PONDICHERRY UNIVERSITY

BACHELOR OF TECHNOLOGY

in

BIOMEDICAL ENGINEEERING

REGULATIONS, CURRICULUM AND SYLLABUS
(For Affiliated Colleges)

(2023- 24)

PONDICHERRY UNIVERSITY

BACHELOR OF TECHNOLOGY PROGRAMMES

(EIGHT SEMESTERS)

REGULATIONS 2023-24

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1. Conditions for Admission:

a) Candidates for admission to the first semester of the 8 semester B.Tech. degree programme should be required to have passed:

The Higher Secondary Examination of the (10+2) curriculum (Academic Stream) prescribed by the different State Boards/ Central Boards or any other examination equivalent there to with minimum of 45% marks (mere pass for OBC and SC/ST candidates) in aggregate of subjects – Mathematics, Physics and any one of the following optional subjects: Chemistry / Biotechnology/ Computer Science / IT and equivalent/ Biology (Botany & Zoology) or an Examination of any University or Authority recognized by the Executive Council of the Pondicherry University as equivalent thereto.

b) For Lateral entry into second year (third semester) of the 8 semester B.Tech. degree programme :

The minimum qualification for admission is a pass in three year diploma or four year sandwich diploma course in Engineering / Technology with a minimum of 60 % marks (50% marks for OBC and a mere pass for SC/ST candidates) in aggregate in the subjects covered from third to final semester or a pass in any B.Sc. course with Mathematics as one of the subjects of study with a minimum of 60 % marks (50% marks for OBC and a mere pass for SC/ST candidates) in aggregate in main and ancillary subjects excluding language subjects. As per AICTE guidelines, Diploma candidates of any branch can join any B.Tech. Degree programme in the second year.

2. Age Limit :

As per applicable AICTE norms.

3. Duration of Programme:

The Bachelor of Technology degree programme shall extend over a period of 8 semesters spread over 4 academic years – two semesters constituting one academic year. The duration of each semester shall normally be 15 weeks excluding examinations.

4. Program Structure

The medium of instruction is English.

A student admitted to the B.Tech. programme in a particular branch of engineering will earn the degree in that branch by fulfilling all the requirements prescribed in the regulations during the course of study.

The student is also permitted to opt for earning an **Honors degree in the same discipline ofEngineering or a Minor degree** in another discipline of Engineering in addition to the degree in his

own discipline of engineering. The student will be allowed to exercise this option at the end of firstyear based on his academic performance in the first year. The students admitted through lateral entry can exercise this option at the end of third semester, based on the GPA scored in the third semester examination.

The student opting for B.Tech. degree with **Honors or B.Tech. degree with Minor** is required to earn additional 20 credits starting from the third semester. The students admitted in the second year through lateral entry and opting for Honors / Minor degree will earn the additional 20 credits starting from the fourth semester.

5. Eligibility for the award of B.Tech. Degree:

No candidate shall be eligible for the award of the degree of Bachelor of Technology, unless he/she has undergone the course for a period of 8 semesters (4 academic years) / 6 semesters (3 academic years for Lateral Entry candidates) in the Faculty of Engineering and has passed the prescribed examinations in all the semesters. Details regarding the possible exits for a B.Tech. Student – in line with one of the goals of the National Education Policy (NEP) 2020 are provided in section 13.

6. Branches of Study:

Branch I - Civil Engineering

Branch II – Mechanical Engineering

Branch III - Electronics & Communication EngineeringBranch IV - Computer Science & Engineering

Branch V – Electrical & Electronics EngineeringBranch VI – Chemical Engineering

Branch VII - Electronics & Instrumentation EngineeringBranch VIII – Information Technology

Branch IX - Instrumentation & Control EngineeringBranch X – Biomedical Engineering

Branch XI - Robotics and AutomationBranch XII – Food Technology

Branch XIII- CSE (Internet of Things & Cyber security including Block chain Technology)Branch XIV – Artificial Intelligence and Machine Learning

Branch XV - Artificial Intelligence and Data Science

or any other branch of study as and when offered. The branch allocation shall be ordinarily done at the time of admission of the candidate to the first semester.

7. Course Structure and Subjects of Study:

Definition of Credit:

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

Range of Credits: The total credits of all the branches for the four-year B. Tech. degree Programme shall be in the range of 160 to 172 (Minor variation is allowed as per AICTE guidelines)

The subjects of study shall include theory, practical courses and project work/internships as given in thecurriculum and shall be in accordance with the prescribed syllabus.

The curriculum of every programme will have courses that are categorized as follows:

(i) Humanities, Social Sciences and Management Courses (HSM)
(ii) Basic Science Courses (BSC)
(iii) Engineering Science Courses (ESC)
(iv) Professional Core Courses (PCC)
(v) Professional Elective Courses (PEC)
(vi) Open Elective Courses (OEC)
(vii) Professional Activity Courses (PAC)
(viii) Mandatory non-Credit Courses (MCC)

Each course will have either one or more of three components namely Lecture (L), Tutorial (T) and Practice (P). Each course is assigned credits as detailed below:

(i) Theory courses will carry either 3 or 4 credits - 3 credits for courses with 3 lecture periods per week and 4 credits for courses with 3 lecture periods and 1 tutorial period per week.

(ii) All Elective courses including online courses will carry maximum 3 credits. The student can earn the credits towards the Open Elective Courses (OEC) by completing the online courses offered in NPTEL anytime between third and seventh semester on prior approval of the courses by the Academic Courses Committee of the Institute. Credits earned through the NPTEL courses will be confined to 2 or 3 credits and subject to a maximum of 9 credits during the entire programme of study.

(iii) Practical courses will normally carry either 1 or 1.5 credits – 1.5 credits for courses with 3 practice periods per week and 1 credit for courses with 2 practice periods per week.

(iv) Out of total credits required for successful completion of the degree, 14 to 22 credits can beassigned for Project work and/or Internship.

(v) Mandatory non-credit courses carry zero credit.

8. Examinations:

The theory and practical examinations shall comprise continuous internal assessment throughout the semester in all subjects as well as university examinations conducted by Pondicherry University at the end of the semester (November / December or April / May).

Evaluation Scheme

All Credit courses are evaluated for 100 marks comprising of Internal assessment and end-semester exam.

For Theory Course, the weightage of internal assessment is 40% and end semester examination is 60%
For Practical course, the weightage of internal assessment is 60% and end semester examination is 40%
For Project, the weightage of internal assessment is 60% and end semester examination is 40%

Internal Assessment (Theory)

Total Internal Assessment mark for a theory course is 40 marks. The breakup is as follows:

Criteria	**Maximum Marks**
a) Internal Assessment Tests	30
b) Percentage of Attendance	5
c) Assignment (s)	5
Total	**40**

Marks for Attendance is as follows:

Below 75%	0
75% - 80%	1
81% - 85%	2

86% - 90%	3
91% - 95%	4
96% - 100%	5

The Principal of the College/Institute schedules the Internal Assessment tests for all courses. All faculty members are expected to conduct this Internal Assessment tests for 1.30 hours duration and evaluate and required to upload the marks to the Controller of Examinations of University. Colleges are also requested to preserve the answer sheets of Internal Assessment tests until declaration of results by the University.

Internal Assessment (Practical's)

Faculty in-charge of Lab courses shall evaluate the practical course for 60 marks. The break up is as follows:

Criteria	**Maximum Marks**
a) Laboratory exercises and Record	30
c) Mid Semester exam (Average of 2 exams)	15
c) Internal Viva voce	5
d) Percentage of Attendance	10
Total	**60**

Marks for Attendance is as follows:

Attendance %	Mark
Below 75%	0
75% - 80%	2
81% - 85%	4
86% - 90%	6
91% - 95%	8
96% - 100%	10

Internal Assessment (Project)

The Project work carried out in the eighth semester shall be assessed as follows:

Criteria	Marks
a) Continuous assessment (Guide)	25
b) Project Evaluation Committee	35
Total	**60**

Requirement for appearing for University Examination

The Controller of Examinations (COE) of Pondicherry University schedules the End-Semester exams for all theory and practical courses based on the University academic calendar.

A detailed Exam Time Table shall be circulated to all Colleges at least 15 days before the start of exams. Question Papers shall be set externally based on BOS approved syllabus.

A candidate shall be permitted to appear for university examinations at the end of any semester only if:

i) He / She secures not less than 75% overall attendance arrived at by taking into account the total number of periods in all subjects put together offered by the institution for the semester under consideration.

   (*Candidates who secure overall attendance greater than 60% and less than 75% have to pay a condonation fee as prescribed by university along with a medical certificate obtained from a medical officer not below the rank of Assistant Director*)

ii) He / She earns a progress certificate from the Head of the institution for having satisfactorily completed the course of study in all the subjects pertaining to that semester

iii) His / Her conduct is found to be satisfactory as certified by the Head of the institution.

A candidate who has satisfied the requirement (i) to (iii) shall be deemed to have satisfied the course requirements for the semester.

End Semester Exam Evaluation Pattern

Course	**Maximum marks**
a) Theory course (Sec A, Sec B and Sec C) Questions from all units of syllabus	60 marks
b) Practical course (Based on Lab exercises/Record/ Practical's /Viva)	40 marks
c) Internship /Project Work (Based on Seminar/Project Work/Project report/Presentation and viva voce)	40 marks

Consolidation of Marks and Passing Minimum

The Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in the end-semester examination.

A student shall be declared to have passed the examination in a subject of study only if he/she secures not less than **40% marks individually both in internal assessment and end-semester examination or an aggregate of 40%.**

A candidate who has been declared "Fail" in a particular subject may reappear for that subject during the subsequent semesters and secure pass marks. However, there is a provision for revaluation of failed or passed subjects provided he/she fulfills the following norms for revaluation.

a) Applications for revaluation should be filed within 15 days from the date of declaration of results or 7days from the date of receipt of grade sheet whichever is earlier.

b) The candidate should have attended all the internal assessments conducted by the college as well as allthe end semester examinations conducted by the University.

c) If a candidate has failed in more than two papers in the end semester examinations, his/her representation for revaluation will not be considered.

d) The request for revaluation must be made in the prescribed format duly recommended by the Head ofthe Institution along with the revaluation fee prescribed by the University.

A student shall be declared to have passed the examination in a subject of study only **if he/she secures not less than 40% marks in the end-semester examination and secures an overall aggregate of 40%.**

Arrear Exams

A student who failed to secure 40% marks in aggregate is declared as "Fail" and he is eligible to take up a supplementary examination by registering to the said course in the following semester. All other candidates who failed due to shortage of attendance those who are seeking to improve the grade shall repeat the course.

Letter Grades and Calculation of CGPA

Total Marks Secured by a student in each course shall be converted into a letter grade. The following Table shows the seven letter grades and corresponding meaning and the grade points for the calculation of Cumulative Grade Point Average (CGPA).

Each course (Theory/Practical) is to be assigned 100 marks, irrespective of the number of credits, and the mapping of marks to grades may be done as per the following table:

Range of Marks	**Assigned Grade**	Grade Points
91-100	A^+	10
81-90	A	9
71-80	B^+	8
61-70	B	7
51-60	C^+	6
46-50	C	5

40-45	D	4
<40	F	0
-	F^R (Fail due to shortage of attendance and therefore, to repeat the course)	

Note: -F- denotes failure in the course; - F^R - denotes absent / detained as per AICTE norms.

After the results are declared, grade sheets will be issued to the students. The grade sheets will contain the following details:

a) The college in which the candidate has studied.

b) The list of courses enrolled during the semester and the grades scored.

c) The Grade Point Average (GPA) for the semester and t he Cumulative Grade PointAverage (CGPA) of all enrolled subjects from first semester onwards.

d) GPA is the ratio of sum of the products of the number of credits (C) of courses registeredand the corresponding Grades Points (GP) scored in those courses, taken for all the courses and sum of the number of credits of all the courses.

$$GPA = \sum(C \times GP) / \sum C$$

CGPA will be calculated in a similar manner, considering all the courses enrolled from first semester. F^Rgrades are to be excluded for calculating GPA and CGPA.

e) The conversion of CGPA into percentage marks is as follows

$$\% \text{ Mark} = (CGPA - 0.5) \times 10$$

9. Procedure for completing the B.Tech. Course:

A candidate can join/rejoin the course of study of any semester only at the time of its normal commencement and only if he/she has satisfied the course requirements for the previous semester and further has registered for the university examinations of the previous semester in all the subjects as well as all arrear subjects if any.

However, the entire B.Tech. Course should be completed within 7 years (14 semesters) and six years (12 semesters) for students admitted under lateral entry.

10. Award of Class and Rank in B.Tech. Degree:

i) A candidate who satisfies the course requirements for all semesters and who passes all the examinations prescribed for all the eight semesters (six semesters for lateral entry candidates) within a maximum period of 7 years (6 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Tech. Degree.

ii) A candidate who qualifies for the award of the B.Tech. Degree passing in all subjects pertaining to the semesters 3 to 8 in his/her first appearance within 6 consecutive semesters (3 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 3 to 8 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.

iii) A candidate who qualifies for the award of the B.Tech. degree by passing in all subjects relating to semesters 3 to 8 within a maximum period of eight semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than 6.5 shall declared to have passed the examination in **FIRST CLASS**.

iv) All other candidates who qualify for the award of B.Tech. Degree shall be declared to have passed the examination in **SECOND CLASS**.

v) For the Award of University ranks and Gold Medal for each branch of study, the CGPA secured from the 1st to 8th semester alone should be considered and it is mandatory that the candidate should have passed all the subjects from the1st to 8th semester in the first attempt. Rank certificates would beissued to the first ten candidates in each branch of study.

11. Provisions for Honors/Minor degree along with B.Tech. Degree:

1. B.Tech. with Honors Degree in the same Engineering discipline

a. The student shall be given an option to earn a honors degree in the same discipline of engineering at the end of first year based on his academic performance in the first year.

b. A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c. Honors degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d. The student is required to earn an additional 20 credits (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of Honors degree. 20 credits shall be earned by the student by completing 5 additional courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The syllabus of these 5 courses are framed so as to cover advanced topics in that discipline of engineering.

e. The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Honors degree. Eligibility to avail this option is CGPA of 7.5 and above withno arrears in the third Semester. The student will join the existing batch of students in the fourth semester and earn 16 credits by registering the prescribed courses offered up to the seventh semester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f. A student is eligible to get the Honors degree only on completing the programme in 'First Class with Distinction' class.

g. A student can exercise the option to withdraw from the Honors degree at any time after entry.

h. Details about the courses completed and credits earned for Honors degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Honors degree'. In the case of students who have either withdrawn from Honors degree or become ineligible for Honors degree by not securing 'First Class with Distinction', the credits earned for the courses registered and successfully completed for Honors degree will be listed under the heading 'Additional Credits Earned'.

i. The CGPA will be calculated for all the courses credited by the students inclusive of major and honors courses

j. Nomenclature of Honors Degree is 'B.Tech.(Honors) in XXX ', where XXX is Discipline in which the student has enrolled.

2. B.Tech. with Minor degree in another Engineering discipline

a) The student shall be given an option to earn a minor degree in another discipline of engineering of his choice at the end of first year based on his academic performance in the first year.

b) A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c) Minor degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d) The student is required to earn an additional 20 credits (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of minor degree. 20 credits shall be earned by the student by completing 5 additional courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The curricular content of these 5 courses are framed in such a way that that these courses will essentially cover the core minimum knowledge required to be fulfilled for award of degree in the discipline of engineering in which the student chooses to earn the minor degree.

e) The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Minor degree. Students with a CGPA of 7.5 and with no arrears in the third semester are eligible to avail this option. The student will join the existing batch of students in the fourth semester and earn 16 credits by registering for prescribed courses offered up to seventhsemester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f) A student can exercise the option to withdraw from the Minor degree at any time after entry.

g) Details about the courses completed and credits earned for Minor degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Minor degree'. In the case of students who have withdrawn from Minor degree, the credits earned for the courses registered and successfully completed for Minor degree will be listed under the heading 'Additional Credits Earned'.

h) Nomenclature of Minor Degree is 'B.Tech. in XXX with Minor in YYY', where XXX is Discipline in which the student is enrolled and YYY is Discipline which the student has opted as Minor.

i) The CGPA will be calculated for all the courses credited by the students inclusive of major and minor courses.

12. Provision for withdrawal:

Based on the recommendation of the Head of the Institution, a candidate with valid reasons may be granted permission by the University to withdraw from writing the entire semester examination as one Unit. The withdrawal application shall be valid only if it is made earlier than the commencement of the last theory examination pertaining to that semester. Withdrawal shall be permitted only once during the entire course. A candidate who has withdrawn is also eligible to be awarded DISTINCTION provided he/she satisfies the other necessary conditions. But, they are not eligible to be awarded a rank.

13. Provisions for exit in B.Tech. Course:

(For courses where AICTE specifies multiple exits in the model curriculum)

The curriculum and the syllabus for all B. Tech programmes have been planned in compliance with the NEP guidelines proposed by AICTE. Accordingly, students joining B.Tech programmes shall have all benefits NEP offers in terms of exercising exit options at different stages during the course of study. Every B.Tech programme governed under this school board shall adopt the NEP guidelines, as and whenproposed/amended by AICTE, and the following scheme will be applied for all such B.Tech programmes.

NEP 2020 suggests that a student can exercise exits at multiple stages of the course of study. As per AICTEnorms, a student can have two possible exits before the completion of the Full Engineering degree and may get a UG Diploma or B.Sc. degree in the relevant discipline if he/she fulfils the following conditions:

1. UG Diploma/Certificate in the relevant branch of study

A student should be able to get a UG Diploma if he/she completes:

a) 50% of the credits for B.Tech. (80-85 credits)
b) 50% of the program core courses
c) Students exiting the program after earning 50% credit requirements will be awarded a UG Diploma provided they secure an additional 6 credits through summer internships/apprenticeship of 2 months duration.
d) Students admitted through lateral entry cannot exercise the exit option as he will not be able to meet out the 50% Credits for B.Tech. Degree.

2. B.Sc. in the relevant branch of study

A student should be able to get a B.Sc. degree if he/she completes:

i. 75% of the credits for B.Tech. (120 -122 credits) and at least 3 years in the program

ii. 100% of the core program courses.

iii. Students exiting the program after earning 75% credit requirements will be awarded a B.Sc. provided, they secure an additional 6 credits through 2 summer internships/apprenticeship for 2 months each.

iv. With B.Sc. degree, the student is eligible for entry into programs which take B.Sc. degree as eligibility criteria.

Award of Class in B.Sc. degree

A candidate who satisfies the course requirements for all semesters and who passes all the examinations within a maximum period of 6 years (5 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Sc. degree in the relevant discipline.

i) A candidate who qualifies for the award of the B.Sc. degree passing in all subjects pertaining to semesters the 3 to 6 in his/her first appearance within 4 consecutive semesters (2 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 3 to 6 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.

ii) A candidate who qualifies for the award of the B.Sc. degree by passing in all subjects relating tosemesters 3 to 6 within a maximum period of six semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than 6.5 shall declared to have passed the examination in **FIRST CLASS.**

iii) All other candidates who qualify for the award of B.Sc. degree shall be declared to have passed the examination in **SECOND CLASS**.

3. Re-entry to complete the program

A student exiting with a UG Diploma or B.Sc. should be entitled to re-enrol in the programme of the same Engineering discipline. Only students admitted to the B.Tech. programme and exercised an exit option are eligible for readmission to the B.Tech. programme under the same discipline. It is suggested that all credits will be transferred, if the student enrols back within a limited period (3 years) of exiting. In case a student enrolls after that, then the decision on the transfer of credits should be based on the changes in the curriculum the student studied. A candidate after exit may rejoin the course only at the commencement of the semester at which he/she discontinued, provided he/she pays the prescribed fees to the University. The total period of completion of the B.Tech. Course reckoned from the commencement of the first semester to which the candidate was admitted shall not in any case exceed 7 years, including of the period of discontinuance.

4. Completion Possibility in other Institutions

A student can earn a UG Diploma/B.Sc. in one institution (Engineering) and complete the degree program in another institution (same Engineering discipline only).

(Note: If these exit options are accepted for multiple B.Tech. programs, it is suggested that AICTE actively communicate these to the industry and other bodies, so they recognize these and accept them as bona-fide credentials for the purposes of recruitment and/or eligibility for admission to programs, appearing in competitive examinations, etc.)

14. Revision of Regulations and Curriculum:

The University may from time-to-time revise, amend or change the regulations of curriculum and syllabus as and when found necessary.

GENERAL COURSE STRUCTURE

&

CREDIT DISTRIBUTION

GENERAL COURSE STRUCTURE & THEME

A. Definition of Credit:

1 Hr. Lecture (L)	1 Credit
1 Hr. Tutorial (T)	1 Credit
2 Hours Practical (P)	1 Credit

B. Range of Credits: In the light of the fact that a typical Model Four-year Under Graduate degree program in Engineering has about 160 credits, the total number of credits proposed for the four-year B. Tech in Biomedical Engineering is kept as 162.

C. Structure of UG Program in BME: The structure of UG program in Biomedical Engineering shall have essentially the following categories of courses with the breakup of credits as given:

S. No	Category	Abbreviation	Credit Breakup	Percentage of Credit Breakup
1	Humanities, Social Sciences and Management courses	HSM	9	5.55
2	Basic Science courses	BSC	26	16.04
3	Engineering Science courses including workshop, drawing, basics of electronics/ electrical/ mechanical/computer etc.	ES	14	8.64
4	Professional Core Courses	PCC	67	41.35
5	Professional Elective Courses relevant to chosen specialization/branch	PEC	18	11.11
6	Open Electives subjects from other technical and /oremerging subjects	OE	9	5.55
7	Project work (Mini, Micro & Major) & Internship	PW	19	11.72
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	MC	(non-credit)	-
	Total		**162***	**100%**

D. Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
MC	Mandatory courses

□ **Course level coding scheme:** Three-digit number (odd numbers are for the odd semester courses and even numbers are for even semester courses) used as suffix with the Course Code for identifying the level of the course. Digit at hundred's place signifies the year in which course is offered. e.g.

101, 102 … etc. for first

year. 201, 202 …. Etc.for second year. 301, 302 … for third year.

□ Category-wise Courses

HUMANITIES, SOCIAL SCIENCES AND MANAGEMENT COURSES [HSM]

(i) Number of Humanities & Social Science Courses: 3
(ii) Credits: 9

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	HSMC01	ENGLISH FOR TECHNICAL WRITING	II	2	0	2	3
2	HSMC 02	UNIVERSAL HUMAN VALUES -II	II	2	1	0	3
3	HSMC-03	ENTREPRENEURSHIP DEVELOPMENT	VII	2	0	0	3
Total Credits							**9**

BASIC SCIENCE COURSE [BSC]

(i) Number of Basic Science Courses:7
(ii) Credits: 26

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	BSC-101	PHYSICS	I	3	1	2	5
2	BSC-102	MATHEMATICS-I	I	3	1	0	4
3	BSC-103	CHEMISTRY	II	3	0	2	4
4	BSC-104	MATHEMATICS-II	II	3	1	0	4
5	BSC-105	BIOLOGY FOR ENGINEERS	II	2	0	2	3
6	BSC-201	NANO SCIENCE	III	2	1	0	3
7	BSC-202	MEDICAL PHYSICS	IV	3	0	0	3
Total Credits							**26**

ENGINEERING SCIENCE COURSE [ESC]

(i) Number of Engineering Science Courses:5
(ii) Credits: 17

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				L	T	P	
1	ESC-101	PROGRAMMING FOR PROBLEMSOLVING	I	2	1	2	4
2	ESC-102	ENGINEERING GRAPHICS & DESIGN	I	1	0	4	3
3	ESC-103	DESIGN THINKING	I	0	0	2	1
4	ESC-104	BASIC ELECTRICAL ENGINEERING	II	2	0	4	4
5	ESC-105	DIGITAL FABRICATION	II	0	0	4	2
Total Credits							**14**

PROFESSIONAL CORE COURSES [PCC]

(i) Number of Professional Core Courses: 29

(ii) Credits: 67

S.NO	SEM	CODE	NAME	L	T	P	C	Page No.
1	III	BMPCT301	HUMAN ANATOMY AND PHYSIOLOGY	3	0	0	3	73
2	III	BMPCT302	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATION	3	1	0	4	75
3	III	BMPCT303	IMMUNOLOGY AND PATHOLOGY	3	0	0	3	77
4	III	BMPCT304	BIOSIGNALS AND SYSTEMS	3	0	0	3	79
5	III	BMPCT305	ELECTRONIC DEVICES AND CIRCUITS	3	0	0	3	81
6	III	BMPCP301	HUMAN ANATOMY AND PHYSIOLOGY LAB	0	0	2	1	85
7	III	BMPCP302	IMMUNOLOGY AND PATHOLOGY LAB	0	0	2	1	86
8	III	BMPCP303	ELECTRONICS DEVICES & CIRCUITS LAB	0	0	2	1	87
9	IV	BMPCT401	PROBABILITY AND RANDOM PROCESS	3	1	0	4	91
10	IV	BMPCT402	BIOMEDICAL SENSORS AND TRANSDUCERS	3	0	0	3	93
11	IV	BMPCT403	MEDICAL INSTRUMENTATION	3	0	0	3	95
12	IV	BMPCT404	BIOCHEMISTRY	3	0	0	3	97
13	IV	BMPCT405	LINEAR INTEGRATED CIRCUITS	3	0	0	3	99
14	IV	BMPCP401	BIOMEDICAL SENSORS AND TRANSDUCERS LAB	0	0	2	1	103
15	IV	BMPCP402	MEDICAL INSTRUMENTATION LAB	0	0	2	1	104
16	IV	BMPCP403	BIOCHEMISTRY LAB	0	0	2	1	105
17	V	BMPCT501	BIOMEDICAL SIGNAL PROCESSING	3	0	0	3	109
18	V	BMPCT502	DIAGNOSTIC INSTRUMENTATION	3	0	0	3	111
19	V	BMPCT503	MICROPROCESSOR AND MICROCONTROLLER	3	0	0	3	113
20	V	BMPCT504	BIOMECHANICS AND BIOFLUIDS	3	0	0	3	115
21	V	BMPCT505	MEDICAL IMAGE TECHNIQUE	3	0	0	3	117
22	V	BMPCT506	BIOMATERIALS	3	0	0	3	119
23	V	BMPCP501	BIOMEDICAL SIGNAL PROCESSING LAB	0	0	2	1	121
24	V	BMPCP502	DIAGNOSTIC INSTRUMENTATION LAB	0	0	2	1	122
25	V	BMPCP503	MICROPROCESSOR AND MICROCONTROLLER LAB	0	0	2	1	123
26	VI	BMPCT601	THERAPEUTIC INSTRUMENTATION	3	0	0	3	126
27	VI	BMPCT602	MEDICAL EMBEDDED SYSTEM	3	0	0	3	128
28	VI	BMPCP601	THERAPEUTIC INSTRUMENTATION LAB	0	0	2	1	130
29	VI	BMPCP602	MEDICAL EMBEDDED SYSTEM LAB	0	0	2	1	131
TOTAL							67	

PROFESSIONAL ELECTIVE [PEC]

(i) Number of Professional Elective Courses: 4

(ii) Credits: 12

S.No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	BMPECO1	Professional Elective-I	VI	3	0	0	3
2	BMPECO2	Professional Elective-II	VI	3	0	0	3
3	BMPECO3	Professional Elective-III	VI	3	0	0	3
4	BMPECO4	Professional Elective- IV	VII	3	0	0	3
5	BMPECO5	Professional Elective- V	VII	3	0	0	3
6	BMPECO6	Professional Elective- VI	VIII	3	0	0	3
Total Credits							**18**

PROGRAM ELECTIVE COURSES

S.NO	ELE	CODE	NAME	L	T	P	C	Page No.
1	I	BMPEC161	MEDICAL DEVICE DESIGN	3	0	0	3	140
2	I	BMPEC162	MEDICAL INFORMATICS AND EXPERT SYSTEM	3	0	0	3	142
3	I	BMPEC163	PATIENT SAFETY, STANDARDS AND ETHICS	3	0	0	3	144
4	I	BMPEC164	BRAIN COMPUTER INTERFACE AND APPLICATIONS	3	0	0	3	146
	I	BMPEC165	MEDICAL IMAGE PROCESSSING					148
5	II	BMPEC261	FUNDAMENTALS OF HEALTHCARE ANALYTICS	3	0	0	3	150
6	II	BMPEC262	NANO ELECTRONICS	3	0	0	3	152
7	II	BMPEC263	ROBOTICS IN MEDICINE	3	0	0	3	154
8	II	BMPEC264	REHABILITATION ENGINEERING	3	0	0	3	156
9	III	BMPEC361	HOSPITAL SAFETY AND MANAGEMENT	3	0	0	3	158
10	III	BMPEC362	BIO MEMS	3	0	0	3	160
11	III	BMPEC363	HOSPITAL PLANNING AND MANAGEMENT	3	0	0	3	162
12	III	BMPEC364	CRITICAL CARE AND OPERATION THEATRE EQUIPMENT	3	0	0	3	164
13	IV	BMPEC471	VIRTUAL INSTRUMENTATION	3	0	0	3	166
14	IV	BMPEC472	BIOMEDICAL OPTICS AND BIOPHOTONICS	3	0	0	3	168
15	IV	BMPEC473	NEURAL ENGINEERING	3	0	0	3	170
16	IV	BMPEC474	MEDICAL WASTE MANAGEMENT	3	0	0	3	172
17	V	BMPEC571	CLINICAL ENGINEERING	3	0	0	3	174
18	V	BMPEC572	PHARMACEUTICAL NANOTECHNOLOGY	3	0	0	3	176

19	V	BMPEC573	VIRTUAL REALITY AND AUGMENTED REALITY IN HEALTHCARE	3	0	0	3	178
20	V	BMPEC574	DRUG DELIVERY SYSTEMS	3	0	0	3	180
21	VI	BMPEC681	TISSUE ENGINEERING AND REGENERATIVE MEDICINE	3	0	0	3	182
22	VI	BMPEC682	ARTIFICIAL ORGANS	3	0	0	3	184
23	VI	BMPEC683	MEDICAL ETHICS AND REGULATORY AFFAIRS	3	0	0	3	185
24	VI	BMPEC684	WEARABLE SYSTEMS FOR HEALTHCARE	3	0	0	3	186
25	VI	BMPEC685	PHYSIOLOGICAL MODELLING	3	0	0	3	188

OPEN ELECTIVE COURSES [OEC]

(i) Number of Open Elective Courses: 3
(ii) Credits: 9

S.No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	BMOEC01	Open Elective-I	VI	3	0	0	3
2	BMOEC02	Open Elective-II	VII	3	0	0	3
3	BMOEC03	Open Elective-III	VIII	3	0	0	3
Total Credits							**9**

OPEN ELECTIVE COURSES [OEC]

S.NO	ELE	CODE	NAME	L	T	P	C	Page No.
			OPEN ELECTIVE I					
1	I	BMOEC161	TELEHEALTH TECHNOLOGY	3	0	0	3	191
2	I	BMOEC162	MEDICAL INFORMATICS	3	0	0	3	193
3	I	BMOEC163	FORENSIC SCIENCE IN HEALTHCARE	3	0	0	3	195
4	I	BMOEC164	ARTIFICIAL INTELLIGENCE	3	0	0	3	197
			OPEN ELECTIVE II					
1	II	BMOEC271	ROBOTIC PROCESS AUTOMATION	3	0	0	3	199
2	II	BMOEC272	FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY	3	0	0	3	201
3	II	BMOEC273	BIOTECHNOLOGY IN HEALTH CARE	3	0	0	3	203
			OPEN ELECTIVE III					
1	III	BMOEC381	MULTIVARIATE DATA ANALYSIS	3	0	0	3	205
2	III	BMOEC383	BIOMEDICAL INDUSTRIAL MANAGEMENT	3	0	0	3	207
3	III	BMOEC384	LIFESTYLE DISEASES	3	0	0	3	209

PROJECT/ SEMINAR/INTERNSHIP

Number of Courses: 4

Credits: 19

S.NO	SEM	CODE	NAME	L	T	P	C
1	VI	BMPW601	MICROPROJECT	0	0	6	2
2	VII	BMPW701	MINI PROJECT	0	0	6	3
3	VII	BMINT701	INTERNSHIP	0	0	4 TO 6 WEEKS	2
4	VIII	BMPW802	MAJOR PROJECT	0	0	24	12
TOTAL CREDITS							19

MANADATORY / AUDITORY COURSE:

Number of Courses: **5**

CREDITS: 0

S.NO	CODE	COURSE NAME	L	T	P	C	Page No.
1	AUC001	IDEA LAB WORKSHOP	1	0	0	0	51
2	AUC002	SPORTS AND YOGA	1	0	0	0	70
3	AUC003	INDIAN CONSTITUTION & KNOWLEDGE SYSTEMS	1	0	0	0	89
4	AUC004	ENVIRONMENTAL SCIENCE	1	0	0	0	106
5	AUC005	INTRODUCTION TO WOMEN AND GENDER STUDIES	1	0	0	0	124

COURSES FOR B. TECH. HONOURS (OPTIONAL)

ELECTIVE I

S.NO	CODE	COURSE NAME	CATEGORY	L	T	P	C	IA	UE	TM	Page No.
1.	BMH131	ARTIFICIAL ORGANS AND IMPLANTS	PEC	4	0	0	4	40	60	100	211
2.	BMH132	BIOSENSORS AND MEASUREMENTS	PEC	4	0	0	4	40	60	100	213
3.	BMH133	PRINCIPLES OF TISSUE ENGINEERING	PEC	4	0	0	4	40	60	100	215
4.	BMH134	GENETIC ENGINEERING	PEC	4	0	0	4	40	60	100	217

ELECTIVE II

S.NO	CODE	COURSE NAME	CATEGORY	L	T	P	C	IA	UE	TM	Page No.
1.	BMH241	BIOCONTROL SYSTEM	PEC	4	0	0	4	40	60	100	219
2.	BMH242	BIOSIGNAL CONDITIONING	PEC	4	0	0	4	40	60	100	221
3.	BMH243	BIO VIRTUAL INSTRUMENTATION	PEC	4	0	0	4	40	60	100	223
4.	BMH244	ANALYTICAL INSTRUMENTATION	PEC	4	0	0	4	40	60	100	225

ELECTIVE III

S.NO	CODE	COURSE NAME	CATEGORY	L	T	P	C	IA	UE	TM	Page No.
1.	BMH351	PATIENT SAFETY, STANDARDS AND ETHICS	PEC	4	0	0	4	40	60	100	227
2.	BMH352	MEDICAL DEVICE REGULATIONS	PEC	4	0	0	4	40	60	100	229
3.	BMH353	BIOMEMS AND NANOTECHNOLOGY	PEC	4	0	0	4	40	60	100	231
4.	BMH354	3D PRINTING FOR BIOMATERIALS	PEC	4	0	0	4	40	60	100	233

