALGEBRA	
		MATH312TH MATH312IA	NUMBER THEORY	
		MATH313TH MATH313IA	PROBABILITY AND STATISTICS	
		MATH314TH MATH314IA	MATHEMATICAL FINANCE	
		MATH315TH MATH315IA	MATHEMATICAL MODELING	
		MATH316TH MATH316IA	THEORY OF EQUATIONS	
		MATH317TH MATH317IA	TRANSPORTATION AND GAME THEORY	
		MATH318TH MATH318IA	GRAPH THEORY	
	SEC4 (IN CASE OF COMPUTER SCIENCE CHOOSE THE GIVEN COURSE)	CHOOSE ONE COURSE OUT OF THE LIST OF SEC COURSES OF PHYSICS/MATHEMATICS, BUT NOT CHOSEN EARLIER IN SEC1 AND SEC3.		4
		COMP303TH COMP303IA	SOFTWARE ENGINEERING	

TH= Theory,IA=Internal Assessment, PR= Practical, TU= Tutorial, SE= Skill Exam

HIMACHAL PRADESH UNIVERSITY
SYLLABUS AND SCHEME OF EXAMINATION FOR B.SC. MATHEMATICS
W.E.F. 2018-19

Year	Course Type	Course Code	Title of Paper	Credits
I	CORE COURSE-1	PHYS101TH PHYS101IA	MECHANICS THEORY	4
		PHYS101PR	MECHANICS LAB	2
	CORE COURSE-II	CHEM101TH CHEM101IA CHEM101PR	ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS	6
	CORE COURSE-III	MATH101TH MATH101IA	DIFFERENTIAL CALCULUS	6
	A.E.C. COURSE-I		ENVIRONMENTAL SCIENCE	4
	CORE COURSE-IV	PHYS102TH PHYS102IA	ELECTRICITY, MAGNETISIM AND EMT THEORY	4
		PHYS102PR	ELECTRICITY, MAGNETISIM AND EMT LAB	2
	CORE COURSE-V	CHEM102TH CHEM102IA CHEM102PR	STATES OF MATTER, CHEMICAL KINETICS & FUNCTIONAL ORGANIC CHEMISTRY	6
	CORE COURSE-VI	MATH102TH MATH102IA	DIFFERENTIAL EQUATIONS	6
	A.E.C. COURSE-II		ENGLISH/MIL COMMNICATION	4
II	CORE COURSE-VII	PHYS201TH PHYS201IA	STATISTICAL AND THERMAL PHYSICS THEORY	4
		PHYS201PR	STATISTICAL AND THERMAL PHYSICS LAB	2
	CORE COURSE-VIII	CHEM201TH CHEM201IA CHEM201PR	SOLUTIONS, PHASE EQUILBRIUM, CONDUCTANCE, ELECTROCHEMISTRY AND ORAGANIC CHEMISTRY	6
	CORE COURSE-IX	MATH201TH MATH201IA	REAL ANALYSIS	6
	CORE COURSE-X	PHYS202TH PHYS202IA	WAVES AND OPTICS THEORY	4
		PHYS202PR	WAVES AND OPTICS LAB	2
	CORE COURSE-XI	CHEM202TH CHEM202IA CHEM202PR	CHEMISTRY OF MAIN GROUP ELEMENTS, CHEMICAL ENERGETICS AND EQUILIBRIA	6
	CORE COURSE-XII	MATH202TH MATH202IA	ALGEBRA	6
	SEC 1 (CHOOSE ANY ONE FROM GIVEN THREE)	MATH307TH MATH307IA	LOGIC AND SETS	TH+IA=4
		MATH308TH MATH308IA	ANALYTIC GEOMETRY	
		MATH309TH MATH309IA	INTEGRAL CALCULUS	

	SEC2 (CHOOSE ANY ONE FROM GIVEN THREE)	MATH310TH MATH310IA	VECTOR CALCULUS	TH+IA=4
		MATH311TH MATH311IA	BOOLEAN ALGEBRA	
		MATH312TH MATH312IA	NUMBER THEORY	
III	DISCIPLINE SPECIFIC ELECTIVES DSE: IA (CHOOSE ANY ONE FROM GIVEN THREE)	PHYS301TH PHYS301IA	ELEMENTS OF MODERN PHYSICS THEORY	4+2=6 (TH+IA=4 PR=2)
		PHYS301PR	ELEMENTS OF MODERN PHYSICS LAB	
		PHYS302TH PHYS302IA	SOLID STATE PHYSICS AND ELECTRONICS THEORY	
		PHYS302PR	SOLID STATE PHYSICS AND ELECTRONICS LAB	
		PHYS303TH PHYS303IA	ASTRONOMY AND ASTROPHYSICS THEORY	
		PHYS303TU	ASTRONOMY AND ASTROPHYSICS TUTORIALS	
	DISCIPLINE SPECIFIC ELECTIVES DSE:2A (CHOOSE ANY ONE FROM GIVEN THREE)	CHEM301TH CHEM301IA CHEM301PR	POLYNUCLEAR HYDROCARBONS DYES, HETROCYCLIC COMPOUNDS AND SPECTROSCOPY (UV, IR, NMR)	6
		CHEM302TH CHEM302IA CHEM302PR	INDUSTRIAL CHEMICALS AND ENVIRONMENT	
		CHEM303TH CHEM303IA CHEM303PR	QUANTUM CHEMISTRY, SPECTROSCOPY & PHOTOCHEMISTRY	
	DISCIPLINE SPECIFIC ELECTIVES DSE:3A (CHOOSE ANY ONE FROM GIVEN THREE)	MATH301TH MATH301IA	MATRICES	4+2 =6 (TH+IA=6
		MATH302TH MATH302IA	MECHANICS	
		MATH303TH MATH303IA	LINEAR ALGEBRA	
	DISCIPLINE SPECIFIC ELECTIVES DSE:1B (CHOOSE ANY ONE FROM GIVEN THREE)	PHYS304TH PHYS304IA	NUCLEAR AND PARTICLE HYSICS THEORY	5+1 (TH+IA=5 TU=1) OR 4+2)TH+IA=4 PR=2)
		PHYS304TU	NUCLEAR AND PARTICLE HYSICS TUTORIALS	
		PHYS305TH PHYS305IA	QUANTUM MECHANICS THEORY	
		PHYS305PR	QUANTUM MECHANICS LAB	
		PHYS306TH PHYS306IA	PHYSICS OF DEVICES AND INSTRUMENTS THEORY	
		PHYS306PR	PHYSICS OF DEVICES AND INSTRUMENTS LAB	

DISCIPLINE SPECIFIC ELECTIVES DSE:2B (CHOOSE ANY ONE FROM GIVEN THREE)	CHEM304TH CHEM304IA CHEM304PR	CHEMISTRY OF TRANSITION AND INNER TRANSITION ELEMENTS, COORDINATION CHEMISTRY, ORGANOMETTALICS, ACIDS AND BASES	6
	CHEM305TH CHEM305IA CHEM305PR	POLYMER CHEMISTRY	
	CHEM306TH CHEM306IA CHEM306PR	MOLECULES OF LIFE	
DISCIPLINE SPECIFIC ELECTIVES DSE: 3B (CHOOSE ANY ONE FROM GIVEN THREE)	MATH304TH MATH304IA	NUMERICAL METHODS	4+2 (TH+IA=6)
	MATH305TH MATH305IA	COMPLEX ANALYSIS	
	MATH306TH MATH306IA	LINEAR PROGRAMMING	
SKILL ENHANCEMENT COURSE SEC3 (CHOOSE ONE COURSE OUT OF THREE COURSES)	MATH313TH MATH313IA	PROBABILITY AND STATISTICS	4
	MATH314TH MATH314IA	MATHEMATICAL FINANCE	
	MATH315TH MATH315IA	MATHEMATICAL MODELING	
SKILL ENHANCEMENT COURSE SEC4 (CHOOSE ONE COURSE OUT OF THREE COURSES)	MATH316TH MATH316IA	THEORY OF EQUATIONS	4
	MATH317TH MATH317IA	TRANSPORTATION AND GAME THEORY	
	MATH318TH MATH318IA	GRAPH THEORY	

TH= Theory,IA=Internal Assessment, PR= Practical, TU= Tutorial, SE= Skill Exam

HIMACHAL PRADESH UNIVERSITY
SYLLABUS AND SCHEME OF EXAMINATION
FOR B.A. WITH MATHEMATICS
w.e.f. session 2018-19

Year	Course Code	Course Type	Title of Paper	Credits (TH+T)*
I	MATH101TH	CORE COURSE	DIFFERENTIAL CALCULUS	5+1=6
	MATH102TH	CORE COURSE	DIFFERENTIAL EQUATIONS	5+1=6
		CORE COURSE	DSC-2A	6
		CORE COURSE	DSC-2B	6
		CORE COURSE	ENGLISH-1	6
		CORE COURSE	SKT./ HINDI-1	6
		A.E.C. COURSE	ENV. STUDIES	4
		A.E.C. COURSE	HINDI/ENG./SKT.	4
II	MATH201TH	CORE COURSE	REAL ANALYSIS	5+1=6
	MATH202TH	CORE COURSE	ALGEBRA	5+1=6
		CORE COURSE	DSC-2C	6
		CORE COURSE	DSC-2D	6
		CORE COURSE	ENGLISH-2	6
		CORE COURSE	SKT./ HINDI-2	6
		SKILL ENHANCEMENT COURSE	SEC 1: CHOOSE ONE OUT OF THE FOLLOWING	4
	MATH307TH	SEC 1	LOGIC AND SETS	4
	MATH308TH	SEC 1	ANALYTICAL GEOMETRY	
	MATH309TH	SEC 1	INTEGRAL CALCULUS	
		SKILL ENHANCEMENT COURSE	SEC 2: CHOOSE ONE OUT OF THE FOLLOWING	4
	MATH310TH	SEC 2	VECTOR CALCULUS	4
	MATH311TH	SEC 2	BOOLEAN ALGEBRA	
	MATH312TH	SEC 2	NUMBER THEORY	
III		DISCIPLINE SPECIFIC ELECTIVE	DSE 1A (MATH): CHOOSE ONE CHOOSE ONE OUT OF THE FOLLOWING	5+1=6
	MATH301TH	DSE 1A	MATRICES	
	MATH302TH	DSE 1A	MECHANICS	
	MATH303TH	DSE 1A	LINEAR ALGEBRA	
		DISCIPLINE SPECIFIC ELECTIVE	DSE 1B (MATH): CHOOSE ONE OUT OF THE FOLLOWING	5+1=6
	MATH304TH	DSE 1B	NUMERICAL METHODS	