ELECTIVE IV

S.NO	CODE	COURSE NAME	CATEGORY	L	T	P	C	IA	UE	TM	Page No.
1.	BMH461	BIO –TELEMETRY	PEC	4	0	0	4	40	60	100	235
2.	BMH462	HUMAN ASSIST DEVICE	PEC	4	0	0	4	40	60	100	236
3.	BMH463	ERGONOMICS	PEC	4	0	0	4	40	60	100	238
4.	BMH464	MEDICAL ETHICS & IPR	PEC	4	0	0	4	40	60	100	240

ELECTIVE V

S.NO	CODE	COURSE NAME	CATEGORY	L	T	P	C	IA	UE	TM	Page No.
1.	BMH571	VR AND AR IN BIOMEDICAL APPLICATIONS	PEC	4	0	0	4	40	60	100	242
2.	BMH572	AI FOR HEALTHCARE	PEC	4	0	0	4	40	60	100	244
3.	BMH573	DEEP LEARNING FOR BIOMEDICAL APPLICATIONS	PEC	4	0	0	4	40	60	100	246
4.	BMH574	MEDICAL BIG DATA ANALYTICS	PEC	4	0	0	4	40	60	100	248

COURSES FOR B. TECH. MINOR DEGREE (OPTIONAL) MEDICAL INSTRUMENTATION

ELECTIVE I

S.NO	CODE	COURSE NAME	L	T	P	C	IA	UE	TM	Page No.
1.	BMM001	PHYSIOLOGICAL CONTROL SYSTEMS	4	0	0	4	40	60	100	251
2.	BMM002	BIOMEDICAL EQUIPMENTS	4	0	0	4	40	60	100	253
3.	BMM003	INFRARED IMAGING & APPLICATIONS	4	0	0	4	40	60	100	255
4.	BMM004	BIOMEDICAL SENSORS AND DATA ACQUISITION TECHNIQUES	4	0	0	4	40	60	100	257
5.	BMM005	MEDICAL ROBOTICS	4	0	0	4	40	60	100	259
6	BMM006	INVASIVE AND NON-INVASIVE MEDICAL DIAGNOSTIC TECHNIQUES	4	0	0	4	40	60	100	261
7	BMM007	BIOMEDICAL INSTRUMENTATION	4	0	0	4	40	60	100	262
8	BMM008	BASICS OF MICROBIAL TECHNOLOGY	4	0	0	4	40	60	100	264
9	BMM009	RADIOIMAGING AND THERAPEUTICS	4	0	0	4	40	60	100	265
10	BMM010	BIOVIRTUAL INSTRUMENTATION	4	0	0	4	40	60	100	267
11	BMM011	MEDICAL EQUIPMENT MAINTENANCE AND TROUBLESHOOTING	4	0	0	4	40	60	100	269
12	BMM012	MEDICAL OPTICS AND LASER APPLICATIONS	4	0	0	4	40	60	100	271
13	BMM013	ADVANCED BIOSIGNAL ANALYSIS	4	0	0	4	40	60	100	273

SEMESTER WISE STRUCTURE

Semester I										
3-Weeks Induction Programme (UHV-I)										
S.No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credit**	**Marks**		
								IA	**UE**	**TM**
THEORY										
1	BSCT101	Chemistry	BSC	3	0	0	3	40	60	100
2	BSCT102	Mathematics-I	BSC	3	1	0	4	40	60	100
3	ESCT102	Programming for Problem Solving	ESC	3	0	0	3	40	60	100
4	BSCT103	Biology for Engineers	BSC	3	0	0	3	40	60	100
PRACTICAL										
5	BSCP101	Chemistry laboratory	BSC	0	0	2	1	60	40	100
6	ESCP101	Engineering Graphics & Design	ESC	1	0	4	3	60	40	100
7	ESCP102	Programming for Problem Solving Laboratory	ESC	0	0	2	1	60	40	100
8	ESCP103	Design Thinking	ESC	0	0	2	1	60	40	100
9	AUC001	IDEA Lab Workshop	AUC	2	0	4	0	-	-	-
Total							**19**	400	400	800
Semester II										
S.No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credit**	**Marks**		
								IA	**UE**	**TM**
THEORY										
1	BSCT104	Physics	BSC	3	1	0	4	40	60	100
3	BSCT105	Mathematics-II	BSC	3	1	0	4	40	60	100
4	ESCT104	Basic Electrical Engineering	ESC	2	1	0	3	40	60	100
7	HSMC101	English for Technical Writing	HSMC	2	0	2	3	60	40	100
8	HSMC 102	Universal Human Values -II	HSMC	2	1	0	3	60	40	100
PRACTICAL										
2	BSCP104	Physics Laboratory	BSC	0	0	2	1	60	40	100
5	ESCP104	Basic Electrical Engineering Laboratory	ESC	0	0	2	1	60	40	100
6	ESCP105	Digital Fabrication	ESC	0	0	4	2	60	40	100
9	AUC002	Sports and Yoga	AUC	1	0	1	0	-	-	-
Total							**21**	420	380	800

Semester-III										
S. No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credit**	**Marks**		
								IA	**UE**	**TM**
THEORY										
1	BMPCT301	Human Anatomy and Physiology	PCC	3	0	0	3	40	60	100
2	BMPCT302	Transforms And Partial Differential Equation	PCC	3	1	0	4	40	60	100
3	BMPCT303	Immunology and Pathology	PCC	3	0	0	3	40	60	100
4	BMPCT304	Biosignals and Systems	PCC	3	0	0	3	40	60	100
5	BMPCT305	Electronic Devices and Circuits	PCC	3	0	0	3	40	60	100
6	BSC-201	Nano Science And Technology	BSC	2	1	0	3	40	60	100
PRACTICAL										
8	BMPCL301	Human Anatomy and Physiology Lab	PCC	0	0	2	1	60	40	100
8	BMPCL302	Electronics Device & Circuits Lab	PCC	0	0	2	1	60	40	100
9	BMPCL303	Immunology & Pathology Lab	PCC	0	0	2	1	60	40	100
10	AUC003	Indian Constitution & Knowledge Systems	AU	0	1		0	-	-	-
TOTAL							**22**	420	480	900

Semester-IV										
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credit**	**Marks**		
								IA	**UE**	**TM**
THEORY										
1	BMPCT401	Probability and Random Process	PCC	3	0	0	4	40	60	100
2	BMPCT402	Biomedical Sensors and Transducers	PCC	3	0	0	3	40	60	100
3	BMPCT403	Medical Instrumentation	PCC	3	0	0	3	40	60	100
4	BMPCT404	Biochemistry	PCC	3	0	0	3	40	60	100
5	BMPCT405	Linear Integrated Circuits	PCC	3	0	0	3	40	60	100
6	BSC-207	Medical Physics	BSC	2	1	0	3	40	60	100
PRACTICAL										
7	BMPCL401	Biomedical Sensors and Transducers Lab	PCC	0	0	2	1	60	40	100
8	BMPCL402	Medical Instrumentation Lab	PCC	0	0	2	1	60	40	100
9	BMPCL403	Biochemistry Lab	PCC	0	0	2	1	60	40	100
10	AUC004	Environmental Science	AUC	1	0	1	0	-	-	-
TOTAL							**22**	420	480	900

Semester-V										
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credit**	**Marks**		
								IA	**UE**	**TM**
THEORY										
1	BMPCT501	Biomedical Signal Processing	PCC	3	0	0	3	40	60	100
2	BMPCT502	Diagnostic Instrumentation	PCC	3	0	0	3	40	60	100
3	BMPCT503	Microprocessor and Microcontroller	PCC	3	0	0	3	40	60	100
4	BMPCT504	Biomechanics And Bio fluids	PCC	3	0	0	3	40	60	100
5	BMPCT505	Medical Image Technique	PCC	3	0	0	3	40	60	100
6	BMPCT506	Biomaterials	PCC	3	0	0	3	40	60	100
PRACTICAL										
7	BMPCL501	Biomedical Signal Processing Lab	PCC	0	0	2	1	60	40	100
8	BMPCL502	Diagnostic Instrumentation Lab	PCC	0	0	2	1	60	40	100
9	BMPCL503	Microprocessor and Microcontroller Lab	PCC	0	0	2	1	60	40	100
10	AUC005	Introduction To Women And Gender Studies	MC/AU	1	0	0	0	-	-	-
TOTAL							**21**	420	480	900

Semester-VI										
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credit**	**Marks**		
								IA	**UE**	**TM**
THEORY										
1	BMPCT601	Therapeutic Instrumentation	PCC	3	0	0	3	40	60	100
2	BMPCT602	Medical Embedded System	PCC	3	0	0	3	40	60	100
3	BMPEC16X	Program Elective - 01	PEC	3	0	0	3	40	60	100
4	BMPEC26X	Program Elective - 02	PEC	3	0	0	3	40	60	100
5	BMPEC36X	Program Elective - 03	PEC	3	0	0	3	40	60	100
6	BMOEC16X	Open Elective - 01	OEC	3	0	0	3	40	60	100
PRACTICAL										
7	BMPCL601	Therapeutic Instrumentation Lab	PCC	0	0	2	1	60	40	100
8	BMPCL602	Medical Embedded System	PCC	0	0	2	1	60	40	100
9	BMPW601	Micro Project	PW I	0	0	6	2	100		100
TOTAL							**22**	460	440	900

Semester-VII										
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credit**	**Marks**		
								IA	**UE**	**TM**
THEORY										
1	BMPEC47X	Program Elective-4	PCC	3	0	0	3	40	60	100
2	BMPEC57X	Program Elective-5	PEC	3	0	0	3	40	60	100
3	BMOEC27X	Open Elective-2	OEC	3	0	0	3	40	60	100
4	HSMC-03	Entrepreneurship Development	HSM	3	0	0	3	40	60	100
PRACTICAL										
5	BMPW701	Mini Project	PW II	0	0	3	3	60	40	100
6	BMINT701	Internship	INT	0	0	4 to 6 Weeks	2	100	-	100
TOTAL							18	320	280	600

Semester-VIII										
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credit**	**Marks**		
								IA	**UE**	**TM**
1	BMPEC68X	Program Elective-6	PEC	3	0	0	3	40	60	100
2	BMOEC38X	Open Elective-3	OEC	3	0	0	3	40	60	100
PRACTICAL										
3	BMPW801	Major Project	PW III	0	0	24	12	60	40	100
TOTAL							**18**	140	160	300

SEMESTER – I

SEMESTER I

Induction program (UHV-I)	**Three-week duration(mandatory)**

Objective:

The induction program for students offered at the start of the first year aims to provide a holistic and enriching experience to new students, fostering their personal growth, academic preparedness, and a strong sense of belonging to the institution.

The program is designed to achieve the following objectives:

1. To help students smoothly transition from school to college life.
2. To facilitate opportunities for students to interact with their peers, faculty, and staff.
3. To enhance Physical Well-being: and encouraging Creative Expression.
4. To instill Universal Human Values.
5. To develop Communication and Literary Skills, Visit Local areas and get inspiration from Eminent Personalities and thus gain Confidence to nurture a Positive Learning Environment.

The Induction program contains.

- Physical activity
- Creative Arts
- Universal Human Values
- Literary
- Proficiency Modules
- Lectures by Eminent People
- Visits to local Areas
- Familiarization to Dept./Branch & Innovations

The Essence and Details of Induction program can also be understood from the "Detailed Guide on Student Induction program", as available on AICTE Portal,

(Link:https://www.aicteindia.org/sites/default/files/Detailed%20Guide%20on%20Student%20I nduction%20program.pdf).

BSCT101	CHEMISTRY	L	T	P	Credit
		3	0	0	3

Course Objectives:

- *To acquaint the students with basic concepts of chemistry in understanding the atomic & molecular structure and its nanoscale applications.*
- *To understand the fundamental concepts of various spectroscopic techniques and applications.*
- *To understand the basic electrochemical properties such as thermodynamic functions, cell potentials, lead storage batteries, corrosion and phase rule.*
- *To describe and explain the observed trends in atomic size, ionization energy, and electron affinity of the elements.*
- *To identify the various types, preparation and applications of polymer used in the industrial processes.*

Course Contents:

MODULE I - ATOMIC AND MOLECULAR STRUCTURE: 9 Hours

Atomic and Molecular Structure: Molecular orbital‟s of diatomic molecules. Band theory of solids. Liquid crystal and its applications. Point defects in solids. Structure and applications of Graphite and Fullerenes. Concepts of Nanomaterials and its application

MODULE II - SPECTROSCOPIC TECHNIQUES AND APPLICATIONS: 9 Hours

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Elementary idea and simple applications of Rotational, Vibrational, Ultravoilet & Visible and Raman spectroscopy.

MODULE III – ELECTRO CHEMISTRY: 9 Hours

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and EMF. Cell potentials, Nernst Equation and application, Lead storage battery. Corrosion; causes, effects and its prevention. Phase Rule and its application to water system.

MODULE IV - PERIODIC PROPERTIES 9 Hours

Effective nuclear charge, penetration of orbital‟s, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electro-negativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

MODULE V – POLYMER: 9 Hours

Basic concepts of polymer-Blend and composites, Conducting and biodegradable polymers. Preparation and application of some industrially important polymers (BunaS, Buna-N, Neoprene, Nylon-6, nylon-6,6 and Terylene). General methods of synthesis of organometallic compounds (Grignard reagent) and their applications.

Total No. of Hours: 45

Text Books:

1. B. H. Mahan, "University chemistry" Pearson Education, 2009.
2. C.N.R. Rao, "University Chemistry" World Scientific Publishing Company, 2009
3. M. J. Sienko and R. A. Plane, "Chemistry: Principles and Applications" McGraw-Hill, 3rd edition 1980.

Reference Books:

1. C. N. Banwell, "Fundamentals of Molecular Spectroscopy" McGraw-Hill Book Company, 1983.
2. B. L. Tembe, Kamaluddin and M. S. Krishnan, "Engineering Chemistry (NPTELWeb-book).
3. P. W. Atkins, Julio de Paula, "Physical Chemistry" Oxford University Press, 2018

Course Outcomes:

On successful completion of this course, the students will be able to,

- Get an understanding of the theoretical principles understanding molecular structure, bonding and properties
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energylevels in various spectroscopic techniques
- Understand and explain the thermodynamic functions and cell potentials for different applications.
- Rationalize specific models and processes for better understanding of material properties and applications.
- Learn the synthesis of various industrially important polymer and its applications.

*****

BSCP101	CHEMISTRY LABORATORY	L	T	P	Credit
		0	0	2	1

Course Objectives:

The Chemistry laboratory course will enable students to get a hands-on experience of determining various analysis parameters learnt in the theory course using different methods/techniques prevalent in analytical chemistry.

List of Experiments:

1. Determination of surface tension and viscosity.
2. Determination of chloride content of water.
3. Determination of cell constant and conductance of solutions.
4. Potentiometry - determination of redox potentials and emfs
5. Synthesis of a polymer/drug.
6. Determination of the partition coefficient of a substance between two immiscible liquids.
7. Saponification/acid value of oil.
8. Chemical analysis of a salt.
9. Lattice structures and packing of spheres.
10. Spectrophotometry: Beer-Lambert‟s law verification and determination of strength of unknown solution.
11. Thin layer chromatography.
12. Ion exchange column for removal of hardness of water.
13. The pH of minimum viscosity for gelatin sols and/or coagulation of the whitepart of egg.

REFERENCES:

Virtual Labs

SL. No.	Experiment Name	Experiment Link(s)
1	Determination of surface tension and viscosity.	http://pcv-au.vlabs.ac.in/physical-chemistry/Determination_of_Viscosity_of_Organic_Solvents/
2	Ion exchange column for removal of hardness of water.	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Chemical_Parameters/
3	Determination of chloride content of water.	http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/Environmental_Engineering_1/experiments/determination-of-chloride-nitk/simulation.html
4	Colligative properties using freezing point depression.	http://pcv-au.vlabs.ac.in/physical-chemistry/Cryoscopy/

5	Determination of the rate constant of are action.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/
6	Determination of cell constant	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Physical_Parameters/
7	Potentiometry - determination of redoxpotentials and EMFs.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/
8	Saponification/acid value of an oil.	http://biotech01.vlabs.ac.in/bio-chemistry/Estimation_of_Saponification_Value_of_Fats_or_Oils/
9	Lattice structures and packing of spheres.	https://vlab.amrita.edu/?sub=1&brch=282&sim=370&cnt=1

Text Books:

1. B. H.Mahan, & Rollie J Meyers , "University chemistry" Pearson Education India; 4th edition (1 January 2009).
2. M.J.Sienkoand R.A.Plane,Ann Arbor, "Principles and Applications" Mich: Edwards Bros., 1955.

Reference Books:

1. B. L. Tembe, Kamaluddin and M. S. Krishnan, "Engineering Chemistry (NPTEL Web-book).
2. P. W. Atkins, Julio de Paula, "Physical Chemistry" Oxford University Press, International Eleventh edition, 2018.
3. K. Peter C. Vollhardt & Neil E. Schore, "Organic Chemistry: Structure and Function" 5th Edition December 28, 2005

Course Outcome*:*

The Chemistry laboratory course aims at developing abilities in combining chemical principles alongside handling instruments/techniques and synthesis methodologies to facilitate good understanding of the subject.

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BSCT102	MATHEMATICS-I	L	T	P	Credits
		3	1	0	4

Course Objective:

- *To comprehend the mathematical concepts of matrices, ordinary differential equations, multivariable calculusand problem-solving.*

Course Contents:

MODULE I LINEAR ALGEBRA (MATRICES) (12 Hrs)

Rank of a matrix - Consistency of a system of linear equations - Characteristic equation of a matrix - Eigen values and Eigen vectors - Properties of Eigen values and Eigen vectors - Cayley-Hamiltontheorem (excluding proof)- Verification- Application (Finding Inverse and Power of a matrix)- Diagonalization of a matrix by orthogonal and similarity transformation- Quadratic form – Nature of Quadratic Form- Orthogonal reduction of quadratic form to canonical form.

MODULE II ORDINARY DIFFERENTIAL EQUATIONS (12 Hrs)

Differential Equations of First Order- Exact equations- Leibnitz's linear equations- Bernoulli's equation- Equations solvable for p- Clairaut's equation- Differential equations of Higher order- Linear differential equations of higher order with constant coefficients- Euler's linear equation of higher order with variable coefficients- Method of variation of parameters.

MODULE III MULTIVARIABLE CALCULUS (DIFFERENTIATION) (12 Hrs)

Partial differentiation- Partial derivatives of first order and higher order- Partial differentiation of implicit functions- Euler's theorem on homogeneous functions - Total derivative - Jacobian Properties - Taylor's series for functions of two variables- Maxima and minima of functions of two variables.

MODULE IV MULTIVARIABLE CALCULUS (MULTIPLE INTEGRALS) (12 Hrs)

Double integration (Cartesian form and Polar form)-constant limits- variable limits- over the region R- Change of variables in double integrals (Cartesian to polar)- Appli- cation of double integral- Area by double integration- Change of Order of Integration- Triple Integration (Cartesian- Spherical and Cylindrical)- constant limits- variable limits- over the region R- Application of triple integral- Volume by triple integration.

MODULE V MULTIVARIABLE CALCULUS (VECTOR CALCULUS) (12 Hrs)

Vector Differential Operator- Gradient - Properties - Directional derivative - Divergence and curl Properties and relations- Solenoidal and Irrotational vector fields - Line integral and Surface integrals - Integral Theorems (excluding Proof) - Green's theorem - Stoke's theorem - Gauss divergence theorem.

Text Books:

1. Veerarajan T., "Engineering Mathematics - I & II ", Tata McGraw-Hill, New Delhi, 2014 &; 2015.
2. Dr. M.K. Venkataraman, "Engineering Mathematics – Volume I and Volume II", The National PublishingCompany, Chennai 2008.

References:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Bali N.P and Manish Goyal., “A Text Book of Engineering Mathematics”, Laxmi Publications(P) Ltd, 2011.
3. Erwin Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, New Delhi, 9th Edition, 2011
4. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 2010.

ONLINE / NPTEL Courses:

1. Differential equations for engineers: https://nptel.ac.in/courses/111106100
2. Calculus of Several Real Variables: https://nptel.ac.in/courses/111104125
3. Engineering Mathematics - I: https://nptel.ac.in/courses/111105121
4. Matrix Analysis with Applications: https://nptel.ac.in/courses/111107112

Course Outcomes:

CO1. To solve practical problems using Matrix algebra.
CO2. To solve various types of ordinary differential equations, including higher-order linear equation.
CO3. To compute partial derivatives, determine total derivatives, Jacobians, employ Taylor series, and find extrema of functions of two variables.
CO4. To demonstrate proficiency in evaluating double integration and triple integration and using them to compute area and volume.
CO5. To apply Green’s theorem, Stoke’s theorem and Gauss divergence theorem.

ESCP101	ENGINEERING GRAPHICS & DESIGN	L	T	P	Credit
		1	0	4	3

Course Objectives:

- *To provide the basic knowledge about Engineering Drawing.*
- *To learn the concepts of projections, technical drawing, dimensioning and specifications*
- *To understand the engineering graphics standards and solid modeling.*
- *To learn the analysis of Isometric views*
- *To understand the basic concepts of computer aided drafting hardware and its importance in the field of engineering and design.*

Course Contents:

MODULE I- INTRODUCTION:

Introduction, Conics and Special Curves

MODULE II- PROJECTIONS:

Projection of points, lines and planes

MODULE III- SOLIDS:

Projection of solids, section of solids, development of surface

MODULE IV- ISOMETRIC PROJECTIONS:

Isometric and Orthographic projections

MODULE V- AUTOCAD:

Introduction to computer Aided Drafting hardware overview of application software – 2D drafting commands (Auto CAD) for simple shapes – Dimensioning

Text Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., "Engineering Drawing" Charotar Publishing House (2014).
2. Shah, M.B. & Rana B.C., "Engineering Drawing and Computer Graphics" Pearson Education (2008).
3. Agrawal B. & Agrawal C. M., "Engineering Graphics" TMH Publication, 2012.
4. K. Venugopal, "Engineering Drawing and Graphics + Auto CAD" 4th edition, New Age International Publication Ltd., 2004

Reference Books:

1. Narayana, K.L. & P Kannaiah, "Text book on Engineering Drawing" Scitech Publishers, 2008.
2. CAD Software Theory and User Manuals.

Course Outcomes:

On successful completion of this course, the students will be able to

- Describe engineering design and its place in society.
- Discuss the visual aspects of engineering design.
- Use engineering graphics standards.
- Illustrate solid modelling.
- Use computer-aided geometric design.
- Design creating working drawings.

ESCT102	PROGRAMMING FOR PROBLEM SOLVING	L	T	P	Credit
		3	0	0	3

Course Objectives:

- *To learn the fundamentals of computers.*
- *To understand the various steps in program development.*
- *To learn the syntax and semantics of any programming language.*
- *To learn the usage of structured programming approach in solving problems.*
- *To understated and formulate algorithm for programming script*
- *To analyze the output based on the given input variables*

Course Contents:

MODULE I - INTRODUCTION TO PROGRAMMING: 6 Hours

Introduction to components of a computer system: - disks, memory, processor, where a program is stored and executed, operating system, compilers etc. Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithms Flowchart/Pseudocode with examples.

MODULE II- ALGORITHMS TO PROGRAMS: 6 Hours

Source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code. Arithmetic expressions and precedence. Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.

MODULE III - INTRODUCTION TO ARRAYS AND APPLICATIONS: 6 Hours

Arrays, Arrays (1-D, 2-D), Character arrays and Strings, Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexitythrough example programs (no formal definition required)

MODULE IV – FUNCTIONS: 6 Hours

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference. Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc.Quick sort or Merge sort.

MODULE V – STRUCTURES AND POINTERS: 6 Hours

Defining structures and Array of Structures. Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), File handling.

Total No. of Hours: 30

Text Books:

1. Byron Gottfried, Schaum's, “Outline of Programming with C”, McGraw-Hill. 1996
2. E. Balaguruswamy, “Programming in ANSI C” Tata McGraw-Hill. 2019

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, " The C Programming Language" Prentice Hall of India. Second Edition 2015.

Course Outcomes:

Upon successful completion of the course, students should be able to:

CO1. Formulate simple algorithms for arithmetic and logical problems and translate the algorithms to programs and execute the programs and correct syntax and logical errors.
CO2. Discuss the use of arrays for to work with arrays, strings, and basic data structures like linked lists, queues, and stacks.
CO3. Understand the use of functions in the programming language.
CO4. Discuss the arrays and its significance in the programming language with involving arrayconcepts.
CO5. Implement the use of pointers and implementation of memory and handling of files in any programming.

ESCP102	PROGRAMMING FOR PROBLEM SOLVING LABORATORY	L	T	P	Credit
		0	0	2	1

Course Objectives:

- *Introduce students to the fundamental concepts of the any programming language, including variables, data types, operators, and control structures.*
- *Introduce problem-solving techniques and algorithms to approach and solveprogramming challenges efficiently.*
- *Develop proficiency in writing any programs to implement algorithms and solve computational problems.*
- *Introduce students to basic data structures in any, such as arrays, strings, andpointers, and guide them in applying these structures to solve problems effectively.*

List of Experiments**:**

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

Course Outcomes:

Upon successful completion of the course, students should be able to:

- Demonstrate the problem solving skills through programming simple logics.
- Demonstrate the array concepts and memory management through programming.
- Illustrate the pointers and file operations through programming.

References:

Virtual Labs

S. No	Experiment Name	Experiment Link(s)
1	Simple computational problems using arithmetic expressions.	http://ps-iiith.vlabs.ac.in/exp7/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

2	Iterative problems e.g., sum of series.	http://ps-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
3	1D Array manipulation.	http://cse02- iiith.vlabs.ac.in/exp4/index.html
4	Matrix problems, String operations.	http://ps-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
5	Simple functions.	http://cse02- iiith.vlabs.ac.in/exp2/index.html
6	Programming for solving Numerical methods problems.	http://ps-iiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
7	Recursive functions.	http://ps-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

BSCT103	BIOLOGY FOR ENGINEERS	L	T	P	Credit
		3	0	0	3

Course Objectives:

- *To familiarize the students with the basic biological concepts and their engineering applications.*
- *To develop the interdisciplinary vision of biological engineering.*
- *Familiarize engineering students with the principles of microbiology, including the structure and function of microorganisms, their significance in various engineering applications, and techniques for microbial analysis and identification.*

Course Contents:

MODULE I - INTRODUCTION AND CLASSIFICATION OF BIOLOGICAL SCIENCE:

9 Hours

Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. Classification based on (a) energy and carbon utilization-Autotrophs, heterotrophs, lithotropes (b) Ammonia excretion – aminotelic, uricoteliec, ureotelic (c) Habitata- acquatic or terrestrial (d) Molecular taxonomy- three major kingdoms of life.

MODULE II – GENETICS: **9 Hours**

Mendel‟s laws, Concept of segregation and independent assortment. Concepts of excessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

MODULE III - BIOMOLECULES AND ENZYMES: **9 Hours**

Discuss - monomeric units, polymeric structures, sugars, starch and cellulose, amino acids and proteins. Enzyme classification. Mechanism of enzyme action. Enzyme kinetics and kinetic parameters.

MODULE IV - INFORMATION TRANSFER: **9 Hours**

DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination. DICOM Image formats, The DNA Technology (Use and Application)Regulation Bill, 2019

MODULE V - MICROBIOLOGY ANALYSIS: **9 Hours**

Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements. Exothermic and endothermic versus endergonic and xergonic reactions. Synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Identification and classification of single celled organisms.

Total No. of Hours: 45

Text Books:

1. Conn,E.E; Stumpf,P.K; Bruening,G; Doi,R.H., "Outlines of Biochemistry" John Wiley and Sons, 2009.
2. Prescott, L.M J.P. Harley and C.A. Klein, "Microbiology" Wm C. Brown Publishers , 2nd edition 1995.

Reference Books:

1. Uma Devi Koduru, "General Biology" Khanna Book Publishing Company. 2022
2. Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. "Biology: A global approach" Pearson Education Ltd. 12th Edition, 2020.
3. E.E; Stumpf, P.K; Bruening, G; Doi, R.H., "Outlines of Biochemistry" John Wiley and Sons. 2006.

Course Outcomes:

Upon successful completion of the course, students should be able to:

CO1. Describe how biological observations of 18th Centurythat lead to major discoveries.
CO2. Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
CO3. Classify enzymes and distinguish between different mechanisms of enzyme action.
CO4. Identify DNA as a genetic material in the molecular basis of information transfer.
CO5. Identify and classify single cell microorganisms

ESCP103	DESIGN THINKING	L	T	P	Credit
		0	0	2	3

Course Objectives:

- *To provide the new ways of creative thinking*
- *To learn the innovation cycle of Design Thinking process*
- *To develop innovative products*

Course Contents:

MODULE I - LEARNING, MEMORY AND EMOTIONS: 9 Hours

Understanding the learning process, kolb‟s learning styles, assessing and interpreting, understanding the memory process, problems in retention, memory enhancement techniques, understanding emotions: experience & expression, assessing empathy, application with peers

MODULE II - DESIGN THINKING, BEING INGENIOUS & FIXING PROBLEM: 9 Hours

Definition of design thinking, need for design thinking, objectives of design thinking, concepts& brainstorming, stages of design thinking process (explain with examples) – empathize, define, ideate, prototype, test, understanding creative thinking process, understanding problem solving, testing creative problem solving.

MODULE III: PRODUCT DESIGN, PROTOTYPING & TESTING: 9 Hours

Process of engineering product design, design thinking approach, stages of product design, examples of best product designs and functions, assignment – engineering product design, Whatis Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example,Test Group Marketing

MODULE IV: CELEBRATING THE DIFFERENCE AND CUSTOMER CENTRICITY: 9 Hours

Understanding of individual differences & uniqueness, group discussion and activities to encourage the understanding, acceptance and appreciation of individual difference. Practical examples of customer challenges, use of design thinking to enhance customer experience, parameters of product experience, alignment of customer expectations with product design.

MODULE V: FEEDBACK, RE-DESIGN & RE-CREATE: 9 Hours

Feedback loop, Focus on User Experience, Address “ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – “Solving Practical Engineering Problem through Innovative Product Design & Creative Solution”.

Total no. of Hours: 45

Course Outcomes:

On successful completion of the module students will be able to:

- Compare and classify the various learning styles and memory techniques and Apply them in their engineering education
- Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products
- Develop new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products
- Propose real-time innovative engineering product designs and Choose appropriate frame works, strategies, techniques during prototype development
- Perceive individual differences and its impact on everyday decisions and further Create a better customer experience

AUC001	IDEA LAB WORKSHOP	L	T	P	Credit
		2	0	4	0

Course Objectives:

- *To learn all the skills associated with the tools and inventory associated with theIDEA Lab.*
- *Learn useful mechanical and electronic fabrication processes.*
- *Learn necessary skills to build useful and standalone system/ project with enclosures.*
- *Learn necessary skills to create print and electronic documentation for the system /project.*

MODULE	Topics
1.	Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using Eagle CAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and Git Hub. Basic 2D and 3D designing using CAD tools such as Free CAD, Sketchup, Prusa Slicer, Flat CAM, Ink space, Open BSP and Veri CUT.
2.	Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output) Circuit prototyping using (a) breadboard, (b) Zero PCB (c) „Manhattan" style and (d) custom PCB. Single, double and multilayer PCBs. Single and double- sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.
3.	Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi-programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types),Wireless power supply, USB PD, Solar panels, Battery types and charging.
4.	Discussion and implementation of a mini project.
5.	Documentation of the mini project (Report and video).

LABORATORY ACTIVITIES:

S. No.	List of Lab activities and experiments
1.	Schematic and PCB layout design of a suitable circuit, fabrication and testing ofthe circuit.
2.	Machining of 3D geometry on soft material such as soft wood or modelingwax.
3.	3D scanning of computer mouse geometry surface. 3D printing of scannedgeometry using FDM or SLA printer.
4.	2D profile cutting of press fit box/casing in acrylic (3 or 6 mm thickness)/cardboard, MDF(2 mm) board using laser cutter & engraver.
5.	2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6.	Familiarity and use of welding equipment.
7.	Familiarity and use of normal and wood lathe.
8.	Embedded programming using Arduino and/or Raspberry Pi.
9.	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Reference Books:

1. Chris Hackett. Weldon Owen, "The Big Book of Maker Skills: Tools & Techniques for BuildingGreat Tech Projects". 2018.
2. Sean Michael Ragan, Weldon Owen; "The Total Inventors Manual (Popular Science): TransformYour Idea into a Top-Selling Product", 2017.
3. Paul Horowitz and Winfield Hill, "The Art of Electronics". Cambridge University Press. 3rdedition. 1995.
4. Simon Monk, "Programming Arduino: Getting Started with Sketches" McGraw Hill. 2ndedition.2012.
5. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: RapidPrototyping to Direct Digital Manufacturing", Springer, 2010.
6. Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors,5th Edition,2002.

SEMESTER II

BSCT104	PHYSICS	L	T	P	Credit
		3	1	0	4

Course Objectives:

- *To understand the physics of simple harmonic motion (SHM) and its applications in various fields.*
- *To understand the characteristics and behavior of non-dispersive transverse and longitudinal waves in one dimension and to introduce the concept of dispersion in waves and its implications.*
- *To understand the behavior and propagation of light and to study the principles of geometric optics and their applications.*
- *To understand the wave nature of light and its interactions with matter and study the principles of wave optics and their applications.*
- *To understand the principles and applications of lasers and study the properties and behavior of laser light.*

Course Contents:

MODULE I - SIMPLE HARMONIC MOTION AND OSCILLATOR: 12 Hours

Mechanical and electrical simple harmonic oscillators, complex number notation and phasor representation of simple harmonic motion, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator, power absorbed by oscillator.

MODULE II -WAVES AND INTRODUCTION TO DISPERSION: 12 Hours

Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, impedance matching, standing waves and their Eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves andspeed of sound, standing sound waves. Waves with dispersion, water waves, superposition of waves and Fourier method, wave groups and group velocity.

MODULE III - PROPAGATION AND GEOMETRIC OPTICS: 12 Hours

Fermat‟s principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster‟s angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them, transfer formula and the matrix method.

MODULE IV - WAVE OPTICS: 12 Hours

Huygens‟ principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young‟s double slit experiment, Newton‟s rings, Michelson

interferometer, Mach- Zehnder interferometer. Farunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power.

MODULE V – LASERS: 12 Hours

Einstein‟s theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO2), solid-state lasers (ruby, Neodymium), dye lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in science, engineering and medicine.