MATH305TH	DSE 1B	COMPLEX ANALYSIS	
MATH306TH	DSE 1B	LINEAR PROGRAMMING	
	DISCIPLINE SPECIFIC ELECTIVE	DSE2A	6
	DISCIPLINE SPECIFIC ELECTIVE	DSE2B	6
	SKILL ENHANCEMENT COURSE	SEC 3: CHOOSE ONE OUT OF THE FOLLOWING	4
MATH313TH	SEC 3	PROBABILITY AND STATISTICS	
MATH314TH	SEC 3	MATHEMATICAL FINANCE	
MATH315TH	SEC 3	MATHEMATICAL MODELING	
	SKILL ENHANCEMENT COURSE	SEC 4: CHOOSE ONE OUT OF THE FOLLOWING	4
MATH316TH	SEC 4	THEORY OF EQUATIONS	
MATH317TH	SEC 4	TRANSPORTATION AND GAME THEORY	
MATH318TH	SEC 4	GRAPH THEORY	
	GENERIC ELECTIVE	GE 1: CHOOSE ONE OUT OF THE FOLLOWING	5+1=6
MATH319TH	GE 1	PORTFOLIO OPTIMIZATION	
MATH320TH	GE 1	QUEUING AND RELIABILITY THEORY	
	GENERIC ELECTIVE	GE 2: CHOOSE ONE OUT OF THE FOLLOWING	5+1=6
MATH321TH	GE 2	DESCRIPTIVE STATISTICS AND PROBABILITY THEORY	
MATH322TH	GE 2	SAMPLE SURVEYS AND DESIGN OF EXPERIMENTS	
		TOTAL CREDITS	**132**

* In B.A. Mathematics, DSE1A and DSE1B are respectively

same as DSE3A and DSE3B in B.Sc. Mathematics

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH101TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Differential Calculus
Type of the Course	Core Course
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Times: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

Core 1.1: Differential Calculus

Unit-I (19 **hrs.**)

Limit and Continuity (epsilon and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem.

Unit-II (19**hrs.**)

Indeterminate forms, Rolle's theorem, Lagrange's & Cauchy Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series. Maclaurin's series of sin x, cos x, e^x, log(l+x), $(l+x)^m$.

Unit-III (19 **hrs.**)

Concavity, Convexity & Points of Inflexion, Curvature, Radius of curvature, center of curvature, Asymptotes, Singular points, Double point, Polar coordinates, Relation between Cartesian and polar coordinates.

<div align="center">Unit-IV (18 hrs.)</div>

Functions of several variables (upto three variables): Limit and Continuity of these functions Partial differentiation, Euler's theorem on homogeneous functions, Maxima and Minima with Lagrange Multipliers Method (two variables), Jacobian (upto three variables).

Books Recommended:

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.

2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

HIMACHAL PRADESH UNIVERSITY

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH102TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Differential Equations
Type of the Course	Core Course
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Times: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

Core 1.2: Differential Equations
Unit-I (19 **hrs.**)

Basic theory of linear differential equations, Wronskian, and its properties. First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p. Clairut's form
Unit-II (19 **hrs.**)

Methods for solving higher-order differential equations. Solving a differential equation by reducing its order. Linear homogenous equations with constant coefficients, Linear non-homogenous equations.
Unit-III (19 **hrs.**)

The method of variation of parameters with constant coefficients. The Cauchy-Euler equation

and Legendre equation. Simultaneous differential equations, Total differential equations.

<div align="center">Unit-IV(18 hrs.)</div>

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations.Formation of first order partial differential equations(PDE). Linear partial differential equation of first order, Lagrange's method. Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

Books Recommended

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.

2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

HIMACHAL PRADESH UNIVERSITY

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH201TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Real Analysis
Type of the Course	Core Course
Number of teaching hours required for this course	75hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

Core 2.1: Real Analysis
Unit-I(19 **hrs.**)

Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Unit-II (19 **hrs.**)

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).
Unit-III(19 **hrs.**)

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test

(Tests of Convergence without proof). Definition and examples of absolute and conditional convergence.

Unit-IV (18 **hrs.**)

Sequences and series of functions, Pointwise and uniform convergence. M_n-test, M-test, Results about uniform convergence, Power series and radius of convergence.