Total No. of Hours: 60

Course Outcomes:

On successful completion of the module students will be able to:

- Solve engineering problems dealing with simple, damped, or forced harmonic oscillation and perform Fourier analysis of wave phenomena.
- Differentiate between transverse and longitudinal waves and explain their properties.
- Understand the generation and propagation of light and explain the principles of geometric optics, including reflection and refraction.
- Understand the wave nature of light and its properties, such as interference and diffraction.
- Understand the basic principles of laser operation, including population inversion and stimulated emission

Text Books:

1. Ian G. Main, “Vibrations and Waves” Physics Cambridge University Press; 3rd edition (1993).
2. H.J. Pain, “The physics of vibrations and waves” John Wiley & Sons, Ltd. Sixth Edition 2005.

Reference Books:

1. E. Hecht, “Optics” addison wesley(2001)
2. O. Svelto, “Principles of Lasers” Springer books, 2010.
3. R.N.Chaudhuri, “Waves and Oscillations” New Age International (P) Limited, 2010.

BSCP104	PHYSICS LABORATORY	L	T	P	Credit
		0	0	2	1

Course Objectives:

- *To observe and study the diffraction pattern produced by a single slit.*
- *To observe and study the interference pattern produced by double slits.*
- *To verify the wave nature of light and measure the wavelength of light.*
- *To measure the speed of light using a Michelson interferometer setup.*
- *To measure the speed of light on a tabletop using the modulation technique.*

List of Experiments

1. **Single-Slit Diffraction Experiment:** A laser pointer or a beam of ordinary light is passed through a single narrow slit, and the resulting diffraction pattern is observed on a screen or a wall. The pattern will show a central maximum and alternating dark and bright fringes on both sides of the central maximum.
2. **Double-Slit Interference Experiment:** A laser or a light source is directed through two closely spaced slits. The resulting pattern on a screen or wall will show a series of alternating bright and dark fringes. This is known as an interference pattern, demonstrating the wave nature of light.
3. **Young's Double-Slit Experiment:** This is an extension of the double-slit interference experiment. By measuring the interference pattern and knowing the distance between the slits and the screen, one can determine the wavelength of light used.
4. **Michelson Interferometer (Measurement of Speed of Light):** In this experiment, a Michelson interferometer is set up, and the speed of light is measured by observing the fringe shift produced when one of the arms of the interferometer is moved.
5. **Measurement of Speed of Light using Modulation:** This experiment involves using a laser, a rotating mirror, and a photosensitive detector to measure the time taken for light to travel a known distance, allowing the speed of light to be calculated.
6. **Minimum Deviation from a Prism:** A prism is placed in a beam of light, and the angle of minimum deviation (where the emergent ray is parallel to the incident ray) is measured. Using this angle, along with the known refractive index of the surrounding medium, the refractive index of the prism material can be calculated.
7. **Lloyd's Mirror Interferometer:** In this experiment, a light source is directed towards a half-silvered mirror (Lloyd's mirror configuration), creating interference fringes by the combination of direct and reflected light.
8. Experiments to study Lasers.

Course Outcomes:

i. Comprehend the concept of interference and how waves combineconstructivelyand destructively to produce varying amplitudes.
ii. Understand the single-slit diffraction pattern and calculate the angles ofdiffraction fordifferent wavelengths and slit sizes.
iii. Understand the double-slit interference pattern and calculate fringe spacingand angles ofinterference for various setups.

iv. Develop skills to analyze and interpret interference patterns resulting from different lightsources and experimental configurations.
v. Develop a comprehensive understanding of the fundamental principlesof laser operation, including stimulated emission, population inversion, and optical gain.

References:

Virtual Labs

S. No.	Experiment Name	Experiment Link(s)
1	Diffraction and interference experiments (from ordinary light or laser pointers).	http://ov-au.vlabs.ac.in/optics/Diffraction_Grating/
2	Minimum deviation from a prism.	http://ov-au.vlabs.ac.in/optics/Spectrometer_i_d_Cu rve/

BSCT105	MATHEMATICS- II	L	T	P	Credit
		3	1	0	4

Course Objective:

- To formulate and solve partial differential equations, Laplace, Fourier transforms within the engineeringdomain.
- To introduce the concepts of Curl, Divergence and integration of vectors in vector calculus which is needed for many application problems.
- To introduce Laplace transform which is a useful technique in solving many application problems and to solve differential and integral equations.
- To acquaint the students with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.

MODULE I PARTIAL DIFFERENTIAL EQUATIONS (12 Hrs)

Formation of partial differential equations, Solutions of standard types of first order partial differential equations, Lagrange s linear equation, Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

MODULE II LAPLACE TRANSFORM (12 Hrs)

Existence conditions, Transforms of elementary functions , Properties, Transform of unit step function and unitimpulse function , Transforms of derivatives and integrals , Transforms of Periodic Functions , Initial and final value theorems.

MODULE III INVERSE LAPLACE TRANSFORM (12 Hrs)

Inverse Laplace Transforms Properties, Convolution theorem, Application - Solution of ordinary differential equations with constant coefficients - Solution of simultaneous ordinary differentialequations.

MODULE IV FOURIER TRANSFORM (12 Hrs)

Fourier Integral theorem (statement only) , Fourier transform and its inverse, Properties: Fourier sine and cosine transforms, Properties, Convolution and Parseval s identity.

MODULE V FOURIER SERIES (12 Hrs)

Dirichlet s conditions , Expansion of periodic functions into Fourier series- Change of interval, Half-range Fourier series, Root mean square value - Parseval s theorem on Fourier coefficients, Harmonic analysis.

Text Books:

1. Grewal B.S, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2015.
2. Veerarajan T, "Transforms and Partial Differential Equations", Tata McGraw-Hill, New Delhi, 2012.

References:

1. Bali N.P and Manish Goyal., "A Text Book of Engineering Mathematics", Laxmi Publications(P) Ltd, 2011.

2. Erwin Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, New Delhi, 9th Edition, 2011.
3. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 2010.

ONLINE / NPTEL Courses:

1. Laplace Transform: https://nptel.ac.in/courses/111106139
2. Partial Differential Equations: https://nptel.ac.in/courses/111101153
3. Advanced Engineering Mathematics: https://nptel.ac.in/courses/111107119

Course Outcomes:

CO1. To formulate and solve various types of partial differential equations.
CO2. To understand the Laplace transform and its properties.
CO3. To apply Laplace transforms to solve ordinary differential equations with constant coefficients and simultaneous ordinary differential equations.
CO4. To understand and apply Fourier transform techniques, including Fourier integral theorem, properties of Fourier transforms, convolution, and Parseval's identity.
CO5. To apply Fourier series and harmonic analysis, enabling them to analyze and synthesize periodicsignals and functions in various engineering an mathematical applications.

ESCT104	BASIC ELECTRICAL ENGINEERING	L	T	P	Credit
		2	1	0	3

Course Objectives:

- *To understand and gain basic knowledge about DC and AC circuits.*
- *To learn the concept of single phase and three phase circuit with power measurement.*
- *To study the operating principles of Transformers.*
- *To explore the working of the DC Machines and motors.*
- *To study the three phase induction motors.*

Course Contents:

MODULE I - D. C. CIRCUITS: 9 Hours

Ohm's Law and Kirchhoff‟s Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy storedin magnetic fields;

MODULE II - A.C. CIRCUITS: 9 Hours

Generation of sinusoidal voltage- definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series-parallel circuits; Three Phase A.C. Circuits - Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method;

MODULE III – TRANSFORMERS: 9 Hours

Principle of operation and construction of single-phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation

MODULE IV - DC MACHINES: 9 Hours

Working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor;

MODULEV- THREE PHASE INDUCTION MOTORS: 9 Hours

Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

Total No. of Hours: 45

Text Books:

1. Nagrath I.J. and D. P. Kothari, " Basic Electrical Engineering" Tata McGraw Hill (2001).
2. Hayt and Kimberly, "Engineering Circuit Analysis" Tata McGraw Hill, 8th Edition, 2013.

References Books:

1. Kulshreshtha D.C., "Basic Electrical Engineering" Tata McGraw Hill (2009).
2. Rajendra Prasad, "Fundamentals of Electrical Engineering" Prentice Hall, India Hughes, 2009.

Course Outcomes:

On successful completion of the module students will be able to:

1. Understand the concept of DC circuits and Electromagnetic principles over inductors,
2. Explain the concepts of AC circuits over RLC circuits and with knowledge of power andload performance and Obtain the power measurement using single phase and three phase circuit
3. Discuss the principles of operation and construction of single-phase transformers
4. Explain the operation and characterizes of DC machines and motors.
5. Illustrate the principle of the three phase induction motors.

ESCP104	BASIC ELECTRICAL ENGINEERING LABORATORY	L	T	P	Credit
		0	0	2	1

Course Objectives:

- *Understand the importance of electrical safety in handling electrical equipment and wiring.*
- *Understand the techniques for making secure and reliable electrical joints.*
- *Understand the principles of series and parallel circuits and their applications in lamp circuits.*
- *Learn the concept and purpose of staircase, wiring in residential andcommercial settings.*
- *Learn the concept of load tests in motors and transformers.*

List of Experiments

1. Electrical Safety, Precautions, studyof tools and accessories.
2. Practices of different joints. Wiring and testing of series and parallel lamp circuits.
3. Staircase wiring, Doctor‟s room wiring.
4. Bed room and godown wiring
5. Wiring and testing a ceiling fan and fluorescent lamp circuit.
6. Studyof different types of fuses, circuit breakers and A.C and D.C meters.
7. OC and SC test on single phase transformer.
8. Load test on single phase transformer.
9. Load test on DC shunt motor.
10. Two wattmeter method of power measurement.
11. Load test on single phase induction . and 3 phase induction motor.
12. Speed control methods of DC motor

Course Outcomes:

On successful completion of the experiment students will be able to:

1. Demonstrate a thorough understanding of electrical safety practices, including the use of personal protective equipment (PPE) and safety guidelines.
2. Design and execute wiring layouts for series and parallel lamp circuits,understanding their applications and advantages.
3. Plan and execute a staircase/ n wiring system, incorporating appropriate switching mechanisms for efficient and convenient lighting control.
4. Evaluate the performance of Transformers and motors for different loads.
5. Discuss the power measurements in DC machines.

ESCP105	DIGITAL FABRICATION	L	T	P	Credit
		0	0	4	2

Course Objectives:

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry environment.

Course Contents:

1. **3D Printing (Additive Manufacturing)**

Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.

2. CAD for Additive Manufacturing

CAD Data formats, Data translation, Data loss, STL format.

3. Additive Manufacturing Techniques

Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology. Process, Process parameter, Process Selection for various applications. Additive Manufacturing Application Domains: Aerospace,

Electronics, Health Care, Defence, Automotive, Construction,Food Processing, Machine Tools

4. Materials

Polymers, Metals, Non-Metals, Ceramics.

Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and theirproperties.

Support Materials.

5. Additive Manufacturing Equipment

Process Equipment- Design and process parameters Governing Bonding Mechanism

Common faults and troubleshooting Process Design

6. Post Processing: Requirement and Techniques

7. **Product Quality**

Inspection and testing Defects and their causes

List of Experiments

1. 3D Modelling of a single component.
2. Assemblyof CAD modelled Components.
3. Exercise on CAD Data Exchange.
4. Generation of .stl files.
5. Identification of a product for Additive Manufacturing and its AM process plan.
6. Printing of identified product on an available AM machine.
7. Post processing of additivelymanufactured product.
8. Inspection and defect analysis of the additivelymanufactured product.
9. Comparison of Additively manufactured product with conventional manufactured counterpart.

Text Books:

1. AICTE‟s Prescribed Textbook: Workshop / Manufacturing Practices (with LabManual), Khanna Book Publishing Co.

2. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

3. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, RapidTooling, Rapid Manufacturing", Hanser Publisher, 2011.

4. Sabrie Soloman, "3D Printing and Design", Khanna Publishing House, Delhi.

Reference Books:

1. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles andApplications", World Scientific, 2017.
2. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Seriesin Material Science, 2013.
3. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for RapidPrototyping", Kulwer Academic Press, 2001.
4. Zhiqiangan and Frank Liou,"NumericalModelling of the Additive Manufacturing (AM) Processes of Titanium Alloy", InTech, 2012.

Course Outcomes**:**

After completion of this course, the students will be able to:

CO1. Develop CAD models for 3D printing.
CO2. Import and Export CAD data and generate. stl file.
CO3. Select a specific material for the given application.
CO4. Select a 3D printing process for an application.
CO5. Produce a product using 3D Printing or Additive Manufacturing (AM).

HSMC101	ENGLISH FOR TECHNICAL WRITING	L	T	P	Credit
		2	0	2	3

Course Objectives:

- *To provide learning environment to practice listening, speaking, reading and writing skills and assist the students to carry on the tasks and activities through guided instructions and materials.*
- *To effectively integrate English language learning with employability skills and training, by providing hands-on experience through case-studies, mini-projects, group and individual presentations.*

Course Contents:

MODULE I - VOCABULARY BUILDING: 9 Hours

The concept of Word Formation, Root words from foreign languages and their use in English. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.

MODULEII - BASIC WRITING SKILLS: 9 Hours

Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely.

MODULE III - IDENTIFYING COMMON ERRORS IN WRITING: 9 Hours

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies and Clichés.

MODULE IV - NATURE, STYLE OF SENSIBLE WRITING: 9 Hours

Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion

MODULE V - WRITING PRACTICES AND ORAL COMMUNICATION: 9 Hours

Comprehension, Précis Writing, Essay Writing, Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues, Communication at Workplace, Interviews, Formal Presentations.

Total No. of Hours: 45

Text Books:

1. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing, 2022.
2. Practical English Usage. Michael Swan. OUP. 1995.
3. Remedial English Grammar. F.T. Wood. Macmillan,2007.

Reference Books:

1. On Writing Well. William Zinsser. Harper Resource Book. 2001.
2. StudyWriting. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

Course Outcomes

Upon successful completion of the course, students should be able to:

CO1. Aware of correct usage of English grammar in writing and speaking
CO2. Increase their reading speed and comprehension of academic articles
CO3. Improve their reading fluency skills through extensive reading
CO4. Speaking ability in English both in terms of fluency and comprehensibility
CO5. Oral presentations and receive feedback on their performance

HSMC-102	UNIVERSAL HUMAN VALUES - II	L	T	P	Credits
		2	1	0	3

PRE-REQUISITES: None. Universal Human Values 1 (Desirable)

Course Objectives:

During the Induction Program, students would get an initial exposure to human valuesthrough Universal Human Values-I. This exposure is to be augmented by this compulsory full semester foundation course. This introductory course input is intended:

- *To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.*
- *To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value- based living in a natural way.*
- *To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.*
- *Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.*

MODULE I – INTRODUCTION TO VALUE EDUCATION: 9 Hours

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) ; Understanding Value Education; Self-exploration as the Process for Value Education; Continuous Happiness and Prosperity – the Basic Human Aspirations; Happiness and Prosperity – Current Scenario; Method to Fulfill the Basic Human Aspirations: Exploring Natural Acceptance.

MODULE II – HARMONY IN THE HUMAN BEING: 9 Hours

Understanding Human being as the Co-existence of the Self and the Body; Distinguishing between the Needs of the Self and the Body; Exploring the difference of Needs of Self and Body; The Body as an Instrument of the Self; Understanding Harmony in the Self ; Harmony of the Self with the Body ; Programme to ensure self-regulation and Health; Exploring Harmonyof Self with the Body.

MODULE III – HARMONY IN THE FAMILY AND SOCIETY: 9 Hours

Harmony in the Family – the Basic Unit of Human Interaction; „Trust' – the Foundational Value in Relationship; 'Respect' – as the Right Evaluation; Other Feelings, Justice in Human- to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order.

MODULE IV – HARMONY IN THE NATURE/EXISTENCE: 9 Hours

Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature: - Exploring the Four Orders of Nature; Realizing Existence as Co-existence at All Levels; The Holistic Perception of Harmony in Existence: - Exploring Co-existence in Existence.

MODULE V – IMPLICATIONS OF THE HOLISTIC UNDERSTANDING – A LOOK AT PROFESSIONAL ETHICS: 9 Hours

Natural Acceptance of Human Values; Definitiveness of (Ethical) Human Conduct: - Exploring Ethical Human Conduct; A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order; Competence in Professional Ethics:- Exploring Humanistic Models in Education; Holistic Technologies, Production Systems and Management Models-Typical Case Studies; Strategies for Transition towards Value-based Life and Profession.

Total No. of Lectures: 45

Text Book and Teachers Manual

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethic",Excel Books, 2nd Revised Edition, New Delhi, 2019.
2. RR Gaur, R Asthana, G P Bagaria, "Teachers‟ Manual for A Foundation Course in Human Values and Professional Ethics", Excel Books, 2nd Revised Edition New Delhi, 2019.ISBN 978-93-87034-53.

Reference Books:

1. Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak," Jeevan Vidya" 1999.
2. A.N. Tripathi, "Human Values" New Age Intl. Publishers, New Delhi, 2004.
3. The Storyof Stuff (Book).
4. Mohandas Karamchand Gandhi "The Story of My Experiments with Truth".

Course Outcomes

CO1. Discuss the Right understanding about the human aspirations.

CO2. Explore the harmony in the human being with the right understanding about the body and self.

CO3. Develop effective communication skills for promoting understanding and resolving conflicts within the family and society with Trust and Respect.

CO4. Develop a comprehensive understanding of the concept of harmony and its significance in nature and human life.

CO5. Recognize the Natural Acceptance of Human Values and Strategies for Transition towards Value-based Life and Profession.

AUC002	SPORTS AND YOGA	L	T	P	Credits
		1	1	1	0

Course Objectives:

- *To make the students understand the importance of sound health and fitness principles as they relate to better health.*
- *To expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness.*
- *To create a safe, progressive, methodical and efficient activity based plan to enhance improvement and minimize risk of injury.*
- *To develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.*

Course Contents:

MODULE I - INTRODUCTION TO PHYSICAL EDUCATION: 9 Hours

Meaning & definition of Physical Education; Aims & OBJECTIVESs of Physical Education; Changing trends in Physical Education; Ancient & Modern Olympics (Summer & Winter); Olympic Symbols, Ideals, OBJECTIVESs & Values; Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanch and Award, Rajiv Gandhi Khel Ratna Award etc.)

MODULE II - PHYSICAL FITNESS, WELLNESS AND LIFE STYLE: 9 Hours

Meaning & Importance of Physical Fitness & Wellness. Components of Physical fitness Components of Health related fitness. -Components of wellness. - Preventing Health Threats through Lifestyle Change; Concept of Positive Lifestyle; Nutritional practices for good Health.

MODULE III - FUNDAMENTALS OF ANATOMY AND PHYSIOLOGY IN PHYSICALEDUCATION, SPORTS AND YOGA: 9 Hours

Define Anatomy, Physiology & Its Importance; Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

MODULE IV - YOGA AND LIFESTYLE: 9 Hours

Meaning & Importance of Yoga, Elements of Yoga; Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas; Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana &Shashakasana); Relaxation Techniques for improving concentration - Yog-nidra Asanas as preventive measures. *Hypertension*: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana Bhujangasana, Sharasana.

Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana, Trikona Ardh Matsyendrasana.

Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana. *Diabetes:* Bhujangasana, Paschimottasana,Pavan Muktasana, Ardh Matsyendrasana. *Asthema:* Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.

MODULE V - PSYCHOLOGY & SPORTS: 9 Hours

Definition & Importance of Psychology in Physical Edu. & Sports; Define & Differentiate Between Growth & Development; Adolescent Problems & Their Management; Emotion: Concept, Type & Controlling of emotions; Meaning, Concept & Types of Aggressions in Sports. Psychological benefits of exercise. Anxiety & Fear and its effects on Sports Performance. Motivation, its type & techniques. Understanding Stress & Coping Strategies. Meaning and Concept of Doping ; Prohibited Substances & Methods :- Side Effects of Prohibited Substances.

Total No. of Lectures: 45

Text Books:

1. Ajmer Singh, Jagdish Bains , Jagtar Singh Gill and Rachpar Singh Brar, "Essentials of Physical Education" by Kalyani publications, 2022.
2. B.K.S. Iyengar, "Light On Yoga: The Classic Guide to Yoga bythe World's Foremost Authority"2006.
3. Health and Physical Education – NCERT (11th and 12th Classes).

Course Outcomes:

On successful completion of the course the students will be able to:

CO1. Discuss the physical education needs and history with reference to awards given in promotion of the sports in India.

CO2. Practice Physical activities and Hatha Yoga and Breathing techniques focusing on yoga for strength, flexibility, and relaxation, including strength and flexibility, balance and coordination.

CO3. Learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.

CO4. Develop understanding of health-related fitness components: cardio respiratory endurance, flexibility and bodycomposition etc.

CO5. Develop understanding of psychological problems associated with the age and lifestyle.

CO6. Demonstrate an understanding of sound nutritional practices as related to health and physical performance.

SEMESTER – III

BMPCT301	HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

- *To integrate the individual functions of all the cells and tissues and organs into functional whole, the human body.*
- *Function is dependent on a structure, the curriculum lays stress on functional anatomy of the organs.*
- *Emphasizes on the cardiovascular, respiratory, urinary and nervous system and their interrelatedness.*
- *Stimulate the students to understand the basic functioning of every system and the resultant unified organization.*

MODULE I BASIC ELEMENTS OF HUMAN BODY 9 Hours

Cell – Cell Structure and organelles - Functions of each component in the cell. Cell membrane – transport across membrane - Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, functions.

MODULE II SKELETAL AND MUSCULAR SYSTEM 9 Hours

Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton -Types of joints and function – Types of cartilage and function. –Types of muscles – Structure and Properties of Skeletal Muscle- Changes during muscle contraction- Neuromuscular junction.

MODULE III CARDIOVASCULAR AND RESPIRATORY SYSTEM 9 Hours

Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle – Cardiac output. Blood: Composition – Functions - Haemostasis – Blood groups and typing. Blood Vessels – Structure and types - Blood pressure - Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Gaseous exchange.

MODULE IV DIGESTIVE AND EXCRETORY SYSTEMS 9 Hours

Structure and functions of gastrointestinal system - secretory functions of the alimentary tract - digestion and absorption in the gastrointestinal tract - structure of nephron - mechanism of urine formation - skin and sweat gland - temperature regulation.

MODULE V NERVOUS AND SENSORY SYSTEM 9 Hours

Structure and function of nervous tissue – Brain and spinal cord – Functions of CNS – Nerve conduction and synapse – Reflex action – Somatic and Autonomic Nervous system. Physiology of Vision, Hearing, Integumentary, Olfactory systems. Taste buds.

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

CO1 Identify and explain basic elements of human body

CO2 Explain the functions of skeletal and muscular system

CO3 Describe the structure, function of cardiovascular system and respiratory system

CO4 Discuss the structure of digestive and excretory system.

CO5 Describe the physiological process of Nervous and sensory system

TEXT BOOKS:

1. Elaine.N. Marieb, “Essential of Human Anatomy and Physiology”, Ninth Edition, Pearson Education, New Delhi, 2018.
2. Gopal B. Saha “Physics and Radiobiology of Nuclear Medicine”, Third edition Springer, 2006. (Unit 2,3,4)

REFERENCES:

1. Guyton & Hall, “Text book of Medical Physiology”, 13th Edition, Saunders, 2015.
2. Ranganathan T S, “Text book of Human Anatomy”, S.Chand& Co. Ltd., New Delhi, 2012.
3. SaradaSubramanyam, K MadhavanKutty, Singh H D, “Textbook of Human Physiology”,S. Chand and Company Ltd, New Delhi, 2012.

BMPCT302	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	Credits
		3	1	0	4

COURSE OBJECTIVES

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

MODULE I PARTIAL DIFFERENTIAL EQUATIONS 12 Hours

Formation of partial differential equations –Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

MODULE II FOURIER SERIES 12 Hours

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis

MODULE III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12 Hours

Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

MODULE IV FOURIER TRANSFORMS 12 Hours

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

MODULE V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 12 Hours

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z – transforms.

TOTAL PERIODS: 60

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Understand how to solve the given standard partial differential equations.

CO2: Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.

CO3:Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.

CO4:Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.

CO5:Use the effective mathematical tools for the solutions

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

REFERENCES:

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4thEdition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett . L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

MPCT303	IMMUNOLOGY AND PATHOLOGY	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

- To know the fundamentals of innate and acquired immunity.
- To understand how immune system fights and combats the infection and diseases.
- To know the control and preventive measures of pathophysiology of various disorders.

MODULE I FUNDAMENTAL CONCEPTS OF IMMUNOLOGY 9 Hrs.

History and Scope of Immunology, Innate and Acquired Immunity; Hematopoiesis, Cells of the immune system, Primary and Secondary lymphoid organs, Immune response-primary and secondary immune response.

MODULE II HUMORAL IMMUNITY 9 Hrs.

Antigens: Characteristics and Types of Antigens, Factors affecting the immunogenicity, Haptens, Adjuvants, Immunoglobulins: Basic structures, classes and sub classes; Monoclonal antibodies, Complement System-Alternate, Classical and Lectin pathways.

MODULE III CELL MEDIATED IMMUNITY 9 Hrs.

Structure, types and function of MHC, Exogenous and Endogenous pathways of antigen processing and presentation; Cytokines- Structure, function, application and regulation of the immune response, Hyper-Sensitivity-Type I, Type II, Type III and Type IV, Autoimmunity.

MODULE IV IMMUNOTECHNOLOGY 9 Hrs.

Antigen-antibody reaction-Cross reactivity, Precipitation reactions, Agglutination reactions, Agglutination inhibition test Immuno diffusion and Immuno electrophoretic techniques, Immune fluorescence, ELISA.

MODULE V INFLAMMATION AND NEOPLASIA 9 Hrs.

Introduction to pathology, Necrosis, inflammation, acute and chronic inflammation, mediators of inflammation, apoptosis, neoplasia, classification, difference between benign and malignant tumor spread of tumors and etiology of tumors, leukemia and lymphoma. **.**

TOTAL PERIODS.45 Hrs.

TEXT BOOK

1. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Roitt's Essential Immunology, 13th Edition, Wiley-Blackwell Publishers 2017.

2. Ivan M. Roitt, Essential Immunology, 4th Edition, Blackwell Scientific Publications, Oxford, London, 2002.

REFERENCE BOOK

1. Jenni Punt; Sharon Stranford; Patricia Jones; Judy Owen, Kuby Immunology, Eighth Edition, Macmillan, 2019

2. Vinay Kumar, Abul Abbas, Jon Aster, Robbins Basic Pathology, 10th Edition, ELSEVIER, 2017.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand overall concept of immune system.
CO2 - Acquire knowledge about different cells and organs involved in immune system.
CO3 - Recognize effectors molecules fight against infectious diseases.
CO4 - Demonstrate to produce monoclonal antibodies to diagnose and treat infectious diseases.
CO5 - Implement immune techniques to diagnose infectious diseases.
CO6 - Describes the basic elements in cell injury, inflammation and neoplasia.

BMPCT304	BIOSIGNALS AND SYSTEMS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

- To have adequate knowledge basics of signals and systems.
- It helps to understand the basic definition and classification of continuous time and discrete time signals.
- To study its analysis and its relevance to physiological signals

MODULE: 1 CLASSIFICATION OF SIGNALS AND SYSTEMS 9 Hours

Continuous time signals (CT Signals) and Discrete time signals (DT Signals)- Step, Ramp, Pulse, Impulse, Exponential - Classification of CT and DT signals - Periodic, aperiodic and Random signals - Real and complex signals - Energy and power signals - CT systems and DT systems - Linear time invariant systems - Basic properties of continuous time systems - Linearity, Causality, Time invariance, Stability.

MODULE: 2 ANALYSIS OF CONTINUOUS TIME SIGNALS 9 Hours

Definition - Continuous time Fourier transform and Laplace transform analysis with examples - Decaying exponential - Rising exponential - Double exponential - Basic properties - Linearity - Parseval's relation - Convolution in time and frequency domain - Time shifting & Time reversal - Relation between Fourier transform and Laplace transform.

MODULE: 3 ANALYSIS OF DISCRETE TIME SIGNALS 9 Hours

Spectrum of DT signals, Sampling theorem – Graphical and analytical proof for Band Limited Signals, effect of under sampling – Aliasing - Basic principles of Z-Transform - Z-Transform definition - Region of convergence - Properties of ROC - Properties of Z- Transform - Poles and zeros - Inverse Z-Transform using contour integration, Residue theorem, power series expansion and Partial fraction expansion.

MODULE: 4 LINEAR TIME INVARIENT SYSTEMS 9 Hour

Frequency response of LTI systems - Analysis and characterization of LTI systems using Laplace transform - computation of impulse response and transfer function using Laplace transform – Differential equation - Impulse response - Convolution integral and frequency response. Causality and Stability of LTI Systems – Impulse response, convolution sum and Frequency Response - Computation of Impulse response and Transfer function using Z-Transform. Random signal-characterization of random signal-stationary and nonstationary random signal –relationship Between two random signals-properties of autocorrelation and cross correlation functions.

MODULE: 5 MEDICAL APPLICATIONS OF SIGNAL ANALYSIS 9 Hours

Analysis of bio signals- Spatial and Frequency domain methods- Detailed Signals analysis of ECG, EMG, EEG.

TOTAL PERIODS: 45

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basics of signals and systems.
CO2 - Acquire knowledge in the types of signals and systems.

CO3 - Apply the acquired knowledge in understanding the signal manipulations.
CO4 - Analyse the various signals using different tools and techniques.
CO5 - Explore techniques to analyze biosignals.
CO6 - Develop the system to analyse the real-time bio signals.

TEXT BOOK /

1. Allan V. Oppenheim et al., Signals and Systems, 2nd Edition, Prentice Hall of India Pvt. Ltd., 2003
2. Ramesh Babu P., Signals and Systems, 4th Edition, Scitech Publishers, 2011.
3. Salivahanan S., Digital signal processing, 2nd Edition, Tata McGraw Hill, 2009.
4. Signals and Systems 2Nd Edition by Simon Haykin, WILEY INDIA,2018

REFERENCE BOOK

1. Michael Roberts, Govind Sharma, Fundamentals of Signals and Systems, McGraw Hill Education, 2017
2. Chittode J.S., Signals & Systems, Technical Publication, 2021.

BMPCT304	ELECTRONIC DEVICES AND CIRCUITS	L	T	P	Credits
		3	0	0	3

Course Objectives:

- To be familiar with the structure of basic electronic devices.
- To be exposed to the operation and applications of electronic device.
- To Acquire and apply applications of semi conductorsthe

MODULE I SEMICONDUCTOR DIODE 9 Hours

PN junction diode, Current equations, Energy Band diagram, Diffusion and drift current densities, forward and reverse bias characteristics, Transition and Diffusion Capacitances, Switching Characteristics, Breakdown in PN Junction Diodes.

MODULE: II BIPOLAR JUNCTION TRANSISTOR 9 Hours

NPN -PNP -Operations-Early effect-Current equations – Input and Output characteristics of CE, CB, CC - Hybrid -π model - h-parameter model, Ebers Moll Model- Gummel Poon- model, Multi Emitter Transistor.

MODULE: III FIELD EFFECT TRANSISTORS 9 Hours

MOSFETs – Drain and Transfer characteristics,-Current equations-Pinch off voltage and its significance- Threshold voltage -Channel length modulation, small signal Characteristics, D-MOSFET, E-MOSFET- Characteristics – Comparison of MOSFET with BJT.

MODULE: IV SPECIAL SEMI CONDUCTOR DEVICES 9 Hours

Metal-Semiconductor Junction - MESFET, FINFET, PINFET, CNTFET, DUAL GATE MOSFET, Point Contact Diode, p-i-n Diode, Avalanche Photodiode, Schottky barrier diode- Zener diode- Varactor diode –Tunnel diode- Gallium Arsenide device, LASER diode, LDR.

MODULE: V POWER DEVICES AND DISPLAY DEVICES 9Hours

UJT, Thyristor - SCR, Diac, Triac, Power BJT- Power MOSFET- DMOS-VMOS. LED, LCD, Opto Coupler, Solar cell, CCD.

TOTAL PERIODS: 45

TEXT BOOK

1. Millman and Halkias, “Electronic Devices and Circuits”, 4th Edition, McGraw Hill, 2015.
2. Mohammad Rashid, “Electronic Devices and Circuits”, Cengage Learning Pvt. Ltd, 2015.
3. Salivahanan. S, Suresh Kumar. N, “Electronic Devices and circuits”, 4th Edition, McGraw Hill, 2016.

REFERENCES

1. Robert L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory” Pearson Prentice Hall, 11th Edition, 2014.
2. Bhattacharya and Sharma, “Solid State Electronic Devices”, 2nd Edition, Oxford University Press, 2014.
3. R.S.Sedha, “A Textbook of Electronic Devices and Circuits”, 2nd Edition, S.Chand Publications, 2008.

COURSE OUTCOMES:

At the end of the course, the student should be able to:

CO1: Analyze the characteristics of semiconductor diodes.

CO2: Analyze and solve problems of Transistor circuits using model parameters.

CO3: Identify and characterize diodes and various types of transistors.

CO4: Analyze the characteristics of special semiconductor devices.

CO5: Analyze the characteristics of Power and Display devices.

BSC201	NANO-SCIENCE TECHNOLOGY	L	T	P	Credits
		3	0	0	3

Course Objectives:

1. Understand the principles and fundamentals of nano electronics and nanotechnology.
2. Introduce students to the principles of quantum mechanics and its relevance in semiconductor nanostructures.
3. Introduce students to the latest developments in nanoscale semiconductor devices.
4. Provide students with an overview of various nanofabrication techniques used to create nanoscale structures and devices.
5. Study the design, fabrication, and performance of nano memory devices.

MODULE I Nano electronics & Nano computer architecture 9 Hours

Introduction to Nano computers, Nano computer Architecture, Quantum DOT cellular Automata (QCA), QCA circuits, Single electron circuits, molecular circuits, Logic switches – Interface engineering – Properties (Self-organization, Size-dependent) – Limitations.

MODULE II Quantum Phenomena in Semiconductor Nanostructures: 9 Hours

Introduction to nano-science and nanotechnology, Quantum confinement and size effects in nanostructures, Semiconductor nanowires, nanotubes, and nanoparticles, Quantum dots and their unique properties, Applications of semiconductor nanostructures in electronics and photonics.

MODULE III Emerging Nanoscale Semiconductor Devices: 9 Hours

Nanoscale MOSFETs and FinFETs: principles and benefits, Tunneling devices: Tunnel diodes and TunnelFETs, Spintronics: Spin-based semiconductor devices and logic, Carbon-based nanomaterials: graphene andcarbon nanotubes for electronic applications, Introduction to other novel nanoscale devices and technologies.

MODULE V Nanofabrication and Characterization Techniques: 9 Hours

Nanofabrication techniques: Top-down and bottom-up approaches, Photolithography and etching processesin nanofabrication, Scanning Probe Microscopy (SPM) for nanoscale characterization, Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM) in nano-science, Nanomaterial characterization using X-ray diffraction and spectroscopy, Hands-on nanofabrication and characterizationlaboratory sessions.

MODULE V Memory Devices and Sensors: 9 Hours

Memory devices and sensors – Nano ferroelectrics – Ferroelectric random access memory –Fe-RAM circuit design –ferroelectric thin film properties and integration – calorimetric -sensors – electrochemical cells – surface and bulk acoustic devices – gas sensitive FETs – resistive semiconductor gas sensors –electronic noses – identification of hazardous solvents and gases – semiconductor sensor array

TOTAL PERIODS: 45

Text books:

1. Edward L.Wolf , "Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience" Wiley-VCH, 2006
2. Chris Binns, "Introduction to Nanoscience and Nanotechnology" Wiley, 2010.

References Book:

1. Dieter Vollath, "Nanomaterials: An Introduction to Synthesis, Properties and Applications" Dieter Vollath, Wiley-VCH. 2013.
2. David J. Griffiths, "Introduction to Quantum Mechanics" Cambridge University Press, 3er Ed. 1985.

COURSES OUTCOMES

CO 1: Understand the behavior of materials at the nanoscale and the effects of quantum mechanics on electronic properties.

CO 2: Comprehend the quantum mechanical effects in nanostructures and their impact on device performance.

CO 3: Explore cutting-edge research and developments in nano electronic devices, including molecularelectronics and 2D materials-based devices.

CO 4: Explain the key nanofabrication techniques used to create nano electronic devices, including top-down and bottom-up approaches.

CO 5: Understand the challenges and opportunities in nanomagnetic device technology.

BMPCP301	HUMAN ANATOMY AND PHYSIOLOGY LAB	L	T	P	Credits
		0	0	2	2

COURSE OBJECTIVE

- To integrate the individual functions of all the cells and tissues and organs into functional whole, the human body.
- Function is dependent on a structure, the curriculum lays stress on functional anatomy of the organs.
- Emphasizes on the cardiovascular, respiratory, urinary and nervous system and their interrelatedness.
- Stimulate the students to understand the basic functioning of every system and the resultant unified organization.

LIST OF EXPERIMENTS

1. Collection of Blood Samples
2. Identification of Blood groups (Forward and Reverse)
3. Bleeding and Clotting time
4. Estimation of Hemoglobin
5. Total RBC and WBC Count
6. Differential count of Blood cells
7. Estimation of ESR, PCV, MCH, MCV, MCHC
8. Hearing test – Tuning fork
9. Visual Activity – Snellen's Chart and Jaeger's Chart.
10. Study of circulatory system.
11. Study of Respiratory system
12. Study of vision system
13. Study of hearing system
14. Study of various joints system
15. Study of skeletal system system.
16. Study of nervous system
17. Study of Digestive system

TOTAL PERIODS: 45

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

CO1 Identify and explain basic elements of human body
CO2 Explain the functions of skeletal and muscular system
CO3 Describe the structure, function of cardiovascular system and respiratory system
CO4 Discuss the structure of digestive and excretory system.
CO5 Describe the physiological process of Nervous and sensory system

BMPCP302	IMMUNOLOGY AND PATHOLOGY LAB	L	T	P	Credits
		0	0	2	2

COURSE OBJECTIVES:

- To know concepts of antigen, antibodies and their interactions.
- To know the about the diagnosis of different infectious diseases.
- To demonstrate adequate knowledge about the advance immunology as prescribed in course details.

LIST OF EXPERIMENTS

1. Determination of ABO blood grouping
2. Detection of CRP in human serum
3. Detection of Rheumatoid factor
4. Urine physical and chemical examination (protein, reducing substances, ketones, bilirubin and blood)
5. Histopathological slides of benign and malignant tumours.
6. Manual paraffin tissue processing and section cutting (demonstration)
7. Cryo processing of tissue and cryosectioning (demonstration)
8. Basic staining – Haematoxylin and eosin staining.
9. Special stains – cresyl fast Blue (CFV)- Trichrome – oil red O – PAS
10. Simple stain.
11. Gram stain.
12. AFB stain.
13. Slides of malarial parasites, micro filaria and leishmania Donovan.
14. Haematology slides of anaemia and leukaemia. Study of bone marrow charts.
15. Bleeding time and clotting time.

TOTAL PERIODS: 30

COURSE OUTCOME:

CO 1. Demonstrate features, principles and procedures of immunological testing and interpretation of their finding.

CO 2. Use accurately advance and smart immunological devices for analyzing the patient's serum, whole blood and others clinical specimens.

CO 3. Work collaboratively and constructively, and lead diverse teams to perform a wide range of immunological experiments with responsibility.

CO 4. The students will learn how to analyze various clinical patients' samples, for estimation of different components which are the cause of the immune disease or are the diagnostic/prognostic markers.

CO 5. Diagnose routine clinical problems on the basis of histopathology (Surgical Pathology) and cytopathology specimens, blood and bone marrow.

BMPCP303	ELECTRONICS DEVICE CIRCUITS LAB	L	T	P	Credits
		0	0	2	2

COURSE OBJECTIVE:

- To supplement the theory courses Semiconductor Devices and Basic Electrical Engineering.
- To assist the students in obtaining a better understanding of the operation of electronic circuits and devices
- To provide experience in analyzing network theorems.

LIST OF EXPERIMENTS

1. Characteristics of PN and zener diode.
2. Characteristics of CE, CB configurations.
3. Half wave and Full wave rectifier with capacitor filter.
4. Voltage regulation using zener diode.
5. Study of characteristics of photo diodes
6. Study of characteristics of SCR
7. Verification of KVL and KCL
8. Verification of Thevenin's and Norton's Theorems.
9. Verification of superposition Theorem.
10. Verification of Maximum power transfer and reciprocity theorems.
11. Frequency response of RLC series and parallel resonance circuits.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Experiment and determine the VI characteristics of given PN junction diode, Zener diode, Photo diode and Silicon Controlled Rectifier.

CO2: Experiment and determine the Input & output characteristics of BJT

CO3: Experiment and test half wave and full wave rectifier circuit using PN Junction diode and obtain the ripple factor, rectifier efficiency and experiment and test voltage regulation characteristics using Zener diode voltage regulator circuit.

CO4: Experiment and test the given electric circuit using Kirchhoff's laws and obtain the mesh current & node voltage and obtain the load current for the given circuit using Superposition, Thevenin's, and Norton's and Reciprocity theorems.

CO5: Construct and test RLC series and parallel circuits to compute the resonant frequency and bandwidth by plotting the frequency response.

AUC003	INDIAN CONSTITUTION & KNOWLEDGE SYSTEMS	L	T	P	Credits
		0	1	0	0

Course Objectives:

- *To recognize ones fundamental duties and rights*
- *To understand the structure and functions of legislature, executive and judiciary*
- *To understand the functioning of state governments and union territories*
- *To understand the centre-state relations and functioning of constitutional bodies*

MODULE I **9 Hours**

Introduction of Indian Constitution:

The Making of Indian Constitution - The Constituent Assembly - Sources of Indian Constitution - Preamble and theSupreme Court‟s Judgments on Preamble.

State, Rights and Duties: State and Union Territories – Citizenship - Fundamental Rights - Directive Principles ofState Policy - Fundamental Duties.

MODULE II **9 Hours**

Union Government:

Union Government - The Powers and Functions of the President, Vice–President, Council of Ministers, Prime Minister, Judiciary, Supreme Court - Judicial Review - Judicial Activism- Public Interest Litigation - Power and Functions of the Parliament - Budget Power and Functions of Parliament, Speaker of Lok Sabha.

MODULE III **9 Hours**

State Governments:

State Governments – Governor - State Council of Ministers - Chief Minister- Legislative Assembly- High Courts Union Territories - Panchayati Raj Institutions - 73th and 74th Constitutional Amendment - Gram Panchayats -Block Panchayats - Municipalities.

MODULE IV **9 Hours**

Union- State Relations, Constitutional Bodies:

Centre – State Relations - Public Service - Election Commission - NITI Ayog, Emergency Powers of the President- Constitution Amendment Procedure- Right to Information Act - Right to Education. Major Constitutional Amendments and their impact on Indian Political System

MODULE V **9 Hours**

Indian traditional knowledge:

Basic structure of Indian knowledge system, Modern science and Indian knowledge system, Yoga andholistic Health care. Philosophical tradition, Indian linguistic tradition, Indian artistic tradition.

TOTAL PERIODS: 45

Text Books:

1. N. Sivaramakrishnan (Ed.) Culteral Heritage of India – Course Materal, BharatiyaVidyaBhavan, Mumbai5th edition, 2014.
2. Swami Jitatmanand, Modern Physics and Vedanta, BharatiyaVidyaBhavan.

Reference Books:

1. Fritzof Capra, Tao of Physics.
2. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta.
3. R.N. Jha, Science of Conciousness Psychotherapy and yoga Practices, VidyanidhiPrakashan, Delhi 2016.

Course Outcome
The course will enable the student to:

CO1: Understand the structure, duties and functions of legislature, executive and judiciary
CO2: Understand the functioning of state governments and union territories
CO3: Understand the centre-state relations and functioning of constitutional bodies
CO4: Understand connect up and explain basics of Indian traditional knowledge in modern scientificperspective.
CO5: Under the Basic structure of Indian knowledge system.

SEMESTER IV

BMPCT401	PROBABILITY AND RANDOM PROCESS	L	T	P	Credits
		3	1	0	4

COURSE OBJECTIVES:

- To introduce the basic notions of vector spaces which will then be used to solve related problems.
- To understand the concepts of vector space, linear transformations, inner product spaces and orthogonalization.
- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To provide necessary basics in probability that are relevant in applications such as random signals, linear systems in communication engineering.
- To understand the basic concepts of probability, one and two dimensional random
- Variables and to introduce some standard distributions applicable to engineering which can describe real life phenomenon.

MODULE - I: PROBABILITY AND RANDOM VARIABLES

Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions - Functions of a random variable.

MODULE - II: TWO - DIMENSIONAL RANDOM VARIABLES

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

MODULE - III: RANDOM PROCESSES

Classification – Stationary process – Markov process - Poisson process - Discrete parameter Markov chain – Chapman Kolmogorov equations (Statement only) - Limiting distributions.

MODULE - IV CORRELATION AND SPECTRAL DENSITIES

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

MODULE - V LINEAR SYSTEMS WITH RANDOM INPUTS

Linear time invariant system – System transfer function – Linear systems with random inputs – Autocorrelation and Cross correlation functions of input and output.

TOTAL PERIODS: 60

TEXT BOOK

1. Ibe.O.C., "Fundamentals of Applied Probability and Random Processes", Elsevier,1st Indian Reprint, 2007.
2. P . Ramesh babu, "Probability Theory and Random Processes", McGraw Hill Education, FirstEdition, New Delhi, 2015.
3. Gross, D., Shortle, J.F, Thompson, J.M and Harris. C.M., "Fundamentals of Queueing Theory", Wiley Student 4th Edition, 2014.
4. Friedberg. A.H., Insel. A.J. and Spence. L., "Linear Algebra", Prentice Hall of India, New Delhi, 4th Edition, 2004.

REFERENCE BOOKS :

1. Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.
2. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, John Wiley and Sons, 2002.
3. Yates, R.D. and Goodman. D. J., "Probability and Stochastic Processes", 2nd Edition, Wiley India Pvt. Ltd., Bangalore, 2012.
4. Kolman. B. Hill. D.R., "Introductory Linear Algebra", Pearson Education, New Delhi, First Reprint, 2009.
5. Kumaresan. S., "Linear Algebra – A Geometric Approach", Prentice – Hall of India, New Delhi, Reprint, 2010.
6. Strang. G., "Linear Algebra and its applications", Thomson (Brooks/Cole), New Delhi, 2005.

COURSE OUTCOMES:

Upon successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.

CO2: Demonstrate accurate and efficient use of advanced algebraic techniques.

CO3: Apply the concept of random processes in engineering disciplines.

CO4: Understand the fundamental concepts of probability with a thorough knowledge of standard distributions that can describe certain real-life phenomenon.

CO5: Understand the basic concepts of one and two dimensional random variables and apply them to model engineering problems.

BMPCT402	BIOMEDICAL SENSORS AND TRANSDUCERS	L	T	P	Credits
		3	0	0	3

Course Objectives:

The overall objective of this course is to introduce students

- To the basic principles and design issues of biomedical sensors and instrumentation, including: the physical principles of biomedical sensors, analysis of biomedical instrumentation systems, and the application-specific biomedical sensor and instrumentation design.

MODULE I SCIENCE OF MEASUREMENT: 9 Hours

Measurement System – Instrumentation – Classification and Characteristics of Transducers – Static and Dynamic – Errors in Measurements – Calibration – Primary and secondary standards.

MODULE II DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS: 9 Hours

Strain Gauge: Gauge factor, sensing elements, configuration, unbounded strain gage, biomedical applications; strain gauge as displacement & pressure transducers: force summing devices, capacitive transducer, inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics, and biomedical applications of Temperature sensors. Active type: Thermocouple – characteristics,

MODULE III PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS: 9 Hours

Phototube, Photo Multiplier Tube (PMT), photovoltaic, photoconductive cells, photo diodes, phototransistor, comparison of photoelectric transducers, spectro-photometric applications of photo electric transducers. Piezoelectric active transducer and biomedical applications as pressure & Ultrasound transducer.

MODULE IV ELECTRODES: 9 Hours

Recording Electrodes – Electrode-tissue interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Surface Electrodes – Needle electrodes – Micro electrodes - Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams.

MODULE V BIOCHEMICAL TRANSDUCERS: 9 Hours

Biosensors - Chemoreceptors, hot and cold receptors, Baro receptors, sensors for smell, sound, vision, osmolality and taste. Transducers for the measurement of ions and dissolved gases. Ion exchange membrane electrodes - Measurement of pH - Glass pH electrodes. Measurement of pO2, Measurement of pCO2. ISFET for glucose, urea.

TOTAL PERIODS: 45

TEXT BOOKS

1. Principles of Applied Biomedical Instrumentation L.A Geddas and L.E.Baker – John Wiley and sons.

2. Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, 2007.

REFERENCE BOOKS

1. Ernest O Doebelin and dhanesh N manik, Measuremet systems, Application and design ,5th edition ,McGraw-Hill, 2007.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2007.
3. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India,New Delhi, 2007.
4. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2004.

Course Outcomes:

By the end of the course the students will be able to:

CO1: Classify systems modeling biomedical sensors and instrumentation

CO2: Calculate the static and dynamic characteristics of bio instrumentation systems

CO3: Analyze fluid mechanics models currently used for clinical research problems Syllabus

CO4: Apply various electrode to tissue for receive and analyze the biological signals.

CO5: Acquire and evaluate the body parameters using biosensors

BMPCT403	MEDICAL INSTRUMENTATION	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

- To understand the origin of various biological signals and electrode configurations specific to bio-potential measurements.
- To understand the characteristics of Bio signals.
- To understand the design of bio amplifiers
- To explain the different techniques used for measurement of non-electrical bio- parameters
- To explain the biochemical measurement techniques as applicable for diagnosis and treatment.

MODULE I: ELECTRODE CONFIGURATIONS 9 Hours

Bio signals characteristics – Origin of bio potential and its propagation. Frequency and amplitude ranges. Electrode configurations: Electrode-electrolyte interface, electrode–skin interface impedance, polarization effects of electrode – non-polarizable electrodes. Unipolar and bipolar configuration, classification of electrodes.

MODULE II: BIOSIGNAL CHARACTERISTICS 9 Hours

Bio signals characteristics – ECG-frequency and amplitude ranges – Einthoven's triangle, standard 12 lead system. EEG - EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. EMG - Electrode configuration -unipolar and bipolar mode.

MODULE III: BIOAMPLIFIERS 9 Hours

Need for bio-amplifier - Differential bio-amplifier – Single ended amplifier - Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier, Chopper amplifier. Power line interference

MODULE IV: MEASUREMENT OF BIO SIGNALS 9 Hours

Temperature, respiration rate and pulse rate measurements. Blood Pressure - indirect methods: auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers - systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurements

MODULE V: BIOCHEMICAL MEASUREMENTS 9 Hours

Biochemical sensors - pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), immunologically sensitive FET (IMFET), Blood glucose sensors. Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer.

TOTAL PERIODS: 45

TEXT BOOKS:

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice hall of India, New Delhi, 2015.

2. John G. Webster, “Medical Instrumentation Application and Design”, 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.

3. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 2003.

REFERENCE BOOKS

1. John Enderle, Susan Blanchard, Joseph Bronzino, “Introduction to Biomedical Engineering”, second edition, Academic Press, 2005.

2. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, Pearson Education, 2000

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Illustrate the origin of various biological signals and their characteristics.

CO2: Gain knowledge on characteristics of bio signals.

CO3: Gain knowledge on various amplifiers involved in monitoring and transmission of biosignals.

CO4: Explain the different measurement techniques for non-electrical bio-parameters

CO5: Explain the biochemical measurement techniques as applicable for diagnosis and further treatment.

BMPCT404	BIOCHEMISTRY	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

The student should be:

• To study structural and functional properties of carbohydrates, proteins, lipids and amino acids

• To emphasize the role of these biomolecules by providing basic information on specific metabolic diseases and disorders of these biomolecules

• Gain knowledge on the structural and functional aspects of living organisms.

• Know the etiology and remedy in treating the pathological diseases.

MODULE I CARBOHYDRATES 9 Hrs.

Introduction. Classification, Properties and Biological importance. Isomers, epimers, enantiomers, mutarotation, open chain and closed chain structures of glucose, glycolysis, TCA cycle.

MODULE II AMINOACIDS AND PROTEINS 9 Hrs.

Amino acids and peptides: Definition, structure, classification- essential and non-essential amino acids, protein and non-protein amino acids, Zwitterions. Amino acids as ampholytes. Structure of proteins: primary, secondary, tertiary and quaternary biological significance. Concept of isoelectric point and its significance.

MODULE III LIPIDS 9 Hrs.

Introduction, Classification, Simple lipids – Physical and chemical properties of fats and biological importance. Fatty acid nomenclature and structure, Lipids in cell membrane, Steroids, Compound lipids – Structure and function of phospholipids, glycolipids and lipoproteins. Derived lipids. Hormones - structure and function.

MODULE IV NUCLEIC ACIDS 9 Hrs.

Introduction- Nitrogenous bases - Purines and Pyrimidines - Nucleosides and Nucleotides -- Structure of nucleic acids- DNA, RNA: m-RNA, t-RNA, r-RNA- Biological importance of nucleic acids, nucleic acid sequencing.16srRNAandits significance.

MODULE V VITAMINS AND MINERALS 9 Hrs.

Vitamins: fat soluble and water-soluble vitamins – sources, structure and physiological functions. Minerals: Essential micro and essential macrominerals – sources and functions. Biological importance of vitamin and minerals, deficiency symptoms.

TOTAL PERIODS: 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the Basic Units Give Rise to Large Molecules Such as Proteins, Carbohydrates, Lipids, Nucleic Acids

CO2 - Describes the Structure, Function and Classifications of Biomolecules.

CO3 - Illustrates the Various Types of Weak Interactions between the Biomolecules

CO4 - Summarize the Structure, Function and Classification of Vitamins and Minerals

CO5 - Investigate the Biological Importance of Vitamins and Minerals

CO6 - Enumerates the Structure of Amino Acids and Protein

TEXT BOOK / REFERENCE BOOK

1. Lehninger, Nelson and Cox, "Principles of Biochemistry", 6th edition, W.H. Freeman & Company, 2018

2. Dr. U. Satyanarayana, Dr. U. Chakrapani, ''Biochemistry'' (with Clinical Concepts & Case Studies), 4th revised edition, Elsevier, 2018

BMPCT405	LINEAR INTEGRATED CIRCUITS	L	T	P	Credits
		3	0	0	3

Course Objectives:

- To introduce the basic building blocks of linear integrated circuits.
- To teach the linear and non-linear applications of operational amplifiers.
- To introduce the theory and applications of analog multipliers and PLL.
- To teach the theory of ADC and DAC.
- To introduce the concepts of waveform generation and introduce some specialfunction ICS.

MODULE 1 INTEGRATED CIRCUITS: 9 Hours

Classification, chip size and circuit complexity, Fundamentals of Monolithic IC technology, basic planar processes, Fabrication of a typical circuit, Activeand passive components of ICs, fabrication of FET, Thin and thick film technology.

OPERATION AMPLIFIER: **9 Hours**

Basic information of Op-amp, ideal and practical Op-amp, Op- amp characteristics, 741 op-amp and its features, modes of operation-inverting, non-inverting, differential mode.

MODULE 2: OP-AMP APPLICATIONS: **9 Hours**

Basic application of Op-amp, instrumentation amplifier, ac amplifier, V to I and I to V converters, Precision rectifiers, log and antilog amplifiers, sample & hold circuits, multipliers and dividers, Differentiators and Integrators, Comparators, Schmitt trigger, Multivibrator, Triangular wave generator.

MODULE 3: ACTIVE FILTERS, OSCILLATORS AND REGULATORS 9 Hours

Introduction-Low pass and High pass filters- Design of first and second order Butterworth lowpass and high pass filters Band pass, Band reject and all pass filters- Oscillator types and principle of operation – RC, Wien bridge oscillators triangular, saw-tooth, square wave and VCO- Introduction to voltage. Stimulators, features of 723, Three Terminal IC regulators- DC to DC Converter-Switching Regulators-UPS-SMPS.

MODULE 4: TIMERS & PHASE LOCKED LOOPS 9 Hours

Introduction to 555 timer, functional diagram, monostable and astable operations and applications, Schmitt Trigger. PLL - introduction, block schematic, principles and description of individual blocks of 565-PLL applications, Analog and digital phase detectors.

MODULE 5: D-A AND A- D CONVERTERS 9 Hours

Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, Different types of ADCs - parallel comparator type ADC, counter type ADC, successive approximation ADC, dual slope ADC and Sigma delta ADC. DAC and ADC specifications. DAC 0800 and ADC 0804 pin diagram and application.

TOTAL PERIODS: 45

TEXT BOOKS:

1 D. Roy Chowdhury, "Linear Integrated Circuits" New Age International (p) Ltd, 2011.

REFERENCES :

1. R.F. Coughlin & Fredrick F. Driscoll. Operational Amplifiers & Linear Integrated Circuits, PHI, 6th Edition, 2003
2. Ramakanth A. Gayakwad, Op-Amps & Linear ICs –PHI, 4th Edition 2004.

COURSE OUTCOMES:

On successful completion of the module students will be able to:

CO1: Design simple circuits like amplifiers using Opamps.

CO2: Design waveform generating circuits

CO3: Design simple filters circuits for particular application..

CO4: Gain knowledge in designing stable voltage regulators.

BSC207	MEDICAL PHYSICS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

- To provide understanding of the application of the radiation concepts and methods of Physics in Medical science
- To accentuate the principle, effects and clinical applications of ionizing, non-ionizing and electromagnetic radiation.
- To enunciate the fundamentals of acoustic waves and their interaction with human tissues.
- To explore the effects of radiation in matter and how isotopes are produced
- To study effects of sound and light in human body

MODULE 1:LOW ENERGY ELECTROMAGNETIC SPECTRUM AND ITS MEDICAL APPLICATION 9

Physics of light, Intensity of light, limits of vision and color vision an overview, Non-ionizing

Electromagnetic Radiation: Overview of non-ionizing radiation effects-Tissue as a leaky dielectric-Low Frequency Effects- Higher frequency effects., Thermography– Application

MODULE 2: PRINCIPLES OF RADIOACTIVE NUCLIDES 9

Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology, Decay series, Production of radionuclides – Cyclotron produced Radionuclide- Reactor produced Radionuclide-fission and neutron capture reaction, radionuclide Generator-Technetium generator

MODULE 3: INTERACTION OF RADIATION WITH MATTER LIPIDS 9

Interaction of charged particles with matter –Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation, Interaction of X and Gamma radiation with matter- Photoelectric effect, Compton Scattering , Pair production, Attenuation of Gamma Radiation, Interaction of neutron with matter and their clinical significance

MODULE 4: RADIATION DOSE AND ITS EFFECTS 9

Dose and Exposure measurements – Units (SI), Inverse square law, Maximum permissible exposure, relationship between the dosimetric quantities, Radiation biology – effects of radiation, concept of LD 50, Stochastic and Non-stochastic effects, Radiation Syndrome.

MODULE 5: PRINCIPLES AND APPLICATIONS OF SOUND IN MEDICINE 9

Physics of sound, Normal sound levels, ultrasound fundamentals, Generation of ultrasound (Ultrasound Transducer), Interaction of Ultrasound with matter- Cavitations, Reflection, Transmission, Scanning methods, Artifacts, Ultrasound- Doppler effect, Clinical Applications

TOTAL PERIODS: 45

TEXT BOOKS:

1. B.H. Brown, R.H. Smallwood, D.C. Barber, P.V. Lawford, D.R. Hose, “Medical Physics and Biomedical Engineering”, Institute of physics publishing, Bristol and Philadelphia, 1999.

2. Gopal B. Saha “Physics and Radiobiology of Nuclear Medicine” Fourth edition Springer, 2006.

REFERENCES:

1. W.J. Meredith and J.B. Massey “Fundamental Physics of Radiology” Varghese Publishing house, Third Edition, 2013.
2. Steve Webb, The Physics of Medical Imaging, Taylor & Francis, Newyork, Second Edition, 2012.
3. R.S. Khandpur, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, New Delhi, 2003.

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Interpret the properties of electromagnetic radiations and its effect on human.

CO2: Apply the principles and understand the production of radioactive nuclides.

CO3: Explain the interaction of radiation with matter.

CO4: Identify and Analyze the radiation quantities and its effects

CO5: Demonstrate the knowledge on the properties of sound and its application in medicine.

BMPCP401	BIOMEDICAL SENSORS AND TRANSDUCERS LAB	L	T	P	Credits
		0	0	2	1

COURSE OBJECTIVES

- Understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- Know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications

EXPERIMENT LIST

1. Characteristic of Temperature transducers (LDR, thermistor and thermocouple).
2. Measurement of Displacement using capacitive transducer, LVDT, inductive transducer andpotentiometric transducer.
3. Characteristics of Optical Transducers (LDR, Phototransistor, Photovoltaic and photoconductivecells)
4. Modeling of RTD and thermocouple.
5. Measurement of Pressure and Temperature using ICs (LM 335, and AD 590)
6. Measurement of strain using strain gauge for (i) Quarter bridge (ii) Half bridge (iii) Full bridge
7. Plotting characteristics of Photoelectric Transducer, Piezo-electric Transducer, and Thermoelectric Transducer.
8. Determination of characteristics of (i) DC Amplifier (ii) Chopper Amplifier and (iii) Instrumentation Amplifier.
9. Characteristics of Ultrasound Transducer and Phono Transducer.
10. Measurement of Skin Resistance.
11. Determination of characteristics of Polarized Electrodes, Non-polarized Electrodes, Multi PointElectrodes.

TOTAL PERIODS: 30

COURSE COUTCOME:

CO1: Describe the purpose and methods of measurements.
CO2: Explain different display and recording devices for various applications.
CO3: Know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications
CO4: Remember and understand the concepts, types, working and practical applications of important biosensors.
CO5: Know some of the commonly used biomedical transducers.
CO6: Know the different display and recording devices

BMPCP402	MEDICAL INSTRUMENTATION LAB	L	T	P	Credits
		0	0	2	1

COURSE OBJECTIVES:

The student should be made to

- To study and design Bio amplifiers.
- To provide hands on training on Measurement of physiological parameters.

LIST OF EXPERIMENTS:

1. Design of pre amplifiers to acquire bio signals along with impedance matching circuit using suitable IC's
2. Design of ECG Amplifiers with appropriate filter to remove power line and other artifacts.
3. Design of EMG amplifier
4. Design a suitable circuit to detect QRS complex and measure heart rate
5. Design of frontal EEG amplifier
6. Design of EOG amplifier to detect eye blink
7. Design a right leg driven ECG amplifier.
8. Design and study the characteristics of optical Isolation amplifier
9. Design a Multiplexer and Demultiplexer for any two biosignals.
10. Measurement of pulse-rate using Photo transducer.
11. Measurement of pH and conductivity.
12. Measurement of blood pressure using sphygmomanometer.
13. Measurement and recording of peripheral blood flow
14. Design a PCB layout for any bio amplifier using suitable software tool.

TOTAL PERIODS: 30

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Design the amplifier for Bio signal measurements

CO2: Measure heart rate and heart sounds.

CO3: Record and analyze pulse rate and respiration rate

CO4: Measure blood pressure and blood flow

CO5: Design isolation amplifier

BMPCP403	BIOCHEMISTRY LABORATORY	L	T	P	Credits
		0	0	2	1

COURSE OBJECTIVES:

To provide practice on:

- Estimation and quantification of biomolecules.
- Separation of macromolecules.
- Use Compound microscope
- Practice on chemical examinations, Histopathological examinations etc

LIST OF EXPERIMENTS:

1. Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutionS
2. General tests for carbohydrates, proteins and lipids.
3. Preparation of serum and plasma from blood.
4. Estimation of blood glucose.
5. Estimation of creatinine
6. Estimation of urea
7. Estimation of cholesterol
8. Assay of SGOT/SGPT
9. Separation of proteins by SDS electrophoresis
10. Separation of amino acids by thin layer chromatography
11. Separation of DNA by agarose gel electrophoresis

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Understand the Biochemistry laboratory functional components

CO2: Have a sound knowledge of qualitative test of different biomolecules.

CO3: Understand the basics knowledge of Biochemical parameter and their interpretation in Blood sample.

CO4: Have a sound knowledge of separation technology of proteins and amino acids.

CO5: Student can perform practical experiments on staining Processes.

AUC004	ENVIRONMENTAL SCIENCE	L	T	P	Credits
		1	0	1	0

Course Objective:

- It is concerned with the exploration, investigation and development of an understanding of the natural, human and social dimensions of local and wider environments.
- It provides opportunities to engage in active learning, to use a wide range of skills, and to acquire open, critical and responsible attitudes.
- The objective of this activity is to raise awareness about sustainable living practices and encourage students to adopt eco-friendly habits in their daily lives.

MODULE 1

Eco system: Introduction- Abiotic and Biotic components, Structure and functions of Ecosystem – Food Chain, Food web, Ecological pyramids, Energy flow and biogeochemical cycles.

MODULE 2

Biodiversity: Values, Type and levels of Biodiversity. Causes of depletion. Conservation of biodiversity

MODULE 3

Pollutions: Water Pollution-Sources of water, water quality standards, type of pollutants – its sources and effects. Air Pollution – composition of atmosphere, Air quality standards, Sources and adverse effects of air pollution, Greenhouse effect, global warming, acid rain, ozone depletion Noise Pollution – Introduction, Level of noise, Sources and adverse effects of noise, Control of noise pollution.

MODULE 4

Solid Waste Management: Municipal waste – Introduction, classification of solid waste, composition and characteristics of solid waste

MODULE 5

Activity for Environmental Studies in Engineering Colleges

1. Green Campus Initiative: Organize a campus-wide green initiative to promote sustainable practices, such as recycling, reducing energy consumption, and minimizing water wastage. Conduct workshops and awareness campaigns on campus to involve students and staff actively.
2. Waste Audit and Management: Conduct a waste audit on campus to analyze the types and quantities of waste generated. Based on the findings, implement effective waste management practices, including recycling programs and proper waste disposal.
3. Environmental Impact Assessment: Assign students real-life projects to conduct environmental impact assessments of construction projects or industrial facilities to identify potential environmental impacts and propose mitigation measures.

4. Energy Efficiency Workshop: Organize workshops and seminars on energy efficiency, renewable energytechnologies, and energy conservation to educate students about sustainable energy practices.
5. Green Design Competition: Host a green design competition where students come up with sustainable engineering solutions for environmental challenges. Encourage innovative designs that promote sustainability and eco-friendliness.
6. Nature Walk and Biodiversity Study: Organize nature walks and biodiversity study trips to nearby natural areas. Students can learn about local ecosystems, wildlife, and the importance of conserving biodiversity.
7. Sustainable Transportation Campaign: Raise awareness about sustainable transportation options such as cycling, carpooling, and public transit. Encourage students to use these eco-friendly modes of transportation on campus.
8. Water Conservation Challenge: Run a water conservation challenge where students compete to reduce water usage in their hostels or departments. Monitor water consumption and reward the most water-conscious groups.
9. Community Outreach Program: Engage with the local community on environmental issues through outreach programs. Students can conduct workshops on waste management, renewable energy, or other eco-friendly practices.
10. Green Tech Exhibition: Organize a green technology exhibition to showcase sustainable engineering solutions and environmentally friendly projects developed by students. Invite industry experts and environmentalists to judge and provide feedback.

Text Books:

1. P.Yugananth, R.Kumaravelan, Environmental Science and Engineering, Scitech Publications (Inida) P.Ltd., Delhi, 2017.
2. John Pichtel, Waste Management Practices: Municipal, Hazardous and Industrial, CRC Press, 2014.

Reference Books:

1. V.S.K.V.Harish, Arunkumar, Green Building Energy Simulation and Modeling, Elsevier Science & Technology,2018.
2. Anubha Kaushik and C.P.Kaushik, Environmental Science and Engineering, New Age International (P) Ltd., New Delhi, 2010.
3. S.S.Dara, A text book of Environmental Chemistry and Pollution Control, S.Chand and Company Ltd., New Delhi, 2014.

Course Outcome:

After completion of this course, students will be able to:

1. Recognize the impact of environmental depletion especially on ecosystem and biodiversity
2. Identify factors causing land, water, air and noise pollution
3. Determine the effects of pollution
4. Develop keen understanding of non conventional energy source, solid waste management and technologies for sustainable development
5. Understand the environment legislations in India.

SEMESTER V

BMPCT501	BIOMEDICAL SIGNAL PROCESSING	L	T	P	Credits
		3	0	0	3

Course Objectives:

- It provides a solid foundation in advanced biomedical signaling and imaging systems including up-to-date coverage of commercially relevant topics.
- It focuses on biomedical signals, processing the signals, and validate the methods and results for optimization of clinical applications.

MODULE I - BIOMEDICAL APPLICATIONS: 9 HOURS

ECG averaging – Reduction of 50 Hz noise – Maternal ECG cancellation in fetal electrocardiography – High frequency noise cancellation in Electro surgery. ECG QRS detection Techniques – Estimation of R-R interval –Arrhythmia analysis monitoring – Basics of ECG data reduction techniques. EEG analysis - time and frequency domain methods

MODULE II DISCRETE-TIME SIGNALS AND LINEAR SYSTEMS: 9 Hours

Classification of signals: continuous and discrete, energy and power -representation of discrete- time signals, elementary discrete-time signals, classification of discrete-time signals, Classification of systems, Representation of a system with difference equation, impulse response and step response, FIR and IIR systems, Convolution sum and correlation, sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect, reconstruction of analog signal from its samples.

MODULE III DTFT AND Z-TRANSFORM: 9 Hours

Discrete-time Fourier series, Frequency range, Discrete-time Fourier transform-properties, Frequency response, ideal filters, Z-transform and its properties- inverse z-transforms- system function- stability criterion- Solving difference equations using Z-transform.