Books Recommended

1. T. M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis,* John Wiley and Sons (Asia) P. Ltd., 2000.
3. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
4. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series-* Undergraduate Texts in Mathematics, Springer Verlag, 2003.

HIMACHAL PRADESH UNIVERSITY

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH202TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Algebra
Type of the Course	Core Course
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

Core 2.2: Algebra

Unit-I (19 **hrs.**)

Definition and examples of groups, examples of abelian and non-abelian groups, the group Z_n of integers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity.

Unit-II (19 **hrs.**)

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element.

Unit-III (19 **hrs.**)

Normal subgroups: their definition, examples, and characterizations, Quotient groups. Definition of Kernel, Basic theorems of homomorphism. First theorem of Homomorphism.

Unit-IV (18 **hrs.**)

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Z_n the ring of integers modulo n. Rings of matrices, Subrings and ideals, Definition of Integral domains and fields.

Books Recommended
1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.

3. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa, 1999.
4. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH301TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Matrices
Type of the Course	Discipline Specific Elective
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Times: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

DSE 3A.1: Matrices
Unit-I (19 **hrs.**)

Types of matrices. Rank of a matrix. Invariance of rank under elementary transformations. Reduction to normal form, Solutions of linear homogeneous and non-homogeneous equations with number of equations and unknowns upto three.
Unit-II(19 **hrs.**)

Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3. Computation of matrix inverses using elementary row operations. Rank of matrix. Solutions of a system of linear equations using matrices. Illustrative examples of above concepts from Geometry, Physics, Chemistry, Combinatorics and Statistics.

Unit-III(19 **hrs.**)

Definition of Vector space, R, R2, R3 as vector spaces over R, Concept of Linear dependence/Independence, Standard basis for R, R2, R3, Examples of different bases. Subspaces of R2, R3.

Unit-IV (18 **hrs.**)

Translation, Dilation, Rotation, Reflection in a point, line and plane. Matrix form of basic geometric transformations. Interpretation of eigenvalues and eigen vectors for such transformations and eigen spaces as invariant subspaces.

Books Recommended
1. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.
2. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH302TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Mechanics
Type of the Course	Discipline Specific Elective
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

DSE 3A.2: Mechanics
Unit-I (19 **hrs.**)

Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body.

Unit-II(19 **hrs.**)

Laws of friction, Problems of equilibrium under forces including friction, Centre of gravity.
Unit-III(19 **hrs.**)

Work and potential energy. Velocity and acceleration of a particle along a curve, Radial and transverse components (plane curve), tangential and normal components (space curve).
Unit-IV(18 **hrs.**)

Newton's Laws of motion, Simple harmonic motion, Simple Pendulum, Projectile Motion.

Books Recommended

1. A.S. Ramsay, *Statics*, CBS Publishers and Distributors (Indian Reprint), 1998.
2. A.P. Roberts, *Statics and Dynamics with Background in Mathematics*, Cambridge University Press, 2003.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH303TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Linear Algebra
Type of the Course	Discipline Specific Elective
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Times: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

DSE 3A.3: Linear Algebra
Unit-I (19 **hrs.**)

Vector spaces, subspaces, algebra of subspaces, quotient spaces.
Unit-II (19**hrs.**)

Linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.
Unit-III (19 **hrs.**)

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.

Unit-IV (18 **hrs.**)

Dual Space, Dual Basis, Double Dual, Eigen values and Eigen vectors, Characteristic Polynomial.

Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Books Recommended

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra,* 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
2. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
3. S. Lang, *Introduction to Linear Algebra,* 2nd Ed., Springer, 2005.

4. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.

HIMACHAL PRADESH UNIVERSITY

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH304TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Numerical Methods
Type of the Course	Discipline Specific Elective
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

DSE 3B.1: Numerical Methods
Unit-I (19 **hrs.**)

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method, LU decomposition.
Unit-II (19 **hrs.**)

Gauss-Jacobi, Gauss-Siedel and SOR iterative methods, Lagrange and Newton interpolation: linear and higher order.
Unit-III (19 **hrs.**)

Finite difference operators, Numerical differentiation: Newton's forward difference and backward difference method, Sterling's Central difference method.
Unit-IV (18 **hrs.**)

Integration: Trapezoidal rule, Simpson's rule, Euler's method.

Recommended Books
1. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007.

HIMACHAL PRADESH UNIVERSITY

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH305TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Complex Analysis
Type of the Course	Discipline Specific Elective
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

DSE 3B.2: Complex Analysis
Unit-I (19 **hrs.**)

Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.
Unit-II (19 **hrs.**)

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions.
Unit-III (19 **hrs.**)

Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy- Goursat theorem, Cauchy integral formula.

Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples.

Books Recommended

1. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications,* 8th Ed., McGraw – Hill International Edition, 2009.