Realization of IIR systems- direct form-I, direct form –II, cascade form and parallel forms. Realization of FIR systems-direct form, linear phase realization, cascade and parallel forms

MODULE IV - DFT and FFT: 9 Hours

Discrete Fourier Transform, Relationship of the DFT to other transforms, Properties of DFT, circular convolution, filtering long duration sequences, parameter selection to calculate DFT. Computation of DFT using FFT algorithm – DIT & DIF - FFT using radix 2 – Butterfly structure- FFT applications.

MODULE V - DESIGN OF DIGITAL FILTERS: 9 Hours

FIR filter design: Linear phase characteristics- Windowing technique of designing FIR filter– Need and choice of windows, frequency sampling method.

IIR filter design: Analog filter design - Butterworth and Chebyshev filters, digital design using impulse invariant and bilinear transformation – Warping effect, prewarping

TOTAL PERIODS: 45

TEXT BOOKS:

1. P.Ramesh Babu, “Digital Signal Processing”, Sixth Edition, Scitech publications, Chennai, 2014 (UNITS I, II, III & IV)

2. DC Reddy, Biomedical Signal Processing – Principles and Techniques, Tata McGraw Hill Publishing company Ltd., 2005 (UNIT V)

REFERENCE BOOK

1. Willis J.Tompkins, Biomedical Digital signal processing, Prentice Hall of India Pvt. Ltd., 2000.

Course Outcomes:

At the end of this course successful students will be able to:

CO 1. To Make Students Understand the Sources, Types & Characteristics of Different Noises and Artifacts Present in Biomedical Signals.

CO 2. To Make Students Able to Design Time Domain and Frequency Domain Filters for Noise and Artifact Removal from Biomedical signals.

CO 3. To Make Students Able to Understand and Apply Various Methods for Analyzing Biomedical Signal Characteristics.

CO 4. To Motivate Students to Explore Alternative Techniques of Analyzing Biomedical Signals in Time and Frequency Domain.

BMPCT502	DIAGNOSTIC INSTRUMENTATION	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

To gather knowledge about measurements of parameters from humans.

To learn about different instruments used for diagnosis of diseases.

To propose designs to manufacture diagnostic equipment.

MODULE I INTRODUCTION AND GENERAL-PURPOSE EQUIPMENT 9 Hours

Basic Medical Instrumentation system and performance requirements, Intelligent medical Instrumentation systems, Basic Audiometer – Bekesy audiometer, Conventional and Digital Hearing aids, BERA Test, Spirometry, Pneumotachometers. Auto Refractometer, Retinoscope, Tonometer's.

MODULE II BIOMEDICAL RECORDERS 9 Hours

ECG-Lead Configuration-Instrumentation set-up - Artifacts. Arrhythmia Monitors, EEG-10-20 Electrodes configuration - Instrumentation - Evoked potentials, Magnetoencephalogram EMG - Measurement of nerve conduction velocity. ERG, EOG, EGG, PCG, Ambulatory Monitors.

MODULE III IMAGING EQUIPMENTS 9 Hours

X-Ray machine, Dental X Ray Machine, Mobile Units, Computed Tomography - Gantry Scanning system & Instrumentation. MRI - The magnet, RF transmitter system, Gradient system, imaging system, Safety considerations, Ultrasonic imaging systems – Instrument & Scan modes, Echocardiography, Thermographic Equipment- Camera and Detectors

MODULE IV FLOW METERS 9 Hours

Flow meters - Electromagnetic flow meters, Ultrasonic Blood flow meters, Laser Doppler Flowmeter, Point of Care Devices- Glucometer, Polygraph GSR Measurement

MODULE V PATIENT MONITORING SYSTEMS 9 Hours

BP measurement - Direct and indirect method, Pulse measurement, Temperature measurement, Respiration Rate Measurement, Apnea Monitors, Central monitoring system. Endoscopy and types, Laparoscopy, Oximetry, Neonatal Instrumentation.

TOTAL PERIODS: 45

TEXT BOOK

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill Publication company Ltd, New Delhi, 2016.
2. Joseph J. Carr, John Michael Brown, Introduction to Biomedical Equipment Technology 4th edition, Pearson Education.2012

REFERENCE BOOK

1. John G. Webster, Biomedical Instrumentation, Wiley Publications.5th edition, 2020.
2. R. Ananda Natarajan, Biomedical Instrumentation & Measurements, PHI Publication, 2015.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1 - Discuss on the measurement systems and instruments for respiration, eye and hearing diagnosis.

CO2 - Explore the instruments used to record Bio signals.

CO3 - Understand and discuss about the various image acquisition machines.

CO4 - Evaluate the flowmeters and point of care devices.

CO5 - Examine the equipment for patient monitoring in hospitals.

CO6 - Apply the knowledge acquired to design diverse diagnostic equipment.

BMPCT503	MICROPROCESSOR AND MICROCONTROLLER	L	T	P	Credits
		3	0	0	3

Course Objectives:

1. To study 8085 programming
2. To study interfacing devices like 8255, 8253, 8259 and 8251
3. To study 8086 and programming
4. To study the applications of 8085

MODULE I INTRODUCTION TO 8085: 9 Hours

Generic-8-bit microprocessor and its architecture-8085 functional block diagram-Architecture-functions of different sections-Memory mapping-Memory Interfacing-Instruction format-addressing modes-instruction set of 8085 CPU-instruction cycle- timing diagram-different machine cycles-fetch and execute operations-estimation of execution time.

MODULE II INTERFACING DEVICES: 9 Hours

8255 programmable peripheral interface-8253 programmable interval timer-8259 programmable interrupt controller-direct memory access (DMA) and 8257 DMA controller-8155 multipurpose programmable devices-8279 programmable keyboard display interface-serial I/O and data communication-8251 USART-Interfacing data converters ADC and DAC.

MODULE III INTRODUCTION TO 8086: 9 Hours

Architecture of 8086 Microprocessor- Special functions of General purpose registers- 8086 flag register and function of 8086 flags- Addressing modes of 8086- Instruction set of 8086-, Assembly language programs involving logical, Branch & Call instructions, sorting, evaluation of arithmetic expressions, string manipulation- Pin diagram of 8086-Minimum mode and maximum mode of operation- Timing diagram- Memory interfacing to 8086 (Static RAM & EPROM).

MODULE IV APPLICATIONS OF MICROPROCESSORS: 9 Hours

Typical application of microprocessors: Seven segment display interface, LCD interface, stepper motor control, temperature control, frequency measurement., phase angle and power factor measurement, Measurement of strain, deflection and water level measurement, Microprocessor based traffic control.

MODULE V INTRODUCTION TO MCS51 MICROCONTROLLER: 9 Hours

Intel MCS51 Architecture – Derivatives - Special Function Registers (SFR), I/O pins, ports and circuits, Instruction set, Addressing Modes, Assembly Language Programming, Timer and Counter Programming, Serial Communication, RS-232 implementation, Interrupts Programming, External Memory interfacing.

TOTAL PERIODS: 45

Text Books:

1. Ramesh S Gaonkar, “Microprocessor Architecture, Programming and application with 8085”, 6th Edition, Penram International Publishing, New Delhi, 2013.

2. A.K. Ray and K.M.Burchandi, and A.K.Ray," Advanced Micrprocessor and Peripherals, McGraw Hill International Edition, 3rd Edition, 2012
3. B. Ram, "Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications, 2001
4. Mohammed Ali Mazidi and Janice Gillispie Mazidi, "The 8051 Microcontroller and Embedded System", Pearson Education Asia, New Delhi, 2006.

Reference Books:

1. N. Senthil Kumar, M.Saravanan and S.Jeevananthan, ―Microprocessor and Microcontrollers, OXFORD UNIVERSITY PRESS, November, 2010.
2. John Uffenbeck, "The 80x86 Family, Design, Programming and Interfacing", Third Edition, Pearson Education, 2002.

Course Outcomes:

CO1: Write simple assembly language program in 8085

CO2: Interface any i/o device and communicate using 8085

CO3: Write simple assembly language programs in 8086

CO4: Design a microprocessor-based system for any application

CO5: Apply various microprocessor to a biological application

BMPCT504	BIOMECHANICS AND BIOFLUIDS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

To observe the fundamentals of biomechanics and fluid mechanics.

To distinguish properties and mechanics of hard and soft tissues.

To apply techniques mastered in biomechanics to real life applications.

MODULE I BIOMECHANICS **9 Hours**

Biomechanics- Definition and perspective, Fundamental Mechanical Concepts- Kinetics and Kinematics, Newton's Laws, Mechanical Properties -Stress, Strain, Elasticity, Shear, Tension, Compression, Plastic Deformation, Creep, and Fatigue. Mechanical testing of biomaterials-UTM-Basic Engineering mechanics, Force - Resolution of forces, Projectiles, All or None law

MODULE II FLUID MECHANICS **9 Hours**

Viscosity-Definition, properties. Types of fluids- Newtonian fluid, non-Newtonian fluid, Types of fluid flow. Hagen- Poiseulle's equation. Viscoelasticity- Viscoelastic Models, Vascular tree, Flow properties of Blood, Physical, Chemical and Rheological properties of blood, Apparent and Relative and viscosity, Fahraeus- Lindqvist Effect.

MODULE III HUMAN LOCOMOTION AND RESPIRATORY MECHANICS **9 Hours**

Anthropometric Characteristics of human body. Types of motion in humans, Gait analysis. Goniometry. Accelerometer, Foot Pressure Measurements - Pedobarograph-Force platform. Mechanics of foot. Alveoli mechanics, blood and lung interaction, PV curve of lungs, cardiac mechanics, fluid dynamics of aortic and mitral valves.

MODULE IV HARD AND SOFT TISSUE MECHANICS **9 Hours**

Biomechanics of upper extremities-Elbow, Shoulder. Biomechanics of lower extremities-Hip and Knee.-Tissue Mechanics-Mechanical Properties of Tissues, Biological materials, Properties of Cortical, Cancellous Bone. Soft Tissue properties Mechanical testing of Soft tissue.

MODULE V SPORTS MECHANICS **9 Hours**

Application of biomechanics to neuromuscular fitness, gymnastics, Application of aerodynamics in sports, hydrodynamics in swimming. Analysis of throw and push patterns. Yoga Mechanics, Sports Medicine.

TOTAL PERIODS: 45

TEXT BOOK / REFERENCE BOOK

1. Duane Knudson, Fundamental of Biomechanics, Kluwer Academic, Second Edition, 2020.

2. Shyamal Koley, Textbook of Biomechanics, AITBS, 2021

3. Y. G. Fung, Biomechanics, Springer-verlag New York Inc, 2013

COURSE OUTCOMES

On completion of the course the students will be able to

CO1 - Interpret the different material properties to aid in selecting appropriate biomaterials.

CO2 - Identify the mechanics involved in flow of blood and viscosity.

CO3 - Predict the movements of human beings and lung mechanics.

CO4 - Analyze the biomechanics of hard and soft tissues.

CO5 - Establish the applications of biomechanics in different sports

CO6 - Generalize on distinct aspects of mechanics in the biological systems.

BMPCT505	MEDICAL IMAGING TECHNIQUE	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

- To study the quality assurance test for radiography, method of recording sectional images
- To study the functioning of radio isotopic imaging equipment's
- To study the MRI, image acquisition and reconstruction
- To study the 3-D image display techniques

MODULE I INTRODUCTION: 9 Hours

Basic imaging principle image modalities, Image properties Projection radiography, interaction between X – Rays and matter, Intensity of an X – Ray, Attenuation, X – Ray Generation and Generators, Beam Restrictors and Grids, Intensifying screens, fluorescent screens and image intensifiers, X – Ray, detectors, Conventional X – Ray radiography, Fluoroscopy, Angiography, Digital radiography.

MODULE II COMPUTED TOMOGRAPHY: 9 Hours

Basic Principle, Generation of CT machines, Detectors & Detector arrays, Details of Acquisition, Digital image display Radiation Dose, Image quality.

MODULE III ULTRASOUND: 9 Hours

Acoustic propagation, Attenuation, Absorption and Scattering, Ultrasonic transducers, Transducer Arrays, A mode, B mode, M mode scanners, Tissue characterization, Color Doppler flow imaging, Echocardiography.

MODULE IV RADIO NUCLIDE IMAGING: 9 Hours

Interaction of nuclear particles and matter, nuclear sources, Radionuclide generators, nuclear radiation detectors, rectilinear scanner, scintillation camera, SPECT, PET, Gamma ray camera, LINAC, molecular imaging.

MODULE V MAGNETIC RESONANCE IMAGING: 9 Hours

Angular momentum, Magnetic dipole moment, Magnetization, Larmor frequency Rotating frame of reference, free induction decay, Relaxation times, Pulse sequences, Generation and Detection of NMR Imager, Slice selection, Frequency encoding, Phase encoding, Spin – Echo imaging, Gradient – Echo imaging, Imaging safety, Biological effects of magnetic field, Introduction to FMRI,EMRI.

TOTAL PERIODS: 45

TEXT BOOKS:

1. Mathematics and Physics of Emerging Biomedical Imaging , National Academies Press, 1996

REFERENCE BOOK:

1. K Kirk Shung, Michael B smith & Benjamim M W Tsui, "Principles of Medical Imaging", Academic press inc, 1992.
2. Jerry L Prince & Jonathan M Links, "Medical Imaging Signals and Systems", Pearson Prentice Hall, 2006.

3. Jerrold T. Bushberg “The essential Physics of Medical Imaging”, Lippincott Williams and Wilkins, 2002.
4. R S Khandpur, “Hand Book of Biomedical Instrumentation”, Tata McGraw Hill Publication, Second Edition. 2003.
5. Ray H. Hashemi , William G. Bradley, Christopher, J. Lisanti, MRI: The Basics, 2004.
6. Frederick W Kremkau “Diagnostic Ultrasound Principles & Instruments”, Saunders Elsevier, 2005.

COURSE OUTCOME:

CO1: Understanding the principles and physics of different imaging techniques.

CO2: Knowledge of instrumentation and equipment used in each imaging modality.

CO3: Ability to operate and maintain imaging equipment safely and effectively.

CO5: Knowledge of the clinical applications of MRI in various medical specialties.

CO4: Ability to communicate effectively with doctors, biomedical engineers and other healthcare professionals regarding medical devices and imaging results.

BMPCT506	BIOMATERIALS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

- The course provides an intriguing insight in chemistry, engineering, biology and medicine that has a significant impact on biomaterials.
- It highlights the way in which modern biology and medicine is inextricably linked to scientific discipline and helping us to understand the complex world of biomaterials.
- To implement the biomaterials for ophthalmic application to correct vision.

MODULE I METALLIC BIOMATERIALS 9

Biomaterials - Overview, Classification of biomaterials, Biocompatibility and Hemocompatibility, Metals and alloys -Stainless steel, Titanium and its alloys, Cobalt chromium alloy, Metallic corrosion, Dental implants - Impression Materials, Fillings and Restoration Materials, Materials for Deep Cavities, Material for oral and Maxillofacial Implants.

MODULE II SYNTHETIC POLYMERSANDAPPLICATIONS 9

Synthetic Polymers, Polymers in biomedical use, Polyethylene, Perfluorinated Polymers, Acrylic Polymers, Hydrogels, Polyurethanes, biodegradable synthetic polymers, silicone rubber, microrganisms in polymeric implants, Polymer Sterilization.

MODULE III BIOCERAMICSANDCOMPOSITES 9

Bio ceramics, types- Carbon, Alumina, Zirconia - bioactive resorbable and non – resorbable bioceramics, bioceramic coatings on metallic implants and bone bonding reactions on implantation, Hydroxyapatite-properties and applications. Composites-Types and Applications, Bioglass.

MODULE IV HARD AND SOFT TISSUE REPLACEMENT 9

BioelectVric effect, Wolff's Law, Temporary orthopaedic fixation devices-pins, screws and plates, Intra Medullary and spinal nails, hard tissue replacements - total hip and knee joint replacements. Soft Tissue Replacements-Sutures-Tapes, Staples, Adhesives, Wound Dressings, Biomaterials in urological practice.

MODULE V BIOMATERIALS IN OPTHALMOLOGY AND BIOLOGICALTESTS 9

Ophthalmology- Introduction, Optical implants, Contact lenses, Eye shields, Viscoelastic solutions, Vitreous implants, Acrylate adhesives, Scleral buckling materials for retinal detachment, artificial tears, Biological Tests.

TOTAL PERIODS: 45

TEXT BOOK

1. Sujata V.Bhat, Biomaterials, Narosa Publishing House, New Delhi, India, 2012.

2. William Wagner, Shelly Sakiyama-Elbert, Guigen Zhang, Michael Yaszemski, Biomaterials Science: An Introduction to Materials in Medicine, ELSEVIER, 4th Edition -, 2020

REFERENCE BOOK

1. Park, Biomaterials an Introduction, Third Edition, Springer, 2007.

2. Joseph D Bronzino, The Biomedical Engineering Hand Book, Fourth Edition, CRC Press, 2015.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Identify different types of biomaterials used for various biomedical applications.

CO2 - Recognize various synthetic polymers, used as biomaterials for organ replacement.

CO3 - Understand different types of ceramics and composite used as biomaterials

CO4 -Acquire knowledge about hard tissue replacement and soft tissue replacement for various fixations.

CO5 - Apply knowledge about how to rectify eye defect using various biomaterials.

CO6 -Implement various methods to test Biocompatibility and Hemocompatibility test of biomaterials.

BMPCP501	BIOMEDICAL SIGNAL PROCESSING LABORATORY	L	T	P	Credits
		0	0	2	1

COURSE OBJECTIVES:

- To enhance practical knowledge in biomedical signal analysis
- To provide hands-on experience in filtering of biomedical signals

MATLAB / SCILAB / EQUIVALENT SOFTWARE PACKAGE

CYCLE 1

1. Generation of sequences (functional & random) & correlation
2. Linear and Circular Convolutions
3. Spectrum Analysis using DFT
4. FIR filter design
5. IIR filter design

CYCLE 2

6. ECG & Arrhythmia signal generation
7. Spectrum analysis & Noise removal of biomedical signals
8. Detection of QRS component from ECG signals using analog circuits
9. Isolation of bio-signal (EMG / ECG) using analog circuits.
10. Measurement of Hearing Threshold using Audiometer and plotting its characteristics.
11. PCG Classification
12. ECG Compression

COURSE OUTCOME

CO1: An ability to y to apply algorithms for signal processing

CO2: Ability to analyse biomedical signals and systems

CO3: Ability to evaluate biomedical signal acquisition and processing systems

BMPCP502	DIAGNOSTIC INSTRUMENTATION	L	T	P	Credits
		0	0	2	1

COURSE OBJECTIVE

- To provide hands-on knowledge on different diagnostic and therapeutic equipment.
- To demonstrate and analyse various bio signals.

LIST OF EXPERIMENTS

1. ECG monitoring using trainer kit and real time monitoring.
2. Plot respiratory waveforms using Spirometer
3. Measuring pulse rate and analyse waveforms.
4. Phonocardiogram monitor
5. Multi parameter monitoring system
6. Respiration rate analysis
7. Measurement of EMG signals.
8. EEG monitoring using simulator.
9. Medical telemetry system to transmit and receive ECG signals.
10. Human auditory response using an Audiometer

TOTAL PERIODS 30

COURSE OUTCOMES

On completion of the course the students will be able to

CO1 - Measure different bioelectrical signals using various methods

CO2 - Illustrate various diagnostic and therapeutic techniques

CO3 - Analyze the different bio signals using suitable tools

CO4 - Apply the learnt knowledge to design or troubleshoot instruments.

CO5 - Acquire skills to operate medical equipment.

CO6 - Design cost effective and simple biomedical instruments.

BMPCP503	MICROPROCESSOR AND MICROCONTROLLER LAB	L	T	P	Credits
		0	0	2	1

COURSE OBJECTIVES:

- This course introduces the assembly language programming of 8086 and 8051 microcontroller.
- It gives a practical training of interfacing the peripheral devices with the 8086 microprocessor.
- The course objective is to introduce the basic concepts of microprocessor and to develop in students the assembly language programming skills and real time applications of Microprocessor as well as microcontroller.

List of experiments

1. Programming 8085 microprocessor kit
2. Programming 8086 microprocessor kit
3. Interfacing programmable interrupt controller
4. Interfacing of display devices
5. Interfacing of D/A and A/D converters
6. Interface of key board and display using programmable controllers
7. Interface of programmable timer
8. Stepper motor control using microprocessor
9. Interfacing of 8251 and 8257
10. Traffic light Controller Interface.
11. Stepper Motor interface
12. Speed control of DC motors
13. Parallel port interface with printer

COURSE OUTCOME:

CO1. Understand and apply the fundamentals of assembly level programming of microprocessors and microcontroller.
CO2. Work with standard microprocessor real time interfaces including GPIO, serial ports, digital-to-analog converters and analog-to-digital converters
CO3. Troubleshoot interactions between software and hardware
CO4. Analyze abstract problems and apply a combination of hardware and software to address the problem
CO5. Use standard test and measurement equipment to evaluate digital interfaces.

AUC005	INTRODUCTION TO WOMEN AND GENDER STUDIES	L	T	P	Credits
		0	1	0	0

MODULE I CONCEPTS

Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

MODULE II GENDER AND LANGUAGE

Linguistic Forms and Gender. Gender and narratives.

MODULE III GENDER AND REPRESENTATION

Advertising and popular visual media. Gender and Representation in Alternative Media. Gender and social media.

MODULE IV FEMINIST THEORY

Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

MODULE V WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL

Rise of Feminism in Europe and America. Women's Movement in India.

TEXT BOOK:

1. Nadine T. Fernandez, SUNY, Katie Nelson Gendered Lives: Global Issues, Milne Open Textbooks 2021

SEMESTER VI

BMPCT601	THERAPEUTIC INSTRUMENTATION	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

- To acquire knowledge on the different therapeutic equipment available in the healthcare industry
- To understand the fundamental principles and working of the biomedical instruments involved in the therapy.

MODULE I INSTRUMENTS FOR CARDIOLOGY 9 Hrs.

Cardiac Pacemakers – Evolution of pacemakers, Need for Cardiac Pacemaker - External Pacemakers - implantable Pacemakers - Recent Developments in Pacemakers, Pacemaker analyzer. Cardiac Defibrillators -Need for a Defibrillator - DC Defibrillator – Automatic Implantable Defibrillators (AID) - Pacer-cardioverter - defibrillator analyzers, LVAD, IABP Machine- Working

MODULE II DIATHERMY AND ELECTROTHERAPY EQUIPMENT 9 Hrs.

Surgical diathermy machine – Principle -Working, Hazards and safety aspects in ESU. High frequency heat therapy - Short wave Diathermy - Microwave diathermy - Ultrasonic diathermy - TENS – Interferential Current Therapy –IFT therapy unit, Bladder Stimulators - DBS.

MODULE III EXTRACORPOREAL UNITS 9 Hrs.

Hemodialysis Machines - Artificial Kidney - Dialyzers - Membranes, Peritoneal Dialysis -Portable Kidney machines. Lithotripters – First and modern lithotripter systems - Extracorporeal Shockwave Therapy, Heart Lung Machine – Oxygenators-Pumps, Cryogenics.

MODULE IV PULMONARY ASSIST INSTRUMENTS 9 Hrs.

Anaesthesia Machine –Components - Electronics in Anesthesia machine. Ventilators – Types and classification- Modern microprocessor-based ventilators, HF Ventilators, Humidifiers - Nebulizers and Aspirators.

MODULE V DRUG DELIVERY AND NEONATAL SYSTEMS 9 Hrs.

Infusion Pumps- Components- Implantable infusion pumps -Insulin Pumps- Syringe Pumps, Peristalitic Pumps, Incubators-Radiant Warmer – Phototherapy Units.

TOTAL PERIODS: 45 Hrs.

TEXT BOOK / REFERENCE BOOK

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill Publication company Ltd, New Delhi, 2016.
2. Joseph J. Carr, John Michael Brown, Introduction to Biomedical Equipment Technology 4th edition, Pearson Education.2012
3. John G. Webster, Biomedical Instrumentation, Wiley Publications.5th edition,2020.
4. Andrew G Webb, Principles of Biomedical Instrumentation, Cambridge Press,2018

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Infer on the components required to design a pacemaker and defibrillator.
CO2 - Discuss on the use of heat and electricity in instruments for therapy.
CO3 - Evaluate the working of dialysis machines and lithotripters.
CO4 - Demonstrate the working of an anaesthesia machine and ventilators.
CO5 - Assess equipment utilised in paediatric care and drug delivery units.
CO6 - Design various therapeutic devices based on the knowledge gathered

BMPCT602	MEDICAL EMBEDDED SYSTEM	L	T	P	Credits
		3	0	0	3

Course Objectives

To identify domain specific topics from embedded systems for developing biomedical products.

To provide an in-depth understanding of both hardware and software aspects of embedded systems.

To enable conceptualisation and design of medical embedded systems to meet required industrial and ethical specifications.

MODULE I Introduction to Medical Embedded Systems: 9 Hours

Application of embedded systems in medical devices. Introduction to Arduino Platform and ATmega328P microcontroller, Overview of subsystems / peripherals within ATMega328P.Interrupt Subsystem: Interrupt Basics, Foreground and Background Processing, ATmega328 Interrupt System. Communications subsystem: Serial/Parallel Communication, Synchronous/Asynchronous Communication, USART, USB, SPI, I2C / Two-wire interface.

MODULE II GPIO Subsystem: 9 Hours

Details of GPIO subsystem, GPIO Registers, , GPIO output stage - Push-Pull & Open Drain, Related Digital concepts (Counters, Shift Registers). Timers: Basics – Prescalers, Types of Timers within ATmega328P, Timer Functions and Modes, PWM Generation, Application of PWM, Clock Sources in ATMega328P, Input Capture functionality, Timer Interrupts, Watchdog Timer, RTC.

MODULE III Analog-to-Digital Conversion: 9 Hours

Concepts related to ADC, Quantization Noise, Errors and Non-linearities within ADC. Different Types of ADC with focus on SAR ADC. Details of ADC present with ATMega328P. Programming concepts specific to Embedded Systems. Embedded systems design: Design of a bio-signal data acquisition system from concept to firmware and hardware.

MODULE IV Memory Subsystem: 9 Hours

Digital Concepts Related to RAM : SRAM, DRAM, Monostable / Bistable circuits, SRAM circuit and top-level design, ROM : EEPROM, Flash, ROM top-level design, Addressing Modes, Memory partitions within ATMega: Data Memory, Program Memory

MODULE V Power Management Subsystem: 9 Hours

Link between Power consumption and clock frequency, Different Types of Sleep Modes in ATMega328P, Reset Logic within ATMega328P, Power-On-Reset, External Reset , Watchdog Timer Reset, Brown-out Reset.

Total Periods: 45 Hours

Course Outcomes

At the end of the course, the student will be able to:

CO1. Gain in-depth understanding of concepts about embedded system.
CO2. Address problems in biomedical devices and develop embedded systems to solve it.
CO3. Learn and link hardware and software concepts used in embedded systems.

CO4. Analyse system level requirements by understanding analogue, digital and firmware related concepts.
CO5. Learn about different tools for embedded systems design and apply the same to medical systems.

Text Book

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “loT Fundamentals: Networking Technologies, Protocols and Use Cases for lnternet of Things, Cisco Press, 2017.
2. Venkata Krishna, Sasikumar Gurumoorthy, Mohammad S. Obaidat, “lnternet of Things and Personalized Healthcare Systems”, Springer Briefs in Applied Sciences, and Technology, Forensic and Medical Bioinformatics, 2019.
3. S. F. Barrett, Arduino, Microcontroller Processing for Everyone! Part I, Morgan & Claypool, Third edition , 2013
4. Embedded Systems – A Contemporary Design Tool, James K Peckol, , John Weily, 2008, ISBN: 0- 444-51616-6.

Reference Book

1. D. J. Russell, and M. A. Thornton, Introduction to Embedded Systems: Using ANSI C and the Arduino Development Environment (Synthesis Lectures on Digital Circuits and Systems), Morgan & Claypool Publishers , 2010
2. C. Amariei, Arduino Development Cookbook, Packt Publishing Limited , 2015.
3. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle, “From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence”, Elsevier, 2014.

BMPCP601	THERAPEUTIC INSTRUMENTATION LABORATORY	L	T	P	Credits
		0	0	2	1

COURSE OBJECTIVE

- To provide hands-on knowledge on different therapeutic equipment.
- To demonstrate and analyse various bio signals.

LIST OF EXPERIMENTS

THERAPEUTIC INSTRUMENTS

1. Cutting and coagulation using Surgical Diathermy machine.
2. Working of Defibrillator
3. Study of Hemodialysis machine
4. Demonstration of Ventilators
5. Study of Shortwave diathermy
6. Design a Pacemaker circuit using modules.
7. Stimulate nerves using a nerve stimulator
8. Study of Heart lung machine model
9. Working of anesthesia machine.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Measure different bioelectrical signals using various methods.

CO2 - Illustrate various therapeutic techniques.

CO3 - Analyze the different bio signals using suitable tools.

CO4 - Apply the learnt knowledge to design or troubleshoot instruments.

CO5 - Acquire skills to operate medical equipment.

CO6 - Design cost effective and simple biomedical instruments.

BMPCP602	MEDICAL EMBEDDED SYSTEM LAB	L	T	P	Credits
		0	0	2	1

COURSE OBJECTIVES:

The student should be made to:

- Acquire knowledge and understand the hardware architecture and programming aspects of embedded system design.
- Understand IoT architecture and Build simple IoT Systems using embedded target boards.
- Understand IoMT infrastructure for healthcare applications.

LIST OF EXPERIMENTS

1. Explore AVR/ARM based controllers using Embedded C.
2. Write Basic and arithmetic Programs Using Embedded C.
3. Write Embedded C program to test interrupt and timers.
4. Develop Real time applications – clock generation, waveform generation, counter using embedded C.
5. Explore different communication methods with IoT devices.
6. To interface LED/Buzzer with platform/ Aurdino /Raspberry Pi. and write an embedded C program to turn on / off LED/Buzzer with specified delay.
7. To interface DC/stepper motor using relay with open platform/ Aurdino /Raspberry Pi. and write an embedded C program to turn on motor if push button is pressed.
8. Develop simple application – testing infrared sensor – IoT Applications – using open platform/Raspberry Pi.
9. Develop simple application to interface DHT11 sensor with and write a program to display temperature humidity readings in LCD.
10. Develop IoMT Application using open platform/ Aurdino. /Raspberry Pi. and sensors such as temperature, ECG, Pulse etc.
11. Deploy IoMT applications using platforms.
12. Mini Project.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student should be able to:

CO1: Explain hardware architecture of embedded systems and use of software design tools.

CO2: Describe IoT Architectures and Build simple IoT Systems using embedded target boards.

CO3: Exhibit understanding of IoMT infrastructure for healthcare with simple applications.

BMPW601	MICRO PROJECT	L	T	P	2 Credit
		0	0	6	

Guidelines:

The mini-project is a team activity having 3-4 students in a team. This is electronic circuit building and testing for developing real life small electronic applications. The micro-project may be a complete hardware or hardware with small programming aspect. It should encompass electronics components, devices, analog or digital ICs, micro controller etc. Micro-Project should cater to a small system required in laboratory or real-life application. Based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of Micro-project.

Course Outcomes:

At the end of the micro project, students will demonstrate the ability to:

CO1: Identify and define a problem statement from the requirements raised from literature survey /need analysis

CO2: Build and Test electronic circuits/prototype for developing real life small electronic applications.

CO3: Work in teams; write comprehensive report and effective presentation of the project work.

CO4: Rapid prototyping which will lead them towards entrepreneurship.

SEMESTER VII

BMPW701	MINI PROJECT	L	T	P	Credits
		0	0	2	3

Guidelines:

The micro-project is a team activity having 3-4 students in a team. This is electronic circuit building and testing for developing real life small electronic applications. The micro-project may be a complete hardware or hardware with small programming aspect. It should encompass electronics components, devices, analog or digital ICs, micro controller etc. Micro-Project should cater to a small system required in laboratory or real-life application. Based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of Micro-project.

Course Outcomes:

At the end of the micro project, students will demonstrate the ability to:

CO1: Identify and define a problem statement from the requirements raised from literature survey /need analysis

CO2: Build and Test electronic circuits/prototype for developing real life small electronic applications.

CO3: Work in teams; write comprehensive report and effective presentation of the project work.

CO4: Rapid prototyping which will lead them towards entrepreneurship.

BMINT701	INTERNSHIP	L	T	P	Credits
		0	0	6 WEEKS	2

COURSE OBJECTIVES:

The student should be made to

- Observe medical professionals at work in the wards and the roles of Allied Health
- Professionals; Provide access to healthcare Professionals to get a better understanding of their work; Demonstrate patient-care in a hospital setting.

ASSESSMENT:

- Students need to complete training in any leading Multi-speciality hospital for a period of 15 days. They need to prepare an extensive report and submit to their respective course in-charges during the session.
  - Out of the following departments, it is mandatory to complete training in any 10.
  - The students can give a presentation of the remaining departments during laboratory hours.

S.No. Departments for visit

1 Cardiology

2 ENT

3 Ophthalmology

4 Orthopaedic and Physiotherapy

5 ICU/CCU

6 Operation Theatre

7 Neurology

8 Nephrology

9 Radiology

10 Nuclear Medicine

11 Pulmonology

12 Urology

13 Obstetrics and Gynaecology

14 Emergency Medicine

15 Biomedical Engineering Department

16 Histo Pathology

17 Biochemistry

18 Paediatric/Neonatal

19 Dental

20 Oncology

21 PAC's

22 Medical Records / Telemetry

COURSE OUTCOMES:

At the end of the course, the student should be able to:

CO1. Advocate a patient-centered approach in healthcare

CO2. Communicate with other health professionals in a respectful and responsible manner

CO3. Recognize the importance of inter-professional collaboration in healthcare.

CO4. Propose a patient-centered inter-professional health improvement plan based upon the patient's perceived needs

CO5. Use the knowledge of one's own role and those of other professions to address the healthcare needs of populations and patients served.

SEMESTER VIII

BMPW801	MAJOR PROJECT	L	T	P	Credits
		0	0	24	12

Guidelines: After interactions with project guides/industry experts, based on a comprehensive literature survey/ Industry requirements analysis, the student shall identify the title and define the aim and objectives of a project. The student is expected to work on details specifications, methodology, resources required, critical issues in design and implementation, and submit the project proposal within the first two weeks of semester. The student is expected to work on the design, development, and testing of the proposed project work as per the schedule.

The project report is to be submitted at the end of the semester. This report includes a summary of the literature survey, detailed objectives, project specifications, design, and proof of concept, developed system/Algorithm, results, contributions, and innovations in project work.

Course Outcomes:

At the end of the project work, students will demonstrate the ability to

CO1: Identify a problem statement from a rigorous literature survey or the industry requirements analysis.

CO2: Simulate and design a solution for the identified problem by applying acquired technical knowledge.

CO3: Develop and test the prototype/algorithm to solve the complex engineering problem.

CO4: Accomplish all objectives of the project in an allocated period with efficient team work.

CO5: Present project work orally and through a comprehensive report.

PROGRAM ELECTIVE COURSES

BMPEC161	MEDICAL DEVICE DESIGN	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

- The student should be made to:
- Introduce the Medical device standards and requirements.
- Illustrate the design procedure of medical devices.
- Outline the quality assessment in design.
- Describe about the design realization.
- Understand the validation and verification of various medical devices

MODULE I NEEDS FINDING AND CONCEPT GENERATION 9 Hours

Strategic Focus – observation and problem identification – Need statement development. Ideation and Brainstorming – concept screening, concept selection: intellectual property basics – reimbursement basics – business models – prototyping – final concept selection. Safety and Risk Management - Tools, Documents and Deliverables.

MODULE II MEDICAL DEVICES STANDARDS AND REQUIREMENTS 9 Hours

FDA, Medical devices classification, Medical Devices Directive Process – Harmonized Standards, ISO13485, ISO 14971, IEC60601-1, IEC 62304. Reliability, Concept of failure, Product Design and Development Process.

MODULE III DESIGN ENGINEERING 9 Hours

Hardware Design, Hardware Risk Analysis, Design and Project Metrics, Design for Six Sigma, Software Design, Software Coding, Software Risk Analysis, Software Metrics.

MODULE IV TESTING AND VALIDATION 9 Hours

Basis and Types of Testing, Hardware Verification and Data Analysis, Software Verification and Data Analysis.

MODULE V DESIGN TRANSFER AND MANUFACTURING 9 Hours

Transfer to Manufacturing, Hardware Manufacturing, Software Manufacturing, Configuration Management, Intellectual Property-Copy Rights-Trademarks-Trade Secrets. Case Study.

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Define the medical devices standards and requirements.

CO2: Summarize the concept of medical device development.

CO3: Recall the engineering design and project metrics.

CO4: Demonstrate the testing and validation of medical equipment.

CO5: Interpret the various design transfer and manufacturing methods.

TOTAL PERIODS: 45

TEXT BOOKS

1. Zenios, Makower and Yock, ―Biodesign – The process of innovating medical technologies‖, Canbridge University Press, 2009

2. Theodore R. Kucklick , The Medical Device R&D Handbook, Second Edition, CRC Press, 2012

3. Peter Ogrodnik, Medical Device Design Innovation from Concept to Market, Elsevier, 2013

REFERENCES

1. Richard C. Fries and Marcel Dekker AG, Handbook of Medical Device Design,2nd edition, 2005.

2. Gail Baura, Medical Device Technologies: A Systems Based Overview Using Engineering, Elsevier science, 2012.

3. Matthew Bret Weinger, Michael E. Wiklund, Daryle Jean Gardner-Bonneau 'Handbook of Human Factors in Medical Device Design', CRC press,2010.

4. Jagdish Chaturvedi, Inventing medical devices: A perspective from India, Create Space Independent Publishing Platform, 1st edition, 2015.

MPEC162	MEDICAL INFORMATICS AND EXPERT SYSTEM	L	T	P	Credits
		3	0	0	3

Course Objectives:

• Medical informatics is the intersection of information science, computer science, and health care.

• It deals with the resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine. Health informatics tools include not only computers but also clinical guidelines, formal medical terminologies, and information and communication systems.

MODULE I MEDICAL INFORMATICS 9 Hours

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues , Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, e-health services, Health Informatics – Medical Informatics, Bioinformatics

MODULE II COMPUTERISED PATIENT RECORD 9 Hours

Introduction - History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

MODULE III COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9 Hours

Automated clinical laboratories - Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, Computer assisted medical imaging- nuclear medicine, Radiation therapy and planning, Nuclear Magnetic Resonance

MODULE IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9 Hours

Neuro computers and Artificial Neural Networks application, Expert system - General model of CMD, Computer – assisted decision support system-production rule system cognitive model, semester networks, decisions analysis in clinical medicine-computers in the care of critically patients- computer assisted surgery – designing

MODULE V RECENT TRENDS IN MEDICAL INFORMATICS 12

Virtual reality applications in medicine, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery computer aids for the handicapped, computer assisted instrumentation in Medical Informatics - Computer assisted patient education and health Medical education and health care information.

TOTAL PERIODS: 45

TEXT BOOKS:

1. M F Collen, “Hospital Computer Systems”-

2. Lee, “Computers in Medicine”, Mc Graw Hill
3. H Dominic Covvey et al , “Computer in the practice of, medicine”, Addison Wesley

Course Outcomes:

Students will be able to:

CO1. Create medical documentation,
CO2. Utilize computer skills to develop expert systems

BMPEC163	PATIENT SAFETY, STANDARDS AND ETHICS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE:

- To understand the importance of patient safety against electrical hazards
- To explain the patient safety laws and regulations
- To understand the standards and testing of patient
- To know the patient safety specialities in clinical
- To know about the health care organization

MODULE I EFFECTS OF ELECTRICITY 9 Hours

Physiological effects of electricity - important susceptibility parameters - microshock - macroshock hazards -patients electrical environment - isolated power system - conductive surfaces

MODULE II PATIENT SAFETY LAWS AND REGULATIONS 9 Hours

Mandatory Reporting systems. Anatomy of a patient safety Law: Compliance Tips, Federal patient safety Legislation Initiatives, Medical Device Reporting, Clinical trials and Adverse-Event Reporting, Patient safety Goals and standards, The Quality Assessment and performance Improvement **rule.**

MODULE III STANDARDS AND TESTING 9 Hours

Guidelines and safety practices to improve patient safety, Electrical safety codes and standards - IEC 60601-1 2005 standard, Basic Approaches to protection against shock, protection equipment design, Electrical safety analyser - Testing the electric system

MODULE IV PATIENT SAFETY IN MAIN CLINICAL SPECIALITIES 9 Hours

Intensive care and Anesthesiology, safety surgery save lives, Emergency department clinical risk, Obstetric safety patient, Patient safety in internal medicine, Patient safety in Radiology.

MODULE V MEDICAL ETHICS 9 Hours

Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession, Professional Independence, The Doctor And Society, Case Studies.

TOTAL PERIODS: 45

COURSE OUTCOME:

At the end of this course, the student will be able to

CO1: Outline the importance of patient safety against electrical hazards.

CO2: Brief out the patient safety laws and regulations

CO3: Explain the standards and testing of patient

CO4: Understand the concept of the patient safety specialities in clinical

CO5: Know about various health care organization

TEXT BOOKS:

1. John G.Webster, “Medical Instrumentation Application and design”, 4th edition, Wiley India PvtLtd, New Delhi, 2015.
2. Liam Donaldson, Walter Ricciardi, “Textbook of patient safety and clinical Risk management”, Springer.

REFERENCE BOOK

1. Fay A. Rozovsky, James R. Woods, Jr, “The Handbook of Patient Safety Compliance”, 2016.

BMPEC164	BRAIN COMPUTER INTERFACE AND APPLICATIONS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

The student should be made to:

- To understand the basic concepts of brain computer interface
- To study the various signal acquisition methods
- To study the signal processing methods used in BCI

MODULE I INTRODUCTION TO BCI **9 Hours**

Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.

MODULE II ELECTROPHYSIOLOGICAL SOURCES **9 Hours**

Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials-P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.

MODULE III FEATURE EXTRACTION METHODS **9 Hours**

Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods –

AR,MA, ARMA models – PCA – Linear and Non-Linear Features.

MODULE IV FEATURE TRANSLATION METHODS **9 Hours**

Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization–

Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.

MODULE V APPLICATIONS OF BCI **9 Hours**

Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device control, Case study: Brain actuated control of mobile Robot.

TOTAL:45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Describe BCI system and its potential applications.

CO2: Analyze event related potentials and sensory motor rhythms.

CO3: Compute features suitable for BCI.

CO4: Design classifier for a BCI system.

CO5: Implement BCI for various applications.

TEXT BOOKS

1. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, “Brain-Computer Interfaces:

Revolutionizing Human-Computer Interaction”, Springer, 2010.

REFERENCES BOOKS:

1. R. Spehlmann, “EEG Primer”, Elsevier Biomedical Press, 1981.

2. Arnon Kohen, “Biomedical Signal Processing”, Vol I and II, CRC Press Inc, Boca Rato, Florida, 1986.

2. Bishop C.M., “Neural Networks for Pattern Recognition”, Oxford, Clarendon Press, 1995.

BMPEC165	MEDICAL IMAGE PROCESSING	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES

The objective of this course is to enable the student to

- Learn the fundamental concepts of medical Image Processing techniques.
- Understand the concepts of various image intensity transformation and filtering operations.
- Be familiar in the techniques of segmentation and restoration of medical images.
- Gain knowledge in medical image registration and visualization.
- Be familiar with the application of medical image analysis.

MODULE I FUNDAMENTALS OF MEDICAL IMAGE PROCESSING AND TRANSFORMS 9 Hours

Overview of Image Processing system and human Visual system- Image representation – pixel and voxels, Gray scale and color models- Medical image file formats- DICOM, ANALYZE 7.5, NIFTI and INTERFILE- Discrete sampling model and Quantization- Relationship between the pixels, Arithmetic and logical operations- Image quality and Signal to Noise ratio- Image Transforms- 2D DFT, DCT, KLT. Interpret the basics of image models, Digitization of images and the transformations of medical images using Matlab.

MODULE II ENHANCEMENT TECHNIQUES 9 Hours

Gray level transformation- Log transformation, Power law transformation, Piecewise linear transformation. Histogram processing- Histogram equalization, Histogram Matching. Spatial domain Filtering-Smoothing filters, sharpening filters. Frequency domain filtering- Smoothing filters, Sharpening filters- Homomorphic filtering -Medical image enhancement using Hybrid filters- Performance measures for enhancement techniques. Experiment with various filtering techniques for noise reduction and enhancement in medical images using Matlab.

MODULE III SEGMENTATION AND RESTORATION TECHNIQUES 9 Hours

ROI definition -Detection of discontinuities–Edge linking and boundary detection – Region based segmentation- Morphological processing, Active contour models. Image Restoration- Noise models– Restoration in the presence of Noise – spatial filtering, Periodic noise reduction by frequency domain filtering- linear position- Invariant degradation- Estimation of degradation function, Inverse filter, Weiner filtering. Analyze the segmentation techniques to extract the region of interest and restoration of degraded images using Matlab.

MODULE IV REGISTRATION AND VISUALISATION 9 Hours

Registration–Rigid body transformation, principal axes registration, and feature based. Visualisation-Orthogonal and perspective projection in medicine, Surface based rendering, Volume visualization in medical image. Explain the significance of registration of various imaging modalities and appraise the concepts of image visualization in healthcare using Matlab

MODULE V APPLICATIONS OF MEDICAL IMAGE ANALYSIS 9

Medical Image compression- DCT and Wavelet transform based image compression, Pre-processing of medical images -Retinal images, Ultrasound –liver, kidney, Mammogram. Segmentation of ROI -blood vessels, lesions, tumour, lung nodules, feature extraction- shape and

texture, Computer aided diagnosis system – performance measures (confusion matrix, ROC, AUC).

TOTAL : 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students will be able to

CO1: Explain and apply the fundamental concepts of image processing techniques for the analysis of medical images.

CO2: Identify and apply suitable filtering and intensity transformation techniques for given medical applications.

CO3: Identify and segment the Region of Interest from the given medical image.

CO4: Explore and apply current research in registration and visualization for medical image analysis.

CO5: Explain and apply the image compression techniques.

CO6: Design and evaluate the use of image processing fundamentals in healthcare applications, as well as their impact on health and society, and any underlying ethical issues, then communicate effectively through reflections, reports, and presentations (Target CO).

TEXT BOOKS

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Pearson Education, 3rd edition, 2016.
2. Isaac N. Bankman, Handbook of Medical Image Processing and Analysis, 2nd Edition, Elsevier, 2009.
3. Wolfgang Birkfellner, Applied medical Image Processing: A Basic course, CRC Press, 2011

REFERENCES BOOK

1. Atam P.Dhawan, Medical Image Analysis, Wiley-Interscience Publication, NJ, USA 2003
2. Rangaraj M. “Rangayyan, Biomedical Image Analysis”, 1st Edition, CRC Press,Published December 30, 2004.
3. Joseph V.Hajnal, Derek L.G.Hill, David J Hawkes, “Medical image registration”, Biomedical Engineering series, CRC press,2001
4. Milan Sonka, Image Processing, Analysis And Machine Vision, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.
5. Anil Jain K, Fundamentals of Digital Image Processing, PHI Learning Pvt. Ltd., 2011.

BMPEC261	FUNDAMENTALS OF HEALTHCARE ANALYTICS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

The objective of this course is to enable the student to

- Understand the statistical methods for the design of biomedical research.
- Comprehend the fundamental of mathematical and statistical theory in the application of Healthcare.
- Apply the regression and correlation analyze in the healthcare data.
- Understand the Meta-analysis and variance analysis.
- Interpret the results of the investigational methods.

MODULE I INTRODUCTION 9 Hours

Introduction, Computers and bio statistical analysis, Introduction to probability, likelihood & odds, distribution variability. Finding the statistical distribution using appropriate software tool like R/ Python.

MODULE II STATISTICAL PARAMETERS 9 Hours

Statistical parameters p-values, computation, level chi square test and distribution and hypothesis testing -single population proportion, difference between two population proportions, single population variance, tests of homogeneity. Testing of statistical parameters using appropriate software R / Python.

MODULE III REGRESSION AND CORRELATION ANALYSIS 9 Hours

Regression model, evaluating the regression equation, correlation model, correlation coefficient. Finding regression, correlation for the data using appropriate software like R / Python.

MODULE IV ANALYSIS OF VARIANCE 9 Hours

META analysis for research activities, purpose and reading of META analysis, kind of data used for META analysis, completely randomized design, randomized complete block design, repeated measures design, factorial experiment. Testing the variance using appropriate software tool like R / Python.

MODULE V CASE STUDIES 9 Hours

Epidemical reading and interpreting of epidemical studies, application in community health, Case study on Medical Imaging like MRI, CT. Case study on respiratory data, Case study on ECG data.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Define the new and existing statistical methodology for their research problem.

CO2: Explain p- values for different statistical test.

CO3: Analyze the biomedical research data and able to report the study results.

CO4: Enumerate the Meta-analysis and variance analysis.

CO5: Describe problems of human health and disease for the interest of advancing the public's Health.

TEXT BOOKS:

1. Wayne W. Daniel, Biostatistics-A Foundation for Analysis in the Health Sciences, John Wiley & Sons Publication, 10th Edition, 2013.
2. Peter Armotage, Geoffrey Berry and J.N.S.Mathews, Statistical methods in Medical Research, Wiley-Blackwell, 4th Edition, 2001.
3. Bernard Rosner. Fundamentals of biostatistics. Nelson Education, 8th Edition 2015 ISBN:978- 1-305-26892-0

REFERENCE BOOKS:

1. Marcello Pagano and Kimberlee Gauvreu, Principles of Biostatistics, Chapman and Hall/CRC, 2ndEdition, 2018.
2. Ronald N Forthofer and EunSul Lee, Introduction to Biostatistics, Academic Press, 1st Edition, 2014.
3. Animesh K. Dutta, Basic Biostatistics and its Applications, New Central Book Agency, 1st Edition, 2006.

BMPEC262	NANO ELECTRONICS	L	T	P	Credits
		3	0	0	3

Course Objectives:

- To learn and understand basic and advance concepts of nanoelectronics.
- The objective of the course on Nano Electronics is to equip the students with the concepts of nano scale electronic that he/she needs for understanding nano scale electronics for developing a strong background if he/she chooses to pursue research in Nanotechnology as a career

MODULE I INTRODUCTION TO NANOTECHNOLOGY 9 Hours

Background to nanotechnology: Types of nanotechnology and nano-machines – periodic table atomic structure – molecules and phases – energy – molecular and atomic size – surface and dimensional space – top down and bottom up; Molecular Nanotechnology: Electron microscope – scanning electron microscope – atomic force microscope – scanning tunneling microscope – nanomanipulator – nanotweezers – atom manipulation – nanodots – self-assembly – dip pen nanolithography. Nanomaterials: preparation – plasma arcing – chemical vapor deposition – sol-gels – electrodeposition – ball milling – applications of nanomaterials;

MODULE II FUNDAMENTALS OF NANOELECTRONICS 9 Hours

Fundamentals of logic devices:- Requirements – dynamic properties – threshold gates; physical limits to computations; concepts of logic devices:- classifications – two terminal devices – field effect devices – coulomb blockade devices – spintronics – quantum cellular automata – quantum computing – DNA computer; performance of information processing systems;- basic binary operations, measure of performance processing capability of biological neurons – performance estimation for the human brain. Ultimate computation:- power dissipation limit – dissipation in reversible computation – the ultimate computer.

MODULE III SILICON MOSFETs & QUANTUM TRANSPORT DEVICES 9 Hours

Silicon MOSFETS - Novel materials and alternate concepts:- fundamentals of MOSFET Devices-scaling rules – silicon-dioxide based gate dielectrics – metal gates – junctions & contacts – advanced MOSFET concepts. Quantum transport devices based on resonant tunneling:- Electron tunneling – resonant tunneling diodes – resonant tunneling devices; Single electron devices for logic applications:- Single electron devices – applications of single electron devices to logic circuits.

MODULE IV CARBON NANOTUBES 9 Hours

Carbon Nanotube: Fullerenes - types of nanotubes – formation of nanotubes – assemblies – purification of carbon nanotubes – electronic propertics – synthesis of carbon nanotubes – carbon nanotube interconnects – carbon nanotube FETs – Nanotube for memory applications prospects of an all carbon nanotube nanoelectronics.

MODULE V MOLECULAR ELECTRONICS 9 Hours

Electrodes & contacts – functions – molecular electronic devices – first test systems – simulation and circuit design – fabrication; Future applications: MEMS – robots – random access memory – mass storage devices.

TOTAL PERIODS: 45

Course Outcomes:

The students will be able to understand basic and advanced concepts of nanoelectronics devices, sensors and transducers and their applications in nanotechnology.

CO1 Explain the nanoscale Semiconductor materials.

CO2 Discuss the basics of Plasmonic

CO3 Characterize the Principle and working of Spintronics

CO4 Describe the fabrication of Photonic crystals.

CO5 Understand current research areas in electronics at nanoscale

TEXTBOOKS:

1. Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and Burkhard Raguse, Nanotechnology: Basic Science and Emerging Technologies, Chapman & Hall / CRC, 2002

2. T. Pradeep, NANO: The Essentials – Understanding Nanoscience and Nanotechnology, TMH, 2007

3. Rainer Waser (Ed.), Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, Wiley-VCH, 2003.

BMPEC263	ROBOTICS IN MEDICINE	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES

The objective of this course is to enable the student to:

- Get introduced to the fundamental of robotics and position analysis
- Learn about Parallel robots, different types of motions and force analysis
- Know the basics of trajectory planning, Motion control systems and actuators
- Have an insight into various sensors and vision systems
- Be acquainted to Fuzzy control and Applications of Robotics in Medicine

MODULE I FUNDAMENTALS AND POSITION ANALYSIS 9 Hours

Fundamentals – Classification, Advantages and disadvantages, Components, Degrees of freedom, Joints, Coordinates, Reference frames, Programming modes, Characteristics, Workspace, Languages, Collaborative robots, Position analysis – Robots as mechanisms, Conventions, Transformations, Forward and inverse kinematics, Denavit Hartenberg Representation, Degeneracy and Dextrerity, Screw based robots, Position analysis of Articulated robot Case studies

MODULE II PARALLEL ROBOTS, DIFFERENTIAL MOTIONS AND FORCE ANALYSIS 9 Hours

Parallel robots – Physical characteristics, Forward and Inverse Kinematic approaches, Planar and Spatial parallel robots, Differential relationships, The Jacobian, Large scale motions, Frame vs Robot, Differential motions and change, Hand frame, Operator, Jacobian and Inverse for Screw based and Parallel Robots, Differential operator, Lagarangian mechanics, Moments of Inertia, Dynamic Equations of Multiple DOF Robots, Static force analysis, Transformation of forces and moments between coordinate framesCase studies

MODULE III TRAJECTORY PLANNING, MOTION CONTROL SYSTEMS AND ACTUATORS 9 Hours

Path and Trajectory, Joint Space and Cartesian Space Descriptions and Trajectory Planning, Cartesian, Trajectory Recording, Basics, Block diagrams, Laplace Transform, Block diagram Algebra, Transfer Functions, Characteristic equation, Steady state error, Root locus, Proportional, Integral and Derivative controllers, Compensators, Bode, Loops, Multiple IO systems, Control - State space and Digital, Nonlinear systems, Characteristics of Hydraulic, Pneumatic, Electric motors, Other actuators, Speed reduction Case studies

MODULE IV SENSORS, IMAGE PROCESSING AND ANALYSIS WITH VISION SYSTEMS 9 Hours

Sensor Characteristics, Position, Velocity, Acceleration, Force, Pressure and Torque,
Microswitches, Visible and IR, Touch, Proximity, Range finders, Sniff, Vision, Transforms – Fourier, Hough, Resolution, Quantization, Sampling, Image processing, Segmentation, Region growing and splitting, Operations, Object recognition, Depth, Specialized lighting, Compression, Colour images, Heuristics, Case studies

MODULE V FUZZY CONTROL AND APPLICATIONS IN MEDICINE 9 Hours

Fuzzy control - Crisp vs Fuzzy, Sets, Inference rules, Defuzzification, Simulation, Applications in Biomedical Engineering, Applications in rehabilitation, Nanobots in medicine, Clinical diagnosis and Surgery – Cardiac and abdominal procedures with teleoperated robots, Orthopedic surgery with cooperative robotsCase studies

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students will be able to

CO1: Describe the fundamental of robotics and position analysis

CO2: Outline the functioning of parallel robots, different types of motions and force analysis.

CO3: Portray the basics of trajectory planning, Motion control systems and actuators.

CO4: Recognize and explain the use of various sensors and vision systems in robotics.

CO5: Employ Fuzzy control in robotics and apply it to Robotics in Medicine

TEXT BOOKS

1. S. B. Niku, Introduction to Robotics, Analysis, Control, Applications, Pearson Education,2020

2. Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India,2003.

3. Fu Gonzales and Lee, Robotics, McGraw Hill, 1987.

4. J Craig, Introduction to Robotics, Pearson Education, 2005.

REFERENCES

1. Grover, Wiess, Nagel and Oderey, Industrial Robotics, McGraw Hill, 2012.

2. Klafter, Chmielewski and Negin, Robot Engineering, Prentice Hall Of India, 1989.

3. Mittal, Nagrath, Robotics and Control, Tata McGraw Hill publications, 2003.

4. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robotics and Automation Sensor – Based integration, Academic Press, 1999.

5. Mikell P. Groover, Mitchell Weiss, Industrial robotics, technology, Programming and Applications, McGraw Hill International Editions, 1986.

6. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, Robotic engineering - An Integrated Approach, Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.

ONLINE RESOURCES

1. https://www.coursera.org/lecture/ghi-healthcare-innovation-what-success-look-like-howto-achieve/robotic-surgery-interview-with-hutan-ashrafian-QIUBV

3. https://onlinecourses.nptel.ac.in/noc21_me49/preview.

BMPEC264	REHABILITATION ENGINEERING	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES

The objective of this course is to enable the student to

- Explain the need for medical aids.
- Understand the sensory rehabilitation systems.
- Learn the use of orthopedic prosthetics and orthotics in rehabilitation.
- Understand virtual reality in rehabilitation
- Have an understanding of rehabilitation medicine and advocacy.

MODULE I INTRODUCTION TO REHABILITATION 9 Hours

Definition - Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function. Rehabilitation. Rehabilitation team – members and their functions. Rehabilitation care –Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.

MODULE II ENGINEERING CONCEPTS IN SENSORY AUGMENTATION AND SUBSTITUTION 9 Hours

Sensory augmentation and substitution- Visual system: Visual augmentation, Tactual vision substitution, and Auditory vision substitution. Auditory system- Auditory augmentation, Hearing aids, cochlear implants, visual auditory substitution, tactual auditory substitution. Tactual system - Tactual augmentation, Tactual substitution.

MODULE III ORTHOPEDIC PROSTHETICS AND ORTHOTICS 9 Hours

Engineering concepts in motor rehabilitation, Artificial limbs- body powered, externally powered and controlled orthotics and prosthetics, Myoelectric hand and arm prosthetics. Functional Electrical Stimulation systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).

MODULE IV VIRTUAL REALITY 9 Hours

Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.

MODULE V REHABILITATION MEDICINE AND ADVOCACY 9 Hours

Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device and provision available in education, job and in day-to-day life.

TOTAL: 45 PERIODS

TEXTBOOKS

1. Joseph D Bronzino, “The Biomedical Engineering Handbook”. 2nd edition, CRC Press, 2000.

2. Robinson C.J, “Rehabilitation Engineering”, CRC Press, 2006.

REFERENCES

1. Sashi S Kommu, “Rehabilitation Robotics”, 1st edition, CRC Press, 2007.

2. Sunder, “Textbooks of Rehabilitation”, Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007.

3. Horia- Nocholai Teodorecu, L.C.Jain, “Intelligent systems and technologies in rehabilitation Engineering”, CRC; December 2000

4. Etienne Grandjean, Harold Oldroyd, “Fitting the task to the man”, Taylor & Francis, 1988.

5. Keswick. J., “What is Rehabilitation Engineering, Annual Reviews of Rehabilitation”, Springer Verlag, New York, 1982.

6. Warren E. Finn, Peter G. Lopressor, “Handbook of Neuroprosthetic Methods”,CRC, 2002.

7. Roy A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), “An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering” CRC Press, 2000.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to

CO1: Summarize the key terminologies used by the rehabilitation team.

CO2: Illustrate Engineering Concepts in Sensory & Motor rehabilitation.

CO3: Design different orthotics and prosthetics for rehabilitation applications.

CO4: Summarize the need of virtual reality tools for different aids.

CO5: Appraise the legal aspects for building rehabilitation aids for the needed people.

BMPEC361	HOSPITAL SAFETY AND MANAGEMENT	L	T	P	Credits
		3	0	0	3

Course Objectives

- This course is designed to provide health policy, health organization, health financing system, Safety and Security, Hazardous materials, Emergency management, Fire safety Medical equipment, Utility systems.

MODULE I **9 Hours**

Clinical engineering program, educational responsibilities, role to be performed by them in hospital, staff structure in hospital – HIS. Need for evolving health policy, health organization in state, health financing system, health education, health insurance, health legislation

MODULE II **9 hours**

Difference between hospital and industrial organization, levels of training, steps of training, developing training program, evaluation of training, wages and salary, employee appraisal method.

MODULE III **9 Hours**

Necessity for standardization, FDA, AERB, Joint Commission of Accreditation of hospitals, ICRP and other standard organization, methods to monitor the standards.

MODULE IV **9 Hours**

Nature and value of strategic management in hospitals - Awareness on the application of IT in Various functions of Hospital. Application of statistical tools in the areas of Health services. Introduction to support services - Disaster management, Ambulance services, Laundry services, Civil Assets etc.

MODULE V **9 Hours**

Elements of Safety - Safety Publications and Standards Organizations - Orientation to Laboratory Safety - Types of risks in the hospitals - factors of environment - Safety showers and Eye Washes – Radiation hazards – radiation detection – safety measures – standards. Ergonomics - Flammables and Explosives – Formaldehydes - PEL Standards and Calculations - Material Safety - Organization of Safety in the hospitals.

TOTAL PERIODS: 45

TEXT BOOKS

1. P.E.Stanley, Handbook of hospital safety, CRC Press (UNIT V)

2. Arun Kumar, Hospital Management, Anmol Publications Pvt. Ltd., Jan 2000 , 1st.ed (UNITS I, II, III & IV)

REFERENCE BOOKS

1. William Charney, Handbook of Modern Hospital Safety, CRC press

2. Webster J.C. and Albert M.Cook, “Clinical Engineering Principle and Practice”, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979

3. Goyal R.C., “Handbook of hospital personal management”, Prentice Hall of India, 1996.

Course Outcomes:

Students will be able to know:

CO1: Reduce and control hazards and risks

CO2: Prevent accidents and injuries

CO3: To Maintain safe conditions.

BMPEC362	BIO MEMS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES

The objective of this course is to enable the student to

● Provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.

● Understand various mechanical and thermal sensors and actuators and their principles of operation at the micro scale level.

● Understand various electrostatic and piezoelectric sensors and actuators at the micro scale level.

● Introduce microfluidic systems.

● Know on the applications of MEMS in different field of medicine.

MODULE I MEMS MATERIALS AND FABRICATION 9 Hours

Semiconductor materials; photo lithography; doping; thin film growth and deposition; CVD and Ion Implantation, metallization; wet and dry etching; silicon micromachining; metal MEMS processes; submicron optical lithography; electron beam lithography; soft lithography and printing.

MODULE II MECHANICAL AND THERMAL SENSORS AND ACTUATORS 9 Hours

Mechanical sensors and actuators – beam and cantilever –microplates, strain, pressure and flow measurements, Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flowsensor.

MODULE III ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATOR 9 Hours

Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.

MODULE IV MICROFLUIDIC SYSTEMS 9 Hours

Laminar flow in circular conduits, fluid flow in micro conduits, in sub micrometer and nanoscale. microfluidic components (filters, mixers, valves, and pumps)

MODULE V APPLICATIONS OF BIOMEMS 9 Hours

CAD for MEMS,DNA sensor, MEMS based drug delivery, Biosensors- sensors for glucose, uric acid, urea and triglyceride sensor. Introduction to the MATLAB/Simulink/ CAD tool for modelling /simulations of bioelectronics systems.

TOTAL PERIODS: 45

TEXT BOOKS:

1. TaiRan **Hsu**,MEMS and Microsystems Design and Manufacture, Tata McGrawHill Publishing Company, New Delhi, 2017.

2. WanjunWang and Stephen A.Soper, BioMEMS:Technologies and Applications, CRC Press, NewYork, 2007.

3. Chang Liu, Foundations of MEMS, Pearson Education International, New Jersey, USA, 2011.

REFERENCE BOOK:

1. Ellis Meng, Biomedical Microsystems, CRC Press, Boca Raton, FL, 2011.

2. P. Tabeling, S .Chen, Introduction to microfluidics, Oxford University Press, 2010.

3. Alok Pandya ,Vijai Singh, Micro/Nanofluidics and Lab-on-Chip Based Emerging Technologies for Biomedical and Translational Research Applications - Part B, Academic Press, 2022.

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Summarize various MEMS fabrication techniques.

CO2: Elucidate different types of mechanical and thermal sensors and actuators and their principles of operation at the micro Scale level.

CO3: Describe different types of various electrostatic and piezoelectric sensors and actuators and their principles of operation at the micro Scale level.

CO4: Explain microfluidic systems

CO5: Illustrate MEMS in different field of medicine.

BMPEC363	HOSPITAL PLANNING AND MANAGEMENT	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

To Study about:

- To introduce the relevance of this course to the existing technology through
- Demonstrations, case studies, simulations, contributions of scientist, national/international
- Policies with a futuristic vision along with socio-economic impact and issues
- The student should be made to understand the principles, practices and areas of
- Application in hospital management.

MODULE I OVERVIEW OF HOSPITAL ADMINISTRATION 9 Hours

Distinction between Hospital and Industry, Challenges in Hospital Administration –Hospital Planning – Equipment Planning- AMC – Functional Planning - Current Issues in Hospital Management - Telemedicine - Bio-Medical Waste Management

MODULE II HUMAN RESOURCE MANAGEMENT IN HOSPITAL 9 Hours

Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer.

MODULE III MARKETING RESEARCH & CONSUMER BEHAVIOUR 9 Hours

Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations - ConsumerMarkets & Consumer Buyer behaviour - Model of consumer behaviour - Types of buying decision behaviour - The buyer decision process - Model of business buyer behaviour - Major types of buying situations - global marketing in the medical sector - WTO and its implications.

MODULE IV HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES

9 Hours

Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information Systems – Medical Transcription, Medical Records Department – Central Sterilization and Supply Department – Pharmacy– Food Services - Laundry Services.

MODULE V QUALITY AND SAFETY ASPECTS IN HOSPITAL 9 Hours

Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – ISO 13485, Environment Management Systems. NABA, JCI, NABL, NABH. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care - Medical Audit – Hazard and Safety in a hospital Setup.

TOTAL PERIODS: 45

TEXT BOOKS

1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI–4th Edition,2006.

2. G.D.Kunders, "Hospitals – Facilities Planning and Management", TMH, New Delhi – 5th edition Reprint 2007.

3. Cesar A.Caceres and Albert Zara, "The Practice of Clinical Engineering", Academic Press, New York, 1977.

REFERENCES

1. Peter Berman, "Health Sector Reform in Developing Countries", Harvard University Press, 1995.

2. Norman Metzger , "Handbook of Health Care Human Resources Management", Aspen Publication Inc. Rockville, Maryland, USA, 2nd Edition 1990.

3. Arnold D. Kalcizony & Stephen M.Shortell, "Health Care Management", 6th Edition, 2011. 21st c entury", Calrendon Press, 1994.

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Explain the principles, practices and areas of application in Hospital Management.

CO2: Understand the biomedical waste disposal concept.

CO3: Explain the importance of supportive services.

CO4: Comprehend the quality aspect specified by the international standards.

CO5: Knowledge on Hospital safety.

BMPEC364	CRITICAL CARE AND OPERATION THEATRE EQUIPMENT	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

The student should be made to:

- To offer clear understanding of various intensive care equipment and their working.
- To understand the necessity of different operation theatre equipment.
- To know about different dialyzers and ventilators.

MODULE I INTENSIVE CARE UNIT EQUIPMENT 9 Hours

Suction apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for small and large units. ICU ventilators. Automated drug delivery systems, Infusion pumps, components of drug infusion system, closed loop control infusion system, implantable infusion system. BMD Measurements – SXA – DXA - Quantitative ultrasound bone densitometer

MODULE II CRITICAL CARE EQUIPMENT 9 Hours

Defibrillators, Hemodialysis Machine, Different types of Dialyzers, Membranes, Machine control and measurements. Heart Lung Machine, different types of oxygenators, peristaltic pumps, Incubators.

MODULE III OPERATION THEATRE EQUIPMENT 9 Hours

Craniotomy, Electrosurgical Machines (ESU), electrosurgical analyzers, surgical aspirator, Instruments for operation. Anesthesia Machine, Humidification, Sterilization aspects, Boyles apparatus. Endoscopy – Laparoscopy - Cryogenic Equipment - Anesthesia gas, Anesthesia gas monitor, - surgical microscope.