2. Joseph Bak and Donald J. Newman, *Complex analysis,* 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

HIMACHAL PRADESH UNIVERSITY

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH306TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Linear Programming
Type of the Course	Discipline Specific Elective
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

DSE 3B.3: Linear Programming
Unit-I (19 **hrs.**)

Linear Programming Problems, Graphical Approach for Solving some Linear Programs. Convex Sets, Supporting and Separating Hyperplanes.
Unit-II (19 **hrs.**)

Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format.
Unit-III (19 **hrs.**)

Introduction to artificial variables, two-phase method, Big-M method and their comparison.
Unit-IV (18 **hrs.**)

Duality, formulation of the dual problem, primal- dual relationships, economic interpretation of

the dual, sensitivity analysis.

Recommended Books

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 8th Ed., Tata McGraw Hill, Singapore, 2004.
Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Third Semester

Course Code	MATH307TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Logic and Sets
Type of the Course	Skill Enhancement Course
Number of teaching hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Times: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC 3.1: Logic and Sets
(In B.Sc/B.A. Mathematics this course is Sec 1.1)

Unit-I (15 **hrs.**)

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.

Unit-II (15**hrs.**)

Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction,

Quantifiers, Binding variables and Negations.

<div align="center">Unit-III(15 hrs.)</div>

Sets, subsets, Set operations, the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

<div align="center">Unit-IV (15 hrs.)</div>

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.

Book Recommended

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.
2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.
3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH308TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Analytical Geometry
Type of the Course	Skill Enhancement Course
Number of teaching hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC 3.2: Analytical Geometry
(In B.Sc/B.A. Mathematics this course is Sec 1.2)

Unit-I (15 **hrs.**)

Techniques for sketching parabola, ellipse and hyperbola, Reflection properties of parabola, ellipse and hyperbola.

Unit-II (15**hrs.**)

Classification of quadratic equations representing lines, parabola, ellipse and hyperbola,

Unit-III (15 **hrs.**)

Sphere. Plane section of a sphere. Sphere through a given circle. Intersection of two spheres.

Radical plane. Radical line and Radical point in spheres. Co-axial system of spheres.

<center>Unit-IV (15 hrs.)</center>

Cylindrical surfaces, Illustrations of graphing standard quadric surfaces like cone, ellipsoid.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd., 2002.

3. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.

4. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994.

HIMACHAL PRADESH UNIVERSITY

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH309TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Integral Calculus
Type of the Course	Skill Enhancement Course
Number of teaching hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC 3.3: Integral Calculus
(In B.Sc/B.A. Mathematics this course is Sec 1.3)

Unit-I (15 **hrs.**)

Integration by Partial fractions, integration of rational and irrational functions. Properties of definite integrals.

Unit-II (15 **hrs.**)

Reduction Formulae, $\int Sin^n x \, dx$, $\int Cos^n x \, dx$, $\int e^{ax} x^n dx$, $\int x^n (logx)^m dx$, $\int x^n Sinxdx$, $\int x^n cosxdx$, $\int Sin^n x \, Cox^n xdx$, , $\int_0^{\pi/2} Sin^n x$dx, $\int_0^{\pi/2} Cos^n x$dx, $\int_0^{\pi/2} Sin^n x Cox^n x$dx. Reduction by connecting two integrals (Smaller Index + 1 Method).

Unit-III (15 **hrs.**)

Areas and lengths of curves in the plane, volumes and surfaces of solids of revolution, Cartesian

and parametric form.

<div align="center">Unit-IV (15 **hrs.**)</div>

Double and Triple integrals.

Books Recommended:
1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd., 2002.

HIMACHAL PRADESH UNIVERSITY

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH310TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Vector Calculus
Type of the Course	Skill Enhancement Course
Number of teaching hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC 3.4: Vector Calculus
(In B.Sc/B.A. Mathematics this course is Sec 2.1)

Unit -I(15 hrs.)

Scalar and vector product of three vectors. Product of four vectors. Reciprocal vectors. Vector differentiation, Scalar valued point functions, vector valued point functions. Derivative along a curve, directional derivatives.

Unit –II(15 hrs.)

Gradient of a scalar point function. Divergence and curl of a vector point function. Gradient,

Divergence and curl of sums and products. Laplacian operator.

Unit -III(15 hrs.)

Orthogonal curvilinear coordinates. Conditions for orthogonality. Fundamental triads of mutually orthogonal unit vectors. Gradient, Divergence, Curl and Laplacian operators in terms of orthogonal curvilinear coordinators.

Unit - IV(15 hrs.)

Vector integration: line integral, surface integral, Volume integral
Theorems of Gauss, Green and Stokes (without proof) and the problems based on these theorems.

Books Recommended
1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.
3. P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH311TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Boolean Algebra
Type of the Course	Skill Enhancement Course
Number of hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Times: 3 hrs.
Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC3.5:Boolean Algebra
(In B.Sc/B.A. Mathematics this course is Sec 2.2)

Unit-I (15 **hrs.**)

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements.

Unit-II (15 **hrs.**)

Lattices as ordered sets, complete lattices, lattices as algebraic structures, sub lattices, products and homomorphisms.

Unit-III (15 **hrs.**)

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials.

<div align="center">Unit-IV (15 **hrs.**)</div>

Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits

Books Recommended:

1. BA.Davey and H.A.Priestley,*IntroductiontoLatticesandOrder,*CambridgeUniversityPress, Cambridge,1990.

2. Rudolf Lidl and Günter Pilz,*AppliedAbstractAlgebra,*2ndEd.,UndergraduateTextsinMathematics, Springer(SIE), Indianreprint,2004.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH312TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Number Theory
Type of the Course	Skill Enhancement Course
Number of teaching hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Times: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC 3.6: Number Theory
(In B.Sc/B.A. Mathematics this course is Sec 2.3)

Unit-I (15 **hrs.**)

Division algorithm, Lame's theorem, linear Diophantine equation, fundamental theorem of arithmetic, prime counting function, statement of prime number theorem, Goldbach conjecture.

Unit-II (15 **hrs.**)

Binary and decimal representation of integers, linear congruences, complete set of residues.

Unit-III (15 **hrs.**)

Number theoretic functions, sum and number of divisors, totally multiplicative functions.

Unit-IV (15 **hrs.**)

Definition and properties of the Dirichlet product, the Möbius inversion formula, the greatest integer function, Euler's phi-function.

Books Recommended:

1. David M. Burton, *Elementary Number Theory* 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.
2. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press, Boca Raton, 2000.
3. Neville Robinns, *Beginning Number Theory,* 2nd Ed., Narosa Publishing House Pvt. Limited, Delhi, 2007.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH313TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Probability and Statistics
Type of the Course	Skill Enhancement Course
Number of hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(2), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Times: 3 hrs.
Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC 3.7: Probability and Statistics
(In B.Sc/B.A. Mathematics this course is Sec 3.1)

Unit-I (15 **hrs.**)

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions.

Unit-II (15 **hrs.**)

Mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform.

Unit-III (15 **hrs.**)

Binomial, Poisson, continuous distributions: uniform, normal, exponential.

Unit-IV (15 **hrs.**)

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables.

Books Recommended:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Application,* 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, *Introduction to Probability Model,* 9th Ed., Academic Press, Indian Reprint, 2007.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH314TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Mathematical Finance
Type of the Course	Skill Enhancement Course
Number of hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(2), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Times: 3 hrs.
Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC 3.8: Mathematical Finance
(In B.Sc/B.A. Mathematics this course is Sec 3.2)

Unit-I (15 **hrs.**)

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money.

Unit-II (15 **hrs.**)

Inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR.

<div align="center">Unit-III (15 hrs.)</div>

Bonds, bond prices and yields. Floating-rate bonds, immunization.

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation).

<div align="center">Unit-IV (15 hrs.)</div>

Random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints).

Books Recommended:

1. David G. Luenberger, *Investment Science*, Oxford University Press, Delhi, 1998.

2. John C. Hull, Options, *Futures and Other Derivatives,* 6th Ed., Prentice-Hall India, Indian reprint, 2006.

3. Sheldon Ross, *An Elementary Introduction to Mathematical Finance*, 2nd Ed., Cambridge University Press, USA, 2003.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH315TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Mathematical Modeling
Type of the Course	Skill Enhancement Course
Number of hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Times: 3 hrs.
Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC 3.9: Mathematical Modeling
(In B.Sc/B.A. Mathematics this course is Sec 3.3)

Unit-I (15 **hrs.**)

Applications of differential equations: the vibrations of a mass on a spring, mixture problem, free damped motion, forced motion.

Unit-II (15 **hrs.**)

Resonance phenomena, electric circuit problem, mechanics of simultaneous differential equations.

Unit-III (15 **hrs.**)

Applications to Traffic Flow. Vibrating string, vibrating membrane.

Unit-IV (15 **hrs.**)

Conduction of heat in solids, gravitational potential, conservation laws.

Books Recommended:
1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH316TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Theory of Equations
Type of the Course	Skill Enhancement Course
Number of teaching hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC 3.10: Theory of Equations
(In B.Sc/B.A. Mathematics this course is Sec 4.1)

Unit-I (15 **hrs.**)

General properties of polynomials, Graphical representation of a polynomials, maximum and minimum values of a polynomials, General properties of equations,

Unit-II (15 **hrs.**)

Descarte's rule of signs f o r positive and negative roots, Relation between the roots and the coefficients of equations.

Unit-III (15 **hrs.**)

Symmetric functions, Applications symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations.

Algebraic solutions of the cubic (Carden's method) and biquadratic (Descarte's & Ferrari's method). Properties of the derived functions.

Books Recommended
1. W.S. Burnside and A.W. Panton, *The Theory of Equations*, Dublin University Press, 1954.
2 C. C. MacDuffee, *Theory of Equations*, John Wiley & Sons Inc., 1954.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH317TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Transportation and Game Theory
Type of the Course	Skill Enhancement Course
Number of hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC 3.11: Transportation and Game Theory
(In B.Sc/B.A. Mathematics this course is Sec 4.2)

Unit-I (15 **hrs.**)

Transportation problem and its mathematical formulation. northwest-corner method, least cost method.