MODULE IV CENTRALISED SYSTEMS 9 Hours

Centralized Oxygen, Nitrogen, Air supply & Suction. Centralized Air Conditioning, Operation Theatre table & Lighting. C Arm.

MODULE V PATIENT SAFETY 9 Hours

Patient electrical safety, Types of hazards, Natural protective mechanisms against electricity, Leakage current, Inspection of grounding and patient isolation, Hazards in operation rooms ICCU and IMCUs, Opto couplers and Pulse transformers.

TOTAL: 45 PERIODS

TEXT BOOKS

1. John G. Webster, “Medical Instrumentation Application and Design”, 4th edition, Wiley India PvtLtd,New Delhi, 2015

2. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, Pearson education, 2012

3. Khandpur. R.S.,“Handbook of Biomedical Instrumentation”. Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003.

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Apply the knowledge acquired, in designing new monitoring devices for ICU and assist the medical personnel's during emergency situations

CO2: Suggest suitable surgical instruments and operational devices.

CO3: Compare the various techniques for clinical diagnosis, therapy and surgery, and its recent methods

CO4: Assess the merits of the operation theatre equipment based on its applications

CO5: Design the devices for the particular application based on given specifications.

BMPEC471	VIRTUAL INSTRUMENTATION	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

- To review background information required for studying virtual instrumentation.
- To study the basic building blocks of virtual instrumentation.
- To study the various techniques of interfacing of external instruments of PC.
- To study the various graphical programming environment in virtual instrumentation.
- To study a few applications in virtual instrumentation.

MODULE I REVIEW OF DIGITAL INSTRUMENTATION 9 Hours

Representation of analog signals in the digital domain – Review of quantization in amplitude and time axes, sample and hold, sampling theorem, ADC and DAC.

MODULE II FUNDAMENTALS OF VIRTUAL INSTRUMENTATION 9 Hours

Concept of virtual instrumentation – PC based data acquisition – Typical on board DAQ card – Resolution and sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card - Use of timer-counter and analog outputs on the universal DAQ card.

MODULE III CLUSTER OF INSTRUMENTS IN VI SYSTEM 9 Hours

Interfacing of external instruments to a PC – RS232, RS 422, RS 485 and USB standards - IEEE 488 standard – ISO-OSI model for serial bus – Introduction to bus protocols of MOD bus and CAN bus.

MODULE IV GRAPHICAL PROGRAMMING ENVIRONMENT IN VI 9 Hours

Concepts of graphical programming – Lab-view software – Concept of VIs and sub VI - Display types – Digital – Analog – Chart – Oscilloscopic types – Loops – Case and sequence structures - Types of data – Arrays – Formulae nodes –Local and global variables – String and file I/O.

MODULE V ANALYSIS TOOLS AND SIMPLE APPLICATIONS IN VI 9 Hours

Fourier transform - Power spectrum - Correlation – Windowing and filtering tools – Simple temperature indicator – ON/OFF controller – P-I-D controller - CRO emulation - Simulation of a simple second order system – Generation of HTML page

TOTAL PERIODS: 45

TEXT BOOKS

1. S. Gupta and J.P Gupta, 'PC Interfacing for Data Acquisition and Process Control', Instrument society of America, 1994.

2. Peter W. Gofton, 'Understanding Serial Communications', Sybex International.

3. Robert H. Bishop, 'Learning with Lab-view', Prentice Hall, 2003.

REFERENCE BOOKS

1. Kevin James, 'PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control', Newness, 2000.

2. Gary W. Johnson, Richard Jennings, ‘Lab-view Graphical Programming’, McGraw Hill Professional Publishing, 2001.

COURSE OUTCOMES:

Course Outcomes (CO):

After the successful completion of the course the students will be able to:

CO1. Demonstrate the working of labview.
CO2. Explain the various types of structures used in labview.
CO3. Analyze and design different type of programs based on data acquisition.
CO4. Demonstrate the use of labview for signal processing, image processing etc.

BMPEC472	BIOMEDICAL OPTICS AND BIOPHOTONICS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES

- To acquire knowledge about the physical properties of light and optical properties of tissues.
- Learn the design and working principle of various optical components.
- Understand the principles and applications of optical biosensors.
- Understand the engineering and practical applications of optics related to diagnostic and surgical applications.
- Understand the phenomenon of laser tissue interaction and practical applications of optics related to therapeutic applications.

MODULE I OPTICAL PROPERTIES 9 Hours

Basic principles of light - Reflection - Refraction - Absorption - Polarization - Interference - Coherence, Basic laws of light - Beer Lambert law - Snell's law, Optical properties of tissues - Absorption - Scattering - Anisotropy.

MODULE II OPTICAL INSTRUMENTATION 9 Hours

Working principle of light sources - Lasers - LEDs, Working principle of optical detectors - Photodiode - Spectrometer - CMOS and CCD cameras - Lens - Optical filters - Optical fibers.

MODULE III OPTICAL BIOSENSORS 9 Hours

Principles of Optical biosensing - Immobilization of bio-recognition elements, Types of optical biosensor - Fiber optic - Planar waveguide - Evanescent - Interferometric - Surface plasmon resonance – Advantages and disadvantages - Applications.

MODULE IVAPPLICATIONS OF LASERS 9 Hours

Diagnostic - Optical coherence tomography, Fluorescence, Raman, Photoacoustic tomography, Laser induced breakdown spectroscopy (LIBS), Hyperspectral imaging. Surgical - Lasers in dentistry, Dermatology, Ophthalmology.

MODULE V LASER TISSUE INTERACTION 9 Hours

Laser tissue interactions via photochemical, Photothermal, Photomechanical techniques, Photodynamic therapy (PDT) - Oncological and non-oncological applications, Low level laser therapy (LLLT) - Biostimulation applications.

TOTAL: 60 PERIODS

TEXT BOOKS

1. Tuan Vo Dinh, "Biomedical Photonics –Handbook, CRC Press, Bocaraton, 2014.
2. Jurgen Popp, Valery V. Tuchin, Arthur Chiou and Stefen Heinemann, Handbook of Biophotonics, Vol 2: Photonics for Healthcare, John Wiley and Sons, 1st Edition, 2011.

REFERENCES

1. Markolf H. Niemz, "Laser-Tissue Interaction Fundamentals and Applications" Springer, 2007.

2. Splinter R and Hooper B. A., “An Introduction to Biomedical Optics”, Taylor and Francis,2006.

3. Mark E. Brezinski, “Optical Coherence Tomography: Principles and Applications”, Academic Press, 2006.

4. Paras N. Prasad, “Introduction to Biophotonics”, A. John Wiley and sons, Inc. Publications, 2003.

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Explain the various physical properties of light and optical properties of tissues.

CO2: Consolidate the working principles of optical components.

CO3: Discuss the various applications of biosensors in medicine.

CO4: Summarize the diagnostic and surgical applications of lasers in medicine.

CO5: Explain the laser tissue interaction and various therapeutic applications of lasers.

BMPEC473	NEURAL ENGINEERING	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

The student should be made to:

- To be familiar with the nervous system development
- To be exposed to neuronal diseases and disorders
- To be familiar with nerve reconstruction and repairing

MODULE I BASICS OF NEURON STRUCTURE AND FUNCTIONS 9 Hours

Nervous system development. Trophic factors, extra cellular matrix components in nervous system development. Neuron: structure – function – classification. Glial cells – myelination. Neurotransmitter – types and functions. Synapses - Transport of materials and impulse in neurons.

MODULE II BRAIN, BRAIN STEM AND SPINAL CORD 9 Hours

Brain: structures – lobes – functional areas. Brain stem: structures – functional areas. Spinal cord: structure – functions. Concepts of nuclei – sensory and motor Tracts - Reticular formation. Blood supply to Brain and spinal cord.

MODULE III NEURONAL DISEASES AND DISORDERS 9 Hours

Neuro degeneration: Degenerative, Demyelinated and injury related disorders associated with nervous system. Wallerian Degeneration. Neuronal plasticity – CNS acting drugs and their pharmacokinetics. Alzheimer‘s, Parkinson‘s and Prion diseases

MODULE IV NEUROPHYSIOLOGY & NEURORADIOLOGY 9 Hours

Physiology of nerve conduction. Peripheral nerves – structure & Functions. Synaptic transmission and cellular signaling of Neurons. Electrical activity of the Brain and recording of brain waves. Evoked potentials. Visualization of nervous system. Neuromotor-machine interface: human voluntary motor control system.

MODULE V NERVE RECONSTRUCTION AND REHABILITATION 9 Hours

Neural plasticity; Neurological dysfunctions - Regeneration of the peripheral nervous system. Neural tissue engineering; Nerve graft; Drug delivery system in CNS. Rehabilitation: Mechanisms for Neuromotor rehabilitation; Robotics and virtual reality in physical therapy; Transcranial magnetic stimulation

TOTAL: 45 PERIODS

TEXT BOOKS

1. Mathews G.G., “Neurobiology”, 2nd edition, Blackwell Science, UK, 2000

2. Malcom Carpenter, “Textbooks of Neuroanatomy”, Mc. Graw hill Edition, 1996

REFERENCES

1. W. Mark Saltzman, “Tissue Engineering – Engineering principles for design of replacement organs and tissue’’, Oxford University Press Inc New York, 2004.

2. Park J.B., “ACS Biomaterials Science and Engineering”, Plenum Press, 2014. Saunders, 2006.

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Explain the basic structure and functions of human nervous system.

CO2: Understand diseases and degeneration related to nervous system.

CO3: Analyze visualization and radiological assessment of nervous system.

CO4: Apply neural tissue engineering for rehabilitation.

CO5: Discuss about Regeneration of nervous system.

BMPEC474	MEDICAL WASTE MANAGEMENT	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

The student should be made to:

- Understand the hazardous materials used in hospital and its impact on health
- Understand various waste disposal procedures and management.

MODULE I HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS 9 Hours

Healthcare Hazard Control : Introduction, Hazard Control, Hazard Control Management, Hazard Control Responsibilities, Addressing Behaviors, Hazard Control Practice, Understanding Hazards, Hazard Analysis, Hazard Control and Correction, Personal Protective Equipment, Hazard Control Committees, Hazard Control Evaluation, Hazards, System Safety, Ergonomics. Understanding Accidents: Accident Causation Theories, Human Factors, Accident Deviation Models, Accident Reporting, Accident Investigations, Accident Analysis, Organizational Functions That Support Accident Prevention, Workers' Compensation, Orientation, Education, and Training.

MODULE II BIOMEDICAL WASTE MANAGEMENT 9 Hours

Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labelling, waste handling, collection, storage and transportation, treatment and disposal.

MODULE III HAZARDOUS MATERIALS 9 Hours

Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection.

MODULE IV FACILITY SAFETY 9 Hours

Facility Safety : Introduction, Facility Guidelines Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Scaffolding, Fall Protection, Tool Safety, Machine Guarding, Compressed Air Safety, Electrical Safety, Control of Hazardous Energy, Permit Confined Spaces, OSHA Hearing Conservation Standard, Heating, Ventilating, and Air-Conditioning Systems, Assessing IAQ, Landscape and Grounds Maintenance, Fleet and Vehicle Safety.

MODULE V INFECTION CONTROL, PREVENTION AND PATIENT SAFETY 9 Hours

Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Blood borne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Medical Waste. Patient Safety: An Organizational Function, Errors and Adverse Events, Safety Cultures, Patient-Centered Healthcare, Quality Improvement Tools and Strategies, Healthcare-Associated Infections, Medication Safety.

TOTAL:45 PERIODS

TEXT BOOKS

1. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012)

2. Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylor and Francis (2014).

REFERENCES

1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006

2. V.J. Landrum, "Medical Waste Management and disposal", Elsevier, 1991

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Analyse various hazards, accidents and its control

CO2: Design waste disposal procedures for different biowastes

CO3: Categorise different biowastes based on its properties

CO4: Design different safety facility in hospitals

CO5: Propose various regulations and safety norms

BMPEC571	CLINICAL ENGINEERING	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

- This course will provide a basic understanding of the clinical engineering profession, qualifications, roles, activities, and expectations.
- This course will enhance students to practice medical equipment and analyze challenges with their healthcare technology.
- This course will engage the students to work as a team to address problems and errors in medical devices.
- This course will help students to design better medical devices with computerized approaches.
- This course will expose students to explore the Health Technology Management systems with medical devices and supportive services with advanced application.

MODULE I INTRODUCTION 9 Hours

Clinical engineering: Definition, Evolution, Role, Responsibilities, Functional status, History of clinical engineering and Technology in Health Care System, Enhancing patient safety.

MODULE II MEDICAL TECHNOLOGY MANAGEMENT PRACTICES 9 Hours

Strategic Medical Technology Planning, Scope , Clinical necessity operational support, strategic planning process – Technology assessment: Technology audit, Budget strategies, Prerequist for medical technology assessment – Management Practice for Medical Equipment – Device evaluation, Risk reduction, Asset management, ESHTA.

MODULE III ESSENTIAL HEALTH CARE TECHNOLOGY PACKAGE (EHTP) 9 Hours

Introduction – Health care technology management – Package development: Methodology, Logical framework, Implementation, Information promotion and dissemination – EHTP Justification – EHTP matrix – EHTP advantages – Impact Analysis.

MODULE IV CLINICAL ENGINEERING PROGRAM INDICATOR 9 Hours

Clinical engineering: program services, Program database – Clinical Engineering Program management, Program indicator, Managing clinical engineering performance using program indicators – Indicator management process.

MODULE V ADVANCED TECHNOLOGY FOR PATIENT SAFETY 9 Hours

Factors Contributing to Medical Errors: Heath Care Reimbursement, Health Care Failure Mode and Effect Analysis (HFMEA), Patient Safety Best Practices Model: Bar coding, Computerized Physician Order Entry (CPOE), and Clinical data repositories – Process analysis, Methodology. Computerized medical equipment management systems.

TOTAL PERIODS: 45

TEXT BOOKS:

1. Ernesto Iadanza, Joseph Dyro, “Clinical Engineering Handbook”, Elsevier Academic Press, 2014
2. Robert Miniati, “Clinical Engineering from Devices to Systems”, Academic Press, 23-Dec-2015 - Technology & Engineering.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1: State the role of clinical engineers and discuss the basic concepts of medical and healthcare technology

CO2: Give the program and framework to recognize the errors of medical equipment

CO3: State the issues or errors in patient safety and formulate patient safety package system

CO4: Define the problem precisely and examine the possible issues using program indicators.

CO5: Demonstrate computer based equipment with automated system by using CPOE method.

BMPEC572	PHARMACEUTICAL NANOTECHNOLOGY	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

- The goal of this course is to provide an insight into the fundamentals of nanotechnology in biomedical and Pharmaceutical research.
- It will also guide the students to understand how nanomaterials can be used for a diversity of analytical and medicinal rationales.

MODULE I NANOSTRUCTURES 9 Hours

Preparation, properties and characterization - Self-assembling nanostructure - vesicular and micellar polymerization-nanofilms - Metal Nanoparticles- lipid nanoparticles- nanoemulsion - Molecular nanomaterials: dendrimers, etc.

MODULE II NANOTECHNOLOGY IN BIOMEDICAL INDUSTRY 9 Hours

Reconstructive Intervention and Surgery- Nanomaterials in bone substitutes and dentistry – Implants and Prosthesis -in vivo imaging- genetic defects and other disease states — Nanorobotics in Surgery –Nanocarriers: sustained, controlled, targeted drug delivery systems.

MODULE III NANOTECHNOLOGY IN CANCER THERAPY 9 Hours

Cancer Cell Targeting and Detection- Polymeric Nanoparticles for cancer treatment mechanism of drug delivery to tumors -advantages and limitations - Multifunctional Agents - Cancer Imaging – Magnetic Resonance Imaging- Cancer Immunotherapy.

MODULE I NANOTECHNOLOGY IN COSMETICS 9 Hours

Polymers in cosmetics: Film Formers – Thickeners – Hair Colouring – Conditioning Polymers: conditioning, Cleansing – Silicons – Emulsions – Stimuli Responsive Polymeric Systems - Formulation of Nano Gels, Shampoos, Hair-conditioners -Micellar self-assembly Sun-screen dispersions for UV protection – Color cosmetics.

MODULE V NANOTOXICITY 9 Hours

NanoToxicology- introduction, dose relationship- Hazard Classification-Risk assessment and management - factors affecting nano toxicity- Dermal Effects of Nanomaterials, Pulmonary, Neuro and Cardiovascular effects of Nanoparticles - Gene–Cellular and molecular Interactions of Nanomaterials.

TOTAL PERIODS: 45

TEXT BOOKS:

1. Springer Handbook of Nanotechnology- Ed. by B. Bhushan, Springer-Verlag 2004
2. Nanobiotechnology: Concepts, Applications and Perspectives,. CM.Niemeyer C A. Mirkin, (Eds) , Wiley, 2004
3. Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, Second Edition, CRC Press, 2013
4. Sarah E. Morgan, Kathleen O. Havelka, Robert Y. Lochhead “Cosmetic Nanotechnology: Polymers and Colloids in Cosmetics”, American Chemical Society, 2006.

REFERENCES:

1. Nanotechnology in Biology and Medicine: Methods, Devices and Applications, Tuan VoDinh, CRC Press, 2007

2. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag 2004

3. Nanotechnology: Environmental Health and safety, Risks, Regulation and Management, Matthew Hull and Diana Bowman, Elsevier, 2010.

COURSE OUTCOMES:

The student will be able to

CO1: Identify the process for the preparation and characterization of the different nanostructured materials.

CO2: Apply the nanotechnology in biomedical discipline with related to drug delivery and disease diagnosis

CO3: Develop the process, experiments and apply in identifying in a societal and global context.

CO4: Design and develop the process with suitable equipment for the preparation of nanomaterials in developing cosmetic products.

CO5: Understand the ethical principles to confirm the safety of the nano products with respect to risk assessment and its management.

CO6: Have the knowledge about nanotechnology products and its different applications in a societal and global context.

BMPEC573	VIRTUAL REALITY AND AUGMENTED REALITY IN HEALTHCARE	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES

The objective of this course is to enable the student to

- Introduce the relevance of this course to the existing technology through demonstrations, case studies and applications with a futuristic vision along with socio-economic impact and issues
- Understand virtual reality, augmented reality and using them to build Biomedical engineering applications
- Know the intricacies of these platform to develop PDA applications with better optimality.
- Learn the various applications of VR.
- Learn the possibilities of implementing target-specific VR applications on mobile.

MODULE I INTRODUCTION 9 Hours

The three I's of virtual reality-commercial VR technology and the five classic components of a VR system - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture interfaces-Output Devices: Graphics displays-sound displays & haptic feedback.

MODULE II VR DEVELOPMENT PROCESS 9 Hours

Geometric modeling - kinematics modeling- physical modeling - behaviour modeling - model management.

MODULE III CONTENT CREATION CONSIDERATIONS 9 Hours

Methodology and terminology-user performance studies-VR health and safety issues-Usability of virtual reality system- cyber sickness -side effects of exposures to virtual reality environment

MODULE IV VR ON THE WEB & VR ON THE MOBILE 9 Hours

JS-pros and cons-building blocks (WebVR, WebGL, Three.js, device orientation events)-frameworks (A-frame, React VR)-Google VR for Android-Scripts, mobile device configuration, building to android-cameras and interaction-teleporting-spatial audio-Assessing human parameters-device development and drivers-Design Haptics

MODULE V APPLICATIONS 9 Hours

Medical applications-military applications-robotics applications- Advanced Real time Tracking-other applications- games, movies, simulations, therapy

TOTAL: 45 PERIODS

TEXT BOOKS

1. C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons, Inc., 2008
2. Jason Jerald. 2015. The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.

REFERENCES

1. Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575
2. Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability),Steve Aukstakalnis, Addison-Wesley Professional; 1 edition, 2016.
3. The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything, Robert Scoble & Shel Israel, Patrick Brewster Press; 1 edition, 2016.
4. Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, Tony Parisi, O'Reilly Media; 1 edition, 2015.
5. Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages, Tony Parisi, O'Reilly Media; 1 edition, 2014.
6. Learning Three.js: The JavaScript 3D Library for WebGL - Second Edition, Jos Dirksen, Packt Publishing - ebooks Account; 2nd Revised ed. Edition 2015.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to

CO1: Analyze and Design a system or process to meet given specifications with realistic engineering constraints.

CO2: Identify problem statements and function as a member of an engineering design team.

CO3: Analyze the implications and issues pertaining to VR

CO4: Propose technical documents and give technical oral presentations related to design VR mini project results.

CO5: Develop simple and portable VR applications using appropriate software.

BMPEC574	DRUG DELIVERY SYSTEMS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

- To enhance the student on drug delivery system which would enable a comprehensive analysis of drug delivery.
- To explore the efficacy and safe release of the drug in to host using implantable and nanomaterials.

MODULE I SUSTAINEDANDCONTROLLEDDRUGDELIVERY 9 Hours

Introduction, properties of drugs, Pharmacokinetic properties of drugs, sustained release formulations – concept, physical-chemical biological properties of drugs, advantages, and disadvantages –controlled drug delivery systems–automatically controlled drug delivery systems and their biomedical applications.

MODULE II POLYMERS & TARGETTED DRUG DELIVERY SYSTEMS 9 Hours

Polymers used in drug delivery systems – modules, classification, characterization, advantages and disadvantages of polymer, targeted drug delivery systems–concepts–nanoparticles–liposomes, microspheres–hydrogels.

MODULE II TRANSDERMAL DRUG DELIVERY SYSTEMS 9 Hours

Transdermal penetration of drugs – formulation – addition – polymers in transdermal drug delivery system– iontophoresis–transdermal controlled release products and devices Development in insulin therapy using biomedical controlled drug delivery systems

MODULE IV IMPLANTABLEDRUGDELIVERYSYSTEMS 9 Hours

Implantable micro–pump systems–peristaltic micro pump–osmotic micro pump-diaphragm micro pump–Fluorocarbon propellent driven micropump–solenoid driver reciprocates micropump–programmable implanted drug administrative device (DAD).

MODULE V NANOMEDICINE INDRUGDELIVERYSYSTEMS 9 Hours

Drug delivery using monoclonal antibodies– Role of biosensors and transducer in diagnostic. drug delivery to cells using nanotubes and nanowires. Quantum dots for drug delivery and imaging. Quantum dots for cancer treatment.

TOTAL PRIODS: 45

tumor antigen and delivering the drug against cancer cells via nanotubes and nanowires.

TEXT BOOK / REFERENCE BOOK

1. Vyas S.P. Khar RK Targeted and controlled drug delivery Novel Carrier System CBSPD, Second Edition,2019.

2. Anya MHillery et al Drug delivery and targeting CRC Press, Second Edition, 2016.

3. Robinson R Robinson Conventional drug delivery systems, CRC Press,2004

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 – Understands the Pharmacokinetic properties of drugs and their delivery mode.

CO2 – Explore the techniques used in the development of drug delivery systems using polymers.

CO3 – Analyse the current trends in drug targeting by the transdermal route and controlled release.

CO4 – Design the advanced techniques that are implantable devices for drug delivery.

CO5 - Examine the efficacy and release of various drugs using quantum dots and monoclonal antibodies.

CO6 - Create a methodology for diagnosing the

BMPEC681	TISSUE ENGINEERING AND REGENERATIVE MEDICINE	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

- To learn the fundamentals of molecular and cellular processes with special emphasis on stem cells, biomaterials and their applications.
- To introduce students to tissue engineering, tissue repair and its practical applications in clinical settings.'

MODULE I CELL AND MOLECULAR BIOLOGY 9 Hours

Cell physiology in the Engineer's perspective – Cell Technology – System Physiology – Molecular Technology.

MODULE II IMMUNOLOGY AND REGENERATIVE MEDICINE 9 Hours

Pathogenic factors – Transplant immunology – Overview of Regenerative Engineering Technologies – Advanced methods applied in the Regenerative medical field.

MODULE III TISSUE ENGINEERING 9 Hours

Origins – Engineering Principles and Triad – Fundamentals of Stem Cells – Biomaterials – Bio Scaffold and Engineering Materials – Bioreactors.

MODULE IV TISSUE ENGINEERING APPLICATIONS 9 Hours

Stem Cell Therapy – In vitro Organogenesis – Tissue-specific engineering: Hard and Soft tissues – Immunomodulation: designer tissues.

MODULE V CHALLENGES, REGULATION AND ETHICS 9 Hours

Assessment and Standardization of engineered tissues – Cryopreservation – Immuno isolation: Engineering challenges – Ethical consideration, Evaluation and Regulation of tissue-engineered products.

TOTAL PERIODS: 45

TEXT BOOK / REFERENCE BOOK

1. Jose A Andrades Regenerative medicine and tissue engineering Intech Open 2013
2. Joseph P. Vacanti Tissue Engineering and Regenerative Medicine A Cold Spring Harbor Prospectives 2017
3. Tatevik Sahakyants & Joseph P. Vacanti Tissue engineering: from the bedside to the bench and back to the bedside Springer Link 2020
4. Anwarul Hasan Tissue Engineering for Artificial Organs: Regenerative Medicine Wiley 2017
5. Robert E Marx and Randy B Miller Stem Cells and Regenerative Medicine Kindle Edition 2020

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand the pathophysiology of human diseases and the potency of stem cells in regenerative medicine.

CO2 - Acquire knowledge of biomaterials in regenerative medicine and their interaction with host tissues.

CO3 - Identify host-graft interaction with a focus on immune and infectious issues related to regeneration and transplants.

CO4 - Demonstrate multidisciplinary aspects in tissue engineering to solve healthcare problems.

CO5 - Apply regenerative engineering strategies to replace damaged or destroyed cells.

CO6 - Implement experimental therapies from the laboratory to the clinic.

BMPEC682	ARTIFICIAL ORGANS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

- To provide a general introduction to the use of artificial materials in the human body for the purpose of aiding healing, correcting deformities and restoring lost function.
- It is expected that the student will have successfully completed an elementary course in the mechanics of deformable bodies and an introductory course to material science prior to undertake a course in biomaterials.

MODULE I ORGAN REPLACEMENT **9 Hours**

Artificial organs – Future scope and importance, Evolution of organ replacement technology. Substitutive medicine, Organ replacement outlook, design considerations, evaluation process. Bioartificial organ manufacturing- Material basis of organ manufacturing, organ manufacturing process, and organ manufacturing technologies.

MODULE II ARTIFICIAL ORGANS **9 Hours**

Artificial heart valves, Heart valve prosthesis- mechanical and tissue valves, Cardiac pacemakers, Pacemaker Implantation, Cardiac Stents, Artificial Lung, Artificial skin, Artificial pancreas, Artificial blood, Artificial kidney, Dialysis-Dialysis Procedure and the Dialysis System, Dialyzer Cartridge Reuse.

MODULE III ORTHOTIC DEVICES **9 Hours**

Orthotic devices- Types of orthotic devices- upper limb orthoses, lower limb orthoses, foot orthoses, Ankle foot orthoses, Knee orthoses, Knee-ankle-foot orthoses, spinal orthoses, and soft braces.

MODULE IV BLOOD INTERFACING IMPLANTS **9 Hours**

Neural and neuromuscular implants, heart valve implants, heart and lung assist devices, artificial heart, cardiac pacemakers, artificial kidney- dialysis membrane and artificial blood.

MODULE V IMPLANTABLE MEDICAL DEVICES AND ORGANS **9 Hours**

Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions.

TOTAL PERIODS: 45 Hrs.

TEXT BOOK / REFERENCE BOOK

1. Michael Lysaght, Thomas J Webster, Biomaterials for Artificial Organs, 1st Edition, ELSEVIER, 2010.
2. Gerald E. Miller, Artificial organs,1st edition, A Publication in the Morgan & Claypool Publishers series, United States of America, 2006.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand organ replacement technology and the evaluation process of various artificial organs.

CO2 - Acquire knowledge about different types of artificial organs and their implantation.

CO3 - Recognize the orthotic devices for paralyzed and non-paralyzed individuals.

CO4 - Demonstrate principles of stem cells and biomaterials used for tissue engineering.

CO5 - Apply tissue engineering to produce biomolecules.

CO6 - Implement artificial organs to replace malfunctioning natural organs.

BMPEC683	MEDICAL ETHICS AND REGULATORY AFFAIRS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

- Students will be able to know about the legal and ethical principles
- To apply these principles in health care settings & gain knowledge about the medical standards that to be followed in hospitals.

MODULE I INTRODUCTION TO MEDICAL ETHICS 9 Hours.

Definition of Medical Ethics, Scope of Ethics In Medicine, American Medical Association Code of Ethics, CMA Code of Ethics Fundamental Responsibilities. The Doctor and Patient, Doctor and Safety, Professional Independence.

MODULE II ETHICAL THEORIES MORAL PRINCIPLES 9 Hours.

Theories-Deontology and Utilitarianism Casuist Theory Virtue Theory, The Right Theory, Ethical Issues in Biomedical Research, Bioethical Issues in Human Genetics and Reproductive Medicine.

MODULE III MEDICAL EQUIPMENTS SAFETY STANDARDS 9 Hours.

General Requirements for Basic Safety and Essential Performance of Medical Equipments.Iec60601 Standard Indian and International Standards Base Standard General Requirement of Electrical Medical Devices. Collateral Standards Particular Types of Medical Device.

MODULE IV MEDICAL DEVICE AND INVITRO DIAGNOSTIC 9 Hours.

Introduction And Types of Devices Including Combination Devices. Medical Devices Rules 2017.Implication on Medical Device, Classification of Medical Devices. Labelling Of Medical Devices and Invitro Diagnostic.

MODULE V STANDARDS OF MEDICAL DEVICE, QUALITY ASSURANCE AND TESTING 9 Hours.

Regulatory Requirements of Biocompatibility of Medical Devices and ISO 10993 Clinical Investigation of Medical Devices, Regulation of Investigational Medical Devices.

TOTAL PERIODS: 45 Hrs.

TEXT BOOK / REFERENCE BOOK

1. Johnna Fisher, Biomedical Ethics: A Canadian Focus. Oxford University Press Canada, 2009.
2. Robert M Veatch, the Basics of Bio Ethics, 3 Rd Edition. Routledge, 2011.
3. Joint Commission Accreditation Standards for Hospitals, 6th Edition 2018
4. Medical Devices Rules 2017, Related Guidance Documents Available at CDCSO Websites.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand the Social Responsibility in Health Care Systems.
CO2 - Analyse the Role of Biomedical Engineers to Know the Importance.
CO3 - Comphrend the Medical Equipment Safety Standards to Medical Device Maintenance.
CO4 - Examine the Types of Medical Devices and Their Invitro Diagnostic Methods.
CO5 - Interpret the Quality Assurance and Testing Procedure for Standard Medical Devices.
CO6 - Create A Protocol for Regulatory Requirement of Biocompatibility on Medical Devices.

BMPEC684	WEARABLE SYSTEMS FOR HEALTHCARE	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

- To impart the importance of smart sensors, sensor interface standards for wearable device applications
- Identify the need for the development of wearable devices and its implications on various sectors
- Comprehend the design and development of various wearable bioelectrode and physiological activity monitoring devices for use in healthcare applications.

MODULE I SENSORS FOR WEARABLE SYSTEMS. 9 Hours

Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensors, Inductive plethysmography, Impedance plethysmography, pneumography, Radiant thermal sensor, Wearable motion sensors, Wearable biochemical Sensors, and Wearable gas sensors.

MODULE II SIGNAL PROCESSING AND ENERGY HARVESTING. 9 Hours

Wearability issues -physical shape and placement of the sensor, technical challenges – sensor design, signal acquisition, lightweight signal processing, Rejection of irrelevant information, Solar cell, Vibration-based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests.

MODULES III SCOPE OF WEARABLE DEVICES. 9 Hours

Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Wearables: Challenges and Opportunities, Future and Research Roadmap

MODULE IV WIRELESS SYSTEMS AND IOT. 9 Hours

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, IoT- Definition and characteristics of IoT, Physical design of IoT, IoT functional blocks, IoT levels, IoT design methodology.

MODULE V APPLICATIONS OF WEARABLE DEVICES. 9 Hours

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Elderly patients, arthritic patients, multi-parameter monitoring, Gait analysis, Sports Medicine, Smart Fabrics.

TOTAL PERIODS: 45 Hrs.

TEXT BOOK / REFERENCE BOOK

1. John G. Webster, Amit J. Nimunkar, Medical Instrumentation application and design – 5th Edition, (An Indian Adaptation), Wiley India, 2021.

2. R. Ananda Natarajan, Biomedical Instrumentation and Measurements, 2nd Edition, PHI, 2016.

3. Leslie Cromwell, ―Biomedical Instrumentation and measurement, Prentice Hall of India, New Delhi, 2nd edition, 2015.

4. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd edition, 2014.

5. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", edition, 2015. Pearson education, 2012.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Discuss and analyse the usage of various biochemical and gas sensors as wearable devices.

CO2 - Identify the technical challenges for signal processing and Energy Harvesting.

CO3 - Describe the scope of the wearable devices and its design constraints for measuring physical and biological signals.

CO4 - Design and develop various wearable device for detection of physiological body signals, blood pressure and body temperature for use in healthcare applications.

CO5 - Acquaint the usage of wearable devices as assistive devices, diagnostic devices and other modern applications.

CO6 - Able to design and perform experiments on the sensors and develop the projects based on the customer needs.

BMPEC685	PHYSIOLOGICAL MODELLING	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

The student should be made to:

- To explain the application of Physiological models and vital organs.
- To Formulate the methods and techniques for analysis and synthesis of dynamic models
- To describe the dynamic models, simulate and visualize, dynamic responses of physiological models using software.
- To describe nonlinear models of physiological systems
- To compute the Simulation of physiological systems

MODULE I INTRODUCTION TO PHYSIOLOGICAL MODELING 9 Hours

Approaches to modelling: The technique of mathematical modelling, classification of models, characteristics of models. Time invariant and time varying systems for physiological modelling. Introduction to physiology (homeostasis, cell biology) Modelling physical systems, linear models of physiological systems, the Laplace transform, Transfer functions and block diagram analysis Physiology.

MODULE II MODELING OF DYNAMIC PHYSIOLOGICAL SYSTEM 9 Hours

Dynamic systems and their control, modelling and block diagrams, the pupil control Systems (Human Eye), general structure of control systems, the dynamic response characteristics of the pupil control system, open &close loop systems instability, automatic aperture control.

MODULE III NONLINEAR MODELS OF PHYSIOLOGICAL SYSTEMS 9 Hours

Nonparametric Modelling-Volterra Models. Wiener Models. Efficient Volterra Kernel Estimation. Parametric Modelling - Basic Parametric Model Forms and Estimation Procedures-Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Models.

MODULE IV COMPARTMENTENTAL PHYSIOLOGICAL MODEL 9 Hours

Modelling the body as compartments, behaviour in simple compartmental system, pharmacokinetic model, and multi compartmental system. Physiological modelling: Electrical analogy of blood vessels, model of systematic blood flow and model of coronary circulation. Mathematical modelling of the system: Thermo regulation, Thermoregulation of cold bloodedness& warm bloodedness, the anatomy of thermo regulation, lumping & partial differential equations, heat transfer examples, mathematical model of the controlled process of the body.

MODULE V SIMULATION OF PHYSIOLOGICALSYSTEMS 9 Hours

Simulation of physiological systems using Open CV / MATLAB software. Biological receptors: - Introduction, receptor characteristics, transfer function models of receptors, receptor and perceived intensity. Neuromuscular model, Renal System, Drug Delivery Model.

TOTAL PERIODS: 45

TEXT BOOKS

1. Michel C Khoo, “Physiological Control Systems -Analysis, simulation and estimation”, Prentice Hall of India, 2001.

2. Marmarelis, “Nonlinear Dynamic Modeling of Physiological Systems”, Wiley-IEEE Press,2004.

REFERENCES

1. Benjamin C Kuo, “Automatic control systems”, Tenth Edition, McGraw-Hill Education, 2017.

2. MinruiFei, Shiwei Ma, Xin Li, Xin Sun, Li Jia and Zhou Su,“Advanced Computational Methods in Life System Modeling and Simulation”, Springer,2017

3. DavidTWestwick, Robert E. Kearney, Identification of Nonlinear PhysiologicalSystems, Wiley-IEEE Press, 2003.

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Explain the application of Physiological models

CO2: Describe the methods and techniques for analysis and synthesis of Linear and dynami system

CO3: Develop differential equations to describe the compartmental physiological model

CO4: Describe Nonlinear models of physiological systems

CO5: Illustrate the Simulation of physiological systems

OPEN ELECTIVE COURSES

BMOEC161	TELEHEALTH TECHNOLOGY	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

- Learn the key principles for telemedicine and health
- Understand telemedical technology.
- Know telemedical standards, mobile telemedicine and it applications

MODULE I FUNDAMENTALS OF TELEMEDICINE 9 Hours

History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.

MODULE II TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR TELEMEDICINE 9 Hours

Audio, video, still images, text and data, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.

MODULE III ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE 9 Hours

Confidentiality, patient rights and consent: confidentiality and the law, the patient-doctor relationship, access to medical records, consent treatment - data protection & security, jurisdictional issues.

MODULE IV PICTURE ARCHIVING AND COMMUNICATION SYSTEM 9 Hours

Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture.

MODULE V APPLICATIONS OF TELEMEDICINE 9 Hours

Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Olga Ferrer Roca, Marcelo Sosa Iudicissa, “Handbook of Telemedicine”, IOS Press, Netherland, 3. 2002

2. Khandpur R S, “TELEMEDICINE – Technology and Applications”, PHI Learning Pvt Ltd., New Delhi, 2017.

3. Norris A C, “Essentials of Telemedicine and Telecare”, John Wiley, New York, 2002

REFERENCES

1. H K Huang, “PACS and Imaging Informatics: Basic Principles and Applications” Wiley, New Jersey, 2010.

2. Khandpur R S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 2003
3. Keith J Dreyer, Amit Mehta, James H Thrall, “Pacs: A Guide to the Digital Revolution”, Springer, New York, 2002.
4. Garrett Grolemund, *Hands–On Programming with R*, O'Reilly, 1 edition , 2014.
5. Michael Dawson, *Python Programming for the Absolute Beginner*, Course Technology , 3rd edition ,2010
6. Magesh Jayakumar, *Arduino and Android Using Mit App Inventor*, Create space Independent Publishing Platform, 1.0 edition, 2016.

COURSE OUTCOMES:

CO1: To analyse the benefits and limitations of telemedicine.

CO2: To apply multimedia technologies in telemedicine.

CO3: To explain protocols behind encryption techniques for secure transmission of data.

CO4: To develop radiology based information system.

CO5: To apply telemedicine in various healthcare domains.

BMOEC162	MEDICAL INFORMATICS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

• To study the applications of information technology in health care management.

• This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

MODULE I INTRODUCTION TO MEDICAL INFORMATICS 9 Hours

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

MODULE II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9 Hours

Automated clinical laboratories- Automated methods in haematology, cytology and histology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

MODULE III COMPUTERISED PATIENT RECORD 9 Hours

Introduction - History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

MODULE IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9 Hours

Neurocomputers and Artificial Neural Networks application, Expert System-General model of CMD, Computer–assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis in clinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

MODULE V RECENT TRENDS IN MEDICAL INFORMATICS 9 Hours

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mohan Bansal, “Medical informatics”, Tata McGraw Hill Publishing Ltd, 2003.

2. R.D.Lele, “Computers in medicine progress in medical informatics”, Tata Mcgraw Hill,2005

REFERENCES:

1. Kathryn J. Hannah, Marion J Ball, “Health Informatics”, 3rd Edition, Springer, 2006.

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1: Explain the structure and functional capabilities of Hospital Information System.

CO2: Describe the need of computers in medical imaging and automated clinical laboratory.

CO3: Articulate the functioning of information storage and retrieval in computerized patient record system.

CO4: Apply the suitable decision support system for automated clinical diagnosis.

CO5: Discuss the application of virtual reality and telehealth technology in medical industry.

BMOEC163	FORENSIC SCIENCE IN HEALTHCARE	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE:

By the end of the course each student will be familiar with:

- The history of the forensic sciences and its place in popular culture
- The roles of different types of professionals involved in evaluating a crime scene and the collected evidence
- Forensic microscope and Anthropology
- The Blood stain identification
- The methodology of collecting & interpreting data for fingerprint application

MODULE I BASICS OF FORENSIC SCIENCE 9

Forensic science, Introduction to the Forensic Sciences, History and Development of Forensic Science, Deductive Reasoning, Organization of a Crime Laboratory Case Studies: The Enrique Camarena Case. A Forensic Nightmare Organization of forensic science laboratories of center and state -NCRA AND NICFS, fundamental rights, criminal profiling, concept of quality control management in forensic institutions.

MODULE - II OBSERVATION AND CRIME SCENE 9

Observational Skills - Sherlock Holmes and Deductive Reasoning - Observations by Witnesses. Case Studies. The Crime Scene -Locard's Exchange Principle, Securing and Recording the Crime Scene, Legal Considerations at the Crime Scene, Evidence Collection and Recordation Techniques. Mock Crime Scene: Processing and Documenting a Crime Scene

MODULE III FORENSIC MICROSCOPE AND ANTHROPOLOGY 9

Forensic Use of the Microscope -The Compound, Comparison, and Stereoscopic Microscope, The Scanning Electron Microscope (SEM). Forensic Anthropology- Introduction, Human Anatomy–The Skeletal System, Skeletal Determination of Demographic Data from Skeletal Remains, Determining Types of Trauma and Disease from Skeletal Remains, Case Studies.

MODULE IV BLOOD STAIN IDENTIFICATION 9

Detection and identification of Blood stains, Determination of species of origin, Blood Group systems, Techniques of Determination of Blood groups of Blood stains, Determination of seminal and other fluids and their Blood Grouping, DNA, DNA Phenotyping and RNA Profiling & their applications. Wildlife forensics.

MODULE V FINGERPRINT APPLICATION 9

Fingerprints -Fundamental Principles of Fingerprint Analysis, Classification of Fingerprints, Collection of Fingerprint Evidence, Automated Fingerprint Identification Systems (AFIS), Track marks, Case Studies.

COURSE OUTCOMES:

Upon successful completion of the course, students will be able to

CO1: Define the significance of forensic sciences

CO2: Observe and document crime scenes

CO3: Determine Trauma and Diseases.

CO4: Describe the various sources of medical data related to forensic science.

CO5: Demonstrate the visual analytical procedure of finger print application.

TEXT BOOKS

1. Nanda, B.B. and Tewari, R.K. (2001) Forensic Science in India: A vision for the twenty first century Select Publisher, New Delhi.

2. James, S.H and Nordby, J.J. (2003) Forensic Science: An introduction to scientific and investigative techniques CRC Press,

REFERENCES

1. Saferstein : Criminalistics (1976) Prentice Hall Inc., USA.

2. Deforest, Gansellen & Lee : Introduction to Criminalistics.

3. Sharma, B.R. (1974) Forensic Science in Criminal Investigation and Trials, Central Law Agency, Allahabad, 1974

BMOEC164	ARTIFICIAL INTELLIGENCE	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

The main objectives of this course are to:

- Study about uninformed and Heuristic search techniques.
- Learn techniques for reasoning under uncertainty.
- Introduce Machine Learning and supervised learning algorithms.
- Study about ensembling and unsupervised learning algorithms.
- Learn the basics of deep learning using neural networks.

MODULE I PROBLEM SOLVING **9 Hours**

Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP).

MODULE II PROBABILISTIC REASONING **9 Hours**

Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.

MODULE III SUPERVISED LEARNING **9 Hours**

Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model –Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests.

MODULE IV ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING 9 Hours

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.

MODULE V NEURAL NETWORKS **9 Hours**

Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

COURSE OUTCOMES:

At the end of this course, the students will be able to:

CO1: Use appropriate search algorithms for problem solving.

CO2: Apply reasoning under uncertainty.

CO3: Build supervised learning models.

CO4: Build ensembling and unsupervised models.

CO5: Build deep learning neural network models.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Fourth Edition, Pearson Education, 2021.

2. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.

REFERENCES

1. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education,2007.

2. Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008.

3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006.
4. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013 (http://nptel.ac.in/).
5. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
6. Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition,1997.
7. Charu C. Aggarwal, “Data Classification Algorithms and Applications”, CRC Press, 2014.
8. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.
9. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.

BMOEC271	ROBOTIC PROCESS AUTOMATION	L	T	P	3 Credits
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic concepts of Robotic Process Automation.

MODULE I INTRODUCTION TO ROBOTIC PROCESS AUTOMATION 9 Hours

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms. Robotic Process Automation Tools - Templates, User Interface, Domains in Activities, Workflow Files.

MODULE II AUTOMATION PROCESS ACTIVITIES 9 Hours

Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, and Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, UiExplorer, Handling Events

MODULE III APP INTEGRATION, RECORDING AND SCRAPING 9 Hours

App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, Scraping data from website and writing to CSV. Process Mining.

MODULE IV EXCEPTION HANDLING AND CODE MANAGEMENT 9 Hours

Exception handling, Common exceptions, Logging- Debugging techniques, Collecting crash dumps, Error reporting. Code management and maintenance: Project organization, nesting workflows, Reusability, Templates, Commenting techniques, State Machine.

MODULE V DEPLOYMENT AND MAINTENANCE 9 Hours

Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates. RPA Vendors - Open Source RPA, Future of RPA

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, 2018.

2. Tom Taulli , “The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems”, Apress publications, 2020.

REFERENCES:

1. Frank Casale (Author), Rebecca Dilla (Author), Heidi Jaynes (Author), Lauren Livingston (Author), Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation, Amazon Asia-Pacific Holdings Private Limited, 2018

2. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Amazon Asia-Pacific Holdings Private Limited, 2018

3. A Gerardus Blokdyk, “Robotic Process Automation Rpa A Complete Guide “, 2020.

COURSE OUTCOME

CO1. To expose to the key RPA design and development strategies and methodologies.
CO2. To learn the fundamental RPA logic and structure.
CO3. To explore the Exception Handling, Debugging and Logging operations in RPA.
CO4. To learn to deploy and maintain the software bot.

BMOEC272	FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES:

- To provide knowledge on the fundamentals of cell biology.
- To understand the signalling mechanisms.
- Understand basic principles of molecular biology at intracellular level to regulate growth,
- Division and development.

MODULE 1I INTRODUCTION TO CELL **9 Hours**

Cell, cell wall and Extracellular Matrix (ECM), composition, cellular dimensions, Evolution, Organisation, differentiation of prokaryotic and Eukaryotic cells, Virus, bacteria, cyanobacteria,

Mycoplasma and prions.

MODULE II CELL ORGANELLES **9 Hours**

Molecular organisation, biogenesis and function Mitochondria, endoplasmic reticulum, Golgi apparatus, plastids, chloroplast, leucoplast, centrosome, lysosome, ribosome, peroxisome, Nucleus and nucleolus. Endo membrane system, concept of compartmentalisation.

MODULE III BIO-MEMBRANE TRANSPORT **9 Hours**

Physiochemical properties of cell membranes. Molecular constitute of membranes, asymmetrical organisation of lipids and proteins. Solute transport across membrane's-fick's law, simple diffusion, passive-facilitated diffusion, active transport- primary and secondary, group translocation, transport ATPases, membrane transport in bacteria and animals. Transportmechanism- mobile carriers and pores mechanisms. Transport by vesicle formation, endocytosis, exocytosis, cell respiration.

MODULE IV CELL CYCLE **9 Hours**

Cell cycle- Cell division by mitosis and meosis, Comparision of meosis and mitosis, regulation of cell cycle, cell lysis, Cytokinesis, Cell signaling, Cell communication, Cell adhesion and Cell junction, cell cycle checkpoints.

MODULE V CENTRAL DOGMA **9 Hours**

Overview of Central dogma DNA replication: Meselson & Stahl experiment, bi–directional DNA replication, Okazaki fragments. Structure and function of mRNA, rRNA and tRNA. RNA synthesis: Initiation, elongation and termination of RNA synthesis Introduction to Genetic code- Steps in translation: Initiation, Elongation and termination of protein synthesis.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", 8th Edition,

Oxford University Press, 2018

2. Friefelder, David. “Molecular Biology.” Narosa Publications, 1999

3. Weaver, Robert F. “Molecular Biology” IInd Edition, Tata McGraw-Hill, 2003.

REFERENCES:

1. Lodish H, Berk A, MatsudairaP,Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J. Molecular Cell Biology, 6th Edition, 2007.

2. Becker, W.M. etal., “The World of the Cell”, 9th Edition, Pearson Education, 2003.

3. Campbell, N.A., J.B. Recee and E.J. Simon “Essential Biology”, VIIrd Edition, Pearson International, 2007.

1. Alberts, Bruce etal., “Essential Cell Biology”, 4th Edition, W.W. Norton, 2013.

COURSE OUTCOMES:

CO1: Understanding of cell at structural and functional level.

CO2: Understand the central dogma of life and its significance.

CO3: Comprehend the basic mechanisms of cell division.

BMOEC273	BIOTECHNOLOGY IN HEALTH CARE	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES

The aim of this course is to

- Create higher standard of knowledge on healthcare system and services
- Prioritize advanced technologies for the diagnosis and treatment of various diseases

MODULE I PUBLIC HEALTH **9 Hours**

Definition and Concept of Public Health, Historical aspects of Public Health, Changing Concepts of Public Health, Public Health versus Medical Care, Unique Features of Public Health, Determinants of Health (Social, Economic, Cultural, Environmental, Education, Genetics, Food and Nutrition). Indicators of health, Burden of disease, Role of different disciplines in Public Health.

MODULE II CLINICAL DISEASES **9 Hours**

Communicable diseases: Chickenpox / Shingles, COVID-19, Tuberculosis, Hepatitis B, Hepatitis C, HIV / AIDS, Influenza, Swine flu. Non Communicable diseases: Diabetes mellitus, atherosclerosis, fatty liver, Obesity, Cancer

MODULE III VACCINOLOGY **9 Hours**

History of Vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems. Instruments related to monitoring of temperature, sterilization, and environment.

MODULE IV OUTPATIENT & IN PATIENT SERVICES **9 Hours**

Radiotherapy, Nuclear medicine, surgical units, OT Medical units, G & Obs. units Pediatric, neonatal units, Critical care units, Physical medicine & Rehabilitation, Neurology, Gastroenterology, Endoscopy, Pulmonology, Cardiology.

MODULE V BASICS OF IMAGING MODALITIES **9 Hours**

Diagnostic X-rays - Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
2. Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers
3. The Vaccine Book (2nd Ed.), Rafi Ahmed, Roy M. Anderson et. al.Editor(s): Barry R. Bloom, PaulHenri Lambert, Academic Press, 2016, Pages xxi-xxiv.

REFERENCE BOOKS

1. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011
2. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
3. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker

BMOEC381	MULTIVARIATE DATA ANALYSIS	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE:

- To know various multivariate data analysis techniques for business research.

MODULE I INTRODUCTION **9 Hours**

Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

MODULE II PREPARING FOR MULTIVARIATE ANALYSIS **9 Hours**

Conceptualization of research model with variables, collection of data –-Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.

MODULE III MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS

9 Hours

Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.

MODULE IV LATENT VARIABLE TECHNIQUES **9 Hours**

Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, longitudinal studies.

MODULE V ADVANCED MULTIVARIATE TECHNIQUES **9 Hours**

Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S.Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012.

REFERENCES BOOK:

1. Richard A Johnson and Dean W.Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi, 2005.
2. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002.

COURSE OUTCOMES:

CO1: Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.

CO2: Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.

CO3: Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.

CO4: Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.

CO5: Make better business decisions by using advanced techniques in data analytics. ‘

BMOEC382	BIOMEDICAL INDUSTRIAL MANAGEMENT	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVES

- To study the basic concepts of management; approaches to management;
- Contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- To study the planning; organizing and staffing functions of management in professional organization.
- To study the leading; controlling and decision making functions of management in professional organization.
- To learn the organizational theory in professional organization.
- To learn the principles of productivity and modern concepts in management in professional organization.

MODULE I INTRODUCTION TO MANAGEMENT **9 Hours**

Management: Introduction; Definition and Functions – Approaches to the study of Management Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

MODULE II FUNCTIONS OF MANAGEMENT - I **9 Hours**

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

MODULE III FUNCTIONS OF MANAGEMENT - II **9 Hours**

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

MODULE IV ORGANIZATION THEORY **9 Hours**

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation-hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

MODULE V PRODUCTIVITY AND MODERN TOPICS **9 Hours**

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering

(BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

TOTAL: 45 PERIODS

TEXTBOOKS:

1. M . Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.
2. K oontz. H. and Weihrich. H., "Essentials of Management: An International Perspective", 8th Edition, Tata McGrawhill, New Delhi, 2010.

REFERENCES:

1. Joseph J, Massie, "Essentials of Management", 4th Edition, Pearson Education, 1987.
2. Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.
3. S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.
4. Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11th Edition, 2012.
2. S. Trevis Certo, "Modern Management Concepts and Skills", Pearson Education, 2018.

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Explain basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.

CO2: Discuss the planning; organizing and staffing functions of management in professional organization.

CO3: Apply the leading; controlling and decision making functions of management in professional organization.

CO4: Discuss the organizational theory in professional organization.

CO5: Apply principles of productivity and modern concepts in management in professional organization.

BMOEC383	LIFESTYLE DISEASES	L	T	P	Credits
		3	0	0	3

MODULE I INTRODUCTION **9 Hours**

Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer;

Prevention – Diet and exercise.

MODULE II CANCER **9 Hours**

Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment

MODULE III CARDIOVASCULAR DISEASES **9 Hours**

Coronary atherosclerosis – Coronary artery disease; Causes -Fat and lipids, Alcohol abuse -– Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation

MODULE IV DIABETES AND OBESITY **9 Hours**

Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Paediatric and adolescent obesity – Weight control and BMI

MODULE V RESPIRATORY DISEASES **9 Hours**

Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing

TOTAL: 45 PERIODS

TEXT BOOKS:

1. R.Kumar&Meenal Kumar, “Guide to Prevention of Lifestyle Diseases”, Deep & Deep

Publications, 2003

2. Gary Eggar et al, “Lifestyle Medicine”, 3rd Edition, Academic Press, 2017

REFERENCES:

1. James M.R, “Lifestyle Medicine”, 2nd Edition, CRC Press, 2013

2. Akira Miyazaki et al, “New Frontiers in Lifestyle-Related Disease”, Springer, 2008

COURSES FOR B.TECH HONOURS (OPTIONAL)

BMH131	ARTIFICIAL ORGANS AND IMPLANTS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVES:

The student should be made to:

- To have an overview of artificial organs & transplants
- To describe the principles of implant design with a case study
- To explain the implant design parameters and solution in use
- To study about various blood interfacing implants
- To study about soft tissue replacement and hard tissue replacement

MODULE I ARTIFICIAL ORGANS & TRANSPLANTS 12 Hours

ARTIFICIAL ORGANS:-Introduction, outlook for organ replacements, design consideration, evaluation process.

TRANSPLANTS:-Overview, Immunological considerations, Blood transfusions, individual organs – kidney, liver, heart and lung, bone marrow, cornea.

MODULE II PRINCIPLES OF IMPLANT DESIGN 12 Hours

Principles of implant design, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and regulators criteria for materials selection, Case study of organ regeneration.

MODULE III IMPLANT DESIGN PARAMETERS AND ITS SOLUTION 12 Hours

Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration.

MODULE IV BLOOD INTERFACING IMPLANTS 12 Hours

Neural and neuromuscular implants, heart valve implants, heart and lung assist devices, artificial heart, cardiac pacemakers, artificial kidney- dialysis membrane and artificial blood.

MODULE V IMPLANTABLE MEDICAL DEVICES AND ORGANS 12 Hours

Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions.

TOTAL: 60 PERIODS

TEXT BOOK

1. Kopff W.J, Artificial Organs, John Wiley and sons, New York, 1st edition, 1976

REFERENCES

1. J D Bronzino, Biomedical Engineering handbook Volume II, (CRC Press / IEEE Press), 2000.
2. R S Khandpur, Handbook of Biomedical Instrumentation,Tata McGraw Hill, 2003
3. Yannas, I. V, “Tissue and Organ Regeneration in Adults”, New York, NY: Springer, 2001.

ISBN:9780387952147.

4. John Enderle, Joseph D.Bronzino, Susan M.Blanchard, “”Introduction to Biomedical Engineering”, Elsevier, 2005.

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Gain adequate knowledge about artificial organs & transplants

CO2: Get clear idea about implant design and its parameters and solution

CO3: Have in-depth knowledge about blood interfacing implants

CO4: Explain different types of soft tissue replacement and hard tissue replacement

CO5: Assess compatibility and functioning of artificial organs inside the living system.

BMH132	BIOSENSORS AND MEASUREMENTS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To provide the basics of measurements, knowledge on the principle and operation of different medical transducers.
- To introduce the application of sensors and transducers in the physiological parameter measuring system.

MODULE I MEASUREMENT SYSTEM. 12 Hours

Measurement System – Functional elements of an instrumentation system - Static and Dynamic Characteristics - Errors in Measurements and their statistical analysis – Calibration - Primary and secondary standards. Sensor for Motion and Position Measurement, GPS, INS, Doppler, SONAR.

MODULE II PASSIVE AND ACTIVE TRANSDUCERS 12 Hours

Classification of transducers and characteristics for selection of transducers - Resistive Transducers-Strain Gauge, Capacitive transducer - various arrangements, Capacitor microphone, Capacitive pressure sensor, Proximity sensor. Inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics, Active type: Thermocouple - characteristics. Piezoelectric active transducer.

MODULE III BIO POTENTIAL ELECTRODES AND CHEMICAL SENSORS 12 Hours

Electrodes Electrolyte Interface, Half-Cell Potential, Polarization, Polarizable and Non-Polarizable, Electrodes, Reference Electrode, Hydrogen Electrode, Electrode Skin-Interface and Motion Artifact. Surface Electrodes. Oxygen electrodes, CO2 electrodes, enzyme electrode, construction, ISFET for glucose, urea etc. fiber optic sensors.

MODULE IV SMART AND BIOSENSORS 12 Hours.

Biological Sensors: Study of various corpuscles like Pacinian, functions and modelling, sensors for smell, sound, vision, osmolality and taste.

Biosensors: Introduction, Advantages and limitations, various components of Biosensors, Biocatalysts based biosensors, bio-affinity based biosensors & microorganisms-based biosensors, Types of membranes used in biosensor constructions, Electronic Nose. SMART SENSORS. Introduction to Smart Sensors and Semiconductor sensors, MEMS.

MODULE V DISPLAY AND RECORDING DEVICES 12 Hours

Digital Display System and Indicators: Classification of display devices, DOT Matrix display, Digital voltmeter, Multimeter, Digital storage oscilloscope, LCD monitor, Recorders: Graphic recorders, strip chart recorders, Galvanometer type recorders and self-balancing type potentiometric recorders, Magnetic tape recorders and Disc recorders.

PRACTICE EXERCISE

1. Characteristics of Temperature Transducers.

2. Characteristics of Optical Transducer.

3. Characteristics of LVDT and Potentiometer Transducer

4. Characteristics of Strain Gauge.

5. Dead weight measurement

6. Study of Characteristics of Hall effect Transducer using Arduino.

7. Measurement of pulse and body temperature using Arduino

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. A. K. Sawhney, A course in electronic Measurements and Instruments, Dhanpat Rai Sons, 2014

2. H.S. Kalsi, Electronic Instrumentation & Measurement, Tata McGraw Hill, 2011.

3. John G. Webster, Medical Instrumentation Application and Design, 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2015.

4. Richard S.C. Cobbold, Transducers for Biomedical Measurements: Principles and Applications, John Wiley & Sons, 2004.

5. Nandini K. Jog, Electronics in Medicine and Biomedical Instrumentation, PHI, 2nd Edition 2013.

6. Harry N, Norton, Biomedical sensors – Fundamentals and Application, 2001.

7. Tatsuo Togawa, Toshiyo Tamma and P. Ake Öberg, Biomedical Transducers and Instruments, 2018.Pillai S.O., Solid state Physics, New age International Publishers, 7th Edition.

COURSE OUTCOMES

CO1 - Understand the calibration procedure for the basic instruments involved in physiological parameter measurement.

CO2 - Identify the characteristics of various transducers and classify transducers.

CO3 - Attain adequate knowledge about the various sensors and measuring instruments used for measurement and detection of physical quantities.

CO4 - Demonstrate the concepts, types, working and practical applications of important biosensors.

CO5 - Apply the suitable design criteria for developing a medical sensor for a particular application.

CO6 - Employ Multimeter, CRO and different types of recorders for appropriate measurement.

BMH133	PRINCIPLES OF TISSUE ENGINEERING	L	T	P	Credits
		3	1	0	4

COURSE OBJECTIVES:

- To study the cell types and differentiation.
- To study basics about stem cells and its applications
- To understand the methods and design involved in tissue engineering

MODULE I INTRODUCTION TO CELL BIOLOGY **12 Hours**

Cell types - Progenitor cells - Cell growth and differentiation - Cell culture: Expansion - Transfer - Storage and Characterization - Cell signalling molecules - Growth factors - Cell attachment: Differential cell adhesion, Receptor-ligand binding - Cell surface markers.

MODULE II FUNDAMENTALS OF TISSUE ENGINEERING **12 Hours**

History and scope of tissue engineering - Tissue organization - Tissue types: Epithelial, Connective - Vascularity and angiogenesis - Wound healing - Extra Cellular Matrix: Matrix molecules and their ligands - Tissue culture – Materials in tissue engineering.

MODULE III STEM CELLS **12 Hours**

Definition of stem cells – Types of stem cells – Differentiation, dedifferentiation maturation, proliferation, pleuripotency and immortalization - Sources of stem cells: Hematopoietic – Fetal - cord blood – Placenta - Bone marrow - Primordial germ cells - Cancer stem cells – Induced pleuripotent stem cells.

MODULE IV ENGINEERING METHODS AND DESIGN **12 Hours**

Soft lithography - Self-assembled monolayer, Micro contact printing, Micro fluidic patterning - Laminar flow patterning - Cell interaction with Polymer scaffolds and gels - Polymer scaffolds fabrications: Electro spinning - Solvent casting and particulate leaching - Micro fabrication of cell seeded scaffolds.

MODULE V APPLICATION OF TISSUE ENGINEERING **12 Hours**

Replacement Engineering: Bone, cartilage, skin, blood, pancreas, kidney, heart valve and liver - Regenerative engineering: Peripheral Nerve regeneration, Cardiac tissue regeneration, Muscle regeneration – Regulation, Commercialization and Patenting.

TOTAL PERIODS: 60

TEXT BOOK

1. Robert P lanza, Robert Langer, Joseph Vacanti, "Principles of Tissue Engineering", Academic Press, United States, 2020.

2. Donglu Shi, Qing Liu, “Tissue Engineering and Nanotheranostics”, World Scientific Publications, Singapore, 2018.

REFERENCES

1. Gary E. Wnek, Gary L Browlin, “Encyclopedia of Biomaterials and Biomedical Engineering”,

Marcel Dekker Inc, New York, 2008.

2. R. Lanza, Anthony Atala (Eds), “Essential of Stem Cell Biology”, Academic Press, USA, 2013.

3. R. Lanza, Anthony Atala,“Handbook of Stem Cells’’, Academic Press, USA, 2012.

COURSE OUTCOMES:

At the end of the course, the student should be able to:

CO1: Understand the basic concepts of tissue engineering

CO2: Acquire ability to function on multi-disciplinary teams

CO3: Apply the knowledge of professional and ethical responsibility in use of stem cells and gene therapy in creating tissue engineered therapies

CO4: Design and develop different biomaterial in tissue engineering application

CO5: Gain knowledge in research or clinical application on tissue repair/ engineering

BMH134	GENETIC ENGINEERING	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVES:

- To discuss the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts.

MODULE I BASICS OF RECOMBINANT DNA TECHNOLOGY 12 Hours

Manipulation of DNA – Restriction and Modification enzymes - Design of linkers and adaptors - Characteristics of cloning and expression vectors - Introduction of recombinant DNA in to host cells and selection methods.

MODULE II DNA LIBRARIES 12 Hours

Construction of genomic and cDNA libraries, Artificial chromosomes – Bacteria, Yeast - Chromosomal walking.

MODULE III SEQUENCING AND AMPLIFICATION OF DNA 12 Hours

Maxam Gilbert's and Sanger's methods of DNA sequencing – PCR: Inverse PCR, Nested PCR, Allele specific PCR, Hot start PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis.

MODULE IV ORGANIZATION AND STRUCTURE OF GENOMES 12 Hours

Organization and structure of genomes - Genome sequencing methods: Conventional and shotgun genome sequencing methods, Next generation sequencing technologies - Ordering the genome sequence - Genetic maps and Physical maps, STS content based mapping, Hybridization mapping, Optical mapping.

MODULE V CURRENT STATUS OF GENOME SEQUENCING PROJECTS 12 hours

Introduction to Functional genomics – Microarrays - Serial Analysis of Gene expression (SAGE), Subtractive hybridization, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics.

TOTAL PERIODS: 60

TEXT BOOK

1. Old RW, Primrose SB, "Principles of Gene Manipulation, An Introduction to Genetic Engineering", Blackwell Science Publications, 1993.

2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, 3rd Ed. (Blackwell Publishing).

REFERENCES

1. Isil Aksan Kurnaz, "Techniques in Genetic Engineering", CRC Press, 2015.

2. Oksana Ableitner, "Introduction to Molecular Biology: Working with DNA and RNA (essentials)", Springer International, 2022.

1. Arun K. Shukla, “Proteomics in Biology”, Academic Press, 2017.

COURSE OUTCOMES:

At the end of the course, the student should be able to:

CO1: Would be aware of how to clone commercially important genes.

CO2: The students would be aware of how to produce the commercially important recombinant proteins.

CO3: Will be familiarized with gene and genome sequencing techniques

CO4: Will be aware of microarrays, Analysis of Gene expression and proteomics.

CO5: Acquire ability to function on multi-disciplinary teams

BMH241	BIOLOGICAL CONTROL SYSTEM	L	T	P	Credits
		3	1	0	4

COURSE OBJECTIVE

- To study physical system with mathematical and electrical analogues.
- To study the system efficiency and stability using time domain and frequency domain techniques.

MODULE I SYSTEM CONCEPTS **12 Hours**

Types of systems - Open loop systems, closed systems, Effects of feedback, Block diagram algebra and Signal flow graphs, Mathematical Models of Physical systems: Differential equations, Transfer functions and block diagrams of simple electrical networks, Translational and Rotational mechanical systems.

MODULE II TIME RESPONSE ANALYSIS OF CONTROL SYSTEMS **12 Hours**

Standard test signals, Time response of first order and second order systems with unit step as input, Time domain specification, steady state errors and static error constants, P, PI, PD and PID controllers, Concept of stability and Algebraic Criteria.

MODULE III THE CONCEPT OF STABILITY & ROOT LOCUS TECHNIQUE 12 Hours

The concept of stability, Routh stability criterion qualitative stability and conditional stability. The Root locus concept, construction of root loci.

MODULE T IV FREQUENCY RESPONSE ANALYSIS **12 Hours**

Frequency response of the systems - Correlation between time and frequency responses - Gain and phase margins, Bode plots, Polar Plots, Nyquist stability Criteria.

MODULE V BIOMEDICAL APPLICATIONS **12 Hours**

Examples of Biological control Systems: Cardiovascular Control System, Endocrine Control Systems, Pupil Control System, Skeletal Muscle Servomechanism, Oculo - motor system, sugar level Control Mechanism. Temperature control, Blood pressure control, Example of physiological control system, difference between engineering and physiological control systems, linear models of physiological systems-Examples.

TOTAL PERIODS: 60

TEXT / REFERENCE BOOKS

1. Nagrath J. and Gopal, Control Systems: Engineering, New Age International Pvt. Ltd., Publishers, 7th Edition, 2021.

2. Richard C. Dorf, Robert H. Bishop, “Modern control systems”, Thirteen edition, Pearson, 2017.

3. Gopal M., “Control Systems Principles and Design”, Tata McGraw Hill, 2008.

4. Sinha N.K., Control Systems, 4th Edition, New Age International Pvt. Ltd. Publishers, 2013.

5. Nageswara Rao, Control Systems, 3rd Edition, A.R. Publications, 2003.

6. Michael C.K. Khoo, “Physiological Control Systems”, IEEE Press, Prentice Hall of India, 2018.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basics of physical systems and mathematical model of electrical systems

CO2 - Acquire knowledge to process the physical systems using mathematical expressions.

CO3 - Apply the acquired knowledge to process the physical systems to check the stability.

CO4 - Analyse the various physical systems in both time and frequency domain

CO5 - Investigate the results of various physical systems in their frequency domain

CO6 - Develop the system to analyse the real time biosignals in time and frequency domain.

BMH242	BIOSIGNAL CONDITIONING	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To gain in depth knowledge of fundamentals of operational amplifier circuits and to study the various applications using operational amplifiers.
- To discuss filters and circuits and introduce the application of signal conditioning in biomedical field.

MODULE I INTRODUCTION TO OPAMP **12 Hours**

Introduction, Signal conditioning, 741 General purpose OPAMP: ideal characteristics, offset voltages and currents. Open &Closed Loop Configuration. Inverting, Non-Inverting, Summing Voltage Follower, Integrator, differentiators, Log & Anti-Log Amplifiers, Differential Amplifiers, CMRR.

MODULE II APPLICATION OF OPAMP **12 Hours**

Comparator-Zero crossing detector, Inverting and non-inverting comparator, Schmitt Trigger