Unit-II (15 **hrs.**)

Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem.

Unit-III (15 **hrs.**)

Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

<div align="center">Unit-IV (15 **hrs.**)</div>

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure.

Books Recommended:
1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.
2. F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research,* 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH318TH
Credits= 4	L-4,T-0,P-0
Name of the Course	Graph Theory
Type of the Course	Skill Enhancement Course
Number of hours required for this course	60 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	Nil
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Lectures to be Delivered (One Hour Each)	60

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

SEC3.12: Graph Theory
(In B.Sc/B.A. Mathematics this course is Sec 4.3)

Unit-I (15 **hrs.**)
Definition, examples and basic properties of graphs, pseudographs, complete graphs, bi-partite graphs.
Unit-II (15 **hrs.**)
Isomorphism of graphs, paths and circuits, Eulerian circuits.
Unit-III (15 **hrs.**)
Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem.
Unit-IV (15 **hrs.**)
Shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended:

1. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory* 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.
2. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH319TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Portfolio Optimization
Type of the Course	Generic Elective
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15hours
Yearly Based Examination	Max Marks: 70 Maximum Times: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

GE1.1: Portfolio Optimization
Unit-I (19 **hrs.**)

Financial markets. Investment objectives. Measures of return and risk. Types of risks.
Unit-II (19 **hrs.**)

Portfolio of assets. Expected risk and return of portfolio. Diversification.
Unit-III (19 **hrs.**)

Mean-variance portfolio optimization- the Markowitz model and the two-fund theorem,
Unit-IV (18 **hrs.**)

Risk-free assets and one fund theorem, efficient frontier. Portfolio performance evaluation measures.

Books Recommended

1. F.K. Reilly, Keith C. Brown, *Investment Analysis and Portfolio Management*, 10th Ed., South-Western Publishers, 2011.
2. H.M. Markowitz, *Mean-Variance Analysis in Portfolio Choice and Capital Markets*, Blackwell, New York, 1987.
3. D.G. Luenberger, *Investment Science*, 2nd Ed., Oxford University Press, 2013.

HIMACHAL PRADESH UNIVERSITY

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH320TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Queuing and Reliability Theory
Type of the Course	Generic Elective
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

GE 1.2: Queuing and Reliability Theory
Unit-I (19 **hrs.**)

General concepts of queueing system, Measures of performance, Arrival and Service Processes, Single server and multi server models, channels in parallel with limited and unlimited queues-M/M/1/K, M/M/C.

Unit-II (19 **hrs.**)

Queues with unlimited service. Finite source queues. Application of simple queueing decision model's, Design and control models.

Unit-III (19 **hrs.**)

Basics of reliability. Classes of life distributions. Series, parallel, configurations. Reliability models,

Reliability, Mean Time before failure and Hazard rate of Exponential and Weibull distributions. Concepts and definitions of preventive maintenance, corrective maintenance and age replacement.

Books Recommended

1. R.B. Cooper, *Introduction to Queueing Theory*, 2nd Ed., North Holland, 1981.

2. D. Gross, C. M. Harris, *Fundamentals of Queueing Theory*, 3rd Ed., John Wiley and Sons Inc. P. Ltd., 2002.

3. U.N. Bhat, *An Introduction to Queueing Theory: Modelling and Analysis in Applications* (*Statistics for Industry and Technology*), Birkhauser Boston, 2008.

4. U.N. Prabhu, *Foundations of Queueing Theory*, International Series in Operations Research & Management Science, Kluwer Academic Publishers, 2nd Ed., 2002.

5. John G. Rau, *Optimization and Probability in Systems Engineering*, V.N. Reinhold Co., 1970.
6. Riccardo Manzini, Alberto Regattieri, Hoang Pham, Emilio Ferrai, *Maintenance for Industrial Systems*, Springer-Verlag, London Limited, 2010.

7. P.K. Kapur, R.B. Garg, S. Kumar, *Contributions to Hardware and Software Reliability*, World Scientific, Singapore, 1999.

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH321TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Descriptive Statistics and Probability Theory
Type of the Course	Generic Elective
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

GE 2.1: Descriptive Statistics and Probability Theory
Unit-I (19**hrs.**)

Concepts of a statistical population and sample from a population, quantitative and qualitative data, nominal, ordinal and time-series data, discrete and continuous data. Presentation of data by tables and by diagrams, frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods).

Unit-II (19 **hrs.**)

Measures of location (or central tendency) and dispersion, moments, measures of skewness and kurtosis, cumulants. Bivariate data: Scatter diagram, principle of least-square and fitting of

polynomials and exponential curves.

<div align="center">Unit-III(19 hrs.)</div>

Correlation and regression. Karl Pearson coefficient of correlation, Lines of regression, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only).

<div align="center">Unit-IV(18 hrs.)</div>

Random experiment, sample point and sample space, event, algebra of events, Definition of Probability - classical, relative frequency and axiomatic approaches to probability, merits and demerits of these approaches (only general ideas to be given). Theorem on probability, conditional probability, independent events. Baye's theorem and its applications.

Books Recommended

1. J.E. Freund, *Mathematical Statistics with Applications*, 7th Ed., Pearson Education, 2009.

2. A.M. Goon, M.K. Gupta and B. Dasgupta, *Fundamentals of Statistics*, Vol. I, 8th Ed., World Press, Kolkatta, 2005.

3. S.C. Gupta and V.K. Kapoor, *Fundamentals of Mathematical Statistics*, 11th Ed., Sultan Chand and Sons, 2007.

4. R.V. Hogg, A.T. Craig and J.W. Mckean, *Introduction to Mathematical Statistics*, 6th Ed., Pearson Education, 2005.

5. A.M. Mood, F.A. Graybill and D.C. Boes, *Introduction to the Theory of Statistics*, 3rd Ed., Tata McGraw Hill Publication, 2007.

HIMACHAL PRADESH UNIVERSITY

B.Sc (Physics, Chemistry/Computer Science, Mathematics),

B.Sc./ B.A. with Mathematics

Syllabus and Examination Scheme

Course Code	MATH322TH
Credits= 6	L-5,T-1,P-0
Name of the Course	Sample Surveys and Design of Experiments
Type of the Course	Generic Elective
Number of teaching hours required for this course	75 hrs.
Continuous Comprehensive Assessment: Based on Minor Test(1), Class tests, Assignments, Quiz, Seminar and Attendance (Marks Attendance: 5 marks to be given as per the regulations)	Max. Marks:30
Tutorials : Solving Problems and exercises	15 hours
Yearly Based Examination	Max Marks: 70 Maximum Time: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions

Instructions for paper setter: The question paper will consist of **two Sections A & B** of 70 marks. **Section A** will be **Compulsory** and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. **Section B** of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.

Instructions for Candidates: Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.

GE 2.2: Sample Surveys and Design of Experiments
Unit-I (19 **hrs.**)

Sample Surveys: Concepts of population and sample. Complete enumeration vs. sampling. Need for sampling. Principal and organizational aspects in the conduct of a sample survey. Properties of a good estimator, Sampling and non-sampling errors.

SRSWR & SRSWOR, determination of sample size. Stratified random sampling and different allocations. Systematic sampling, comparison of known sampling strategies under linear trend.

Ratio and Regression estimators and their comparison with SRSWOR estimator.Unit-II (19 **hrs.**)

Indian Official Statistics: Present Official Statistical System in India relating to census of population, agriculture, industrial production, and prices; methods of collection of official statistics, their reliability and limitation and the principal publications containing such statistics. Also the various agencies responsible for the data collection- C.S.O., N.S.S.O., Office of Registrar General, their historical development, main functions and important publications.
Analysis of variance and covariance: Analysis of variance and covariance (with one concomitant variable) in one-way and two-way classified data with equal number of observations per cell.

<div align="center">Unit-III (19 hrs.)</div>

Design of experiments: Principles of experimentation, uniformity trails, completely randomized, Randomized block and Latin square designs. Missing plot technique, 2^2 and 2^3 Factorial experiments: construction and analysis.

<div align="center">Unit-IV (18 hrs.)</div>

Regression Analysis: Two variable linear model – estimation, testing and problems of predication. Predication of the estimated regression equation, interval estimation, variance estimation.

Books Recommended

1. W.G. Cochran*, Sampling Techniques,* John Wiley and Sons, New York, 1997.
2. A.M. Goon, M.K. Gupta, and B. Dasgupta, *Fundamentals of Statistics* (Vol. II), 8th Ed., World Press, Kolkata, 2005.
3. A.M. Goon, M.K. Gupta and B. Dasgupta, *An Outline of Statistical Theory* (Vol. II), 3rd Ed., World Press, Kolkata, 2005.
4. S.C. Gupta and V.K. Kapoor, *Fundamentals of Applied Statistics*, 4th Ed., Sultan Chand and Sons, 2008.
5. A.M. Kshirsagar, *A Course in Linear Models*, Marcel Dekker, Inc., N.Y., 1983.
6. D.C. Montgomery, *Designs and Analysis of Experiments*, John Wiley and Sons, New York, 2001.
7. D.C. Montgomery, E.A. Peak and G.G. Vinning, *Introduction to Linear Regression Analysis*, 3rd Ed., John Wiley and Sons, 2006.
8. P. Mukhopadhyay, *Theory and Methods of Surveys Sampling*, Prentice Hall of India, 1998.
9. D. Singh and F.S. Chaudhary, *Theory and Analysis of Sample Survey Designs*, New Age International (P) Ltd., 1995.
10. P.V. Sukhatme, B.V. Sukhatme, S. Sukhatme and C. Ashok, *Sampling Theory of Surveys with Applications*, Lowa State University Press, Lowa, USA, 1984.

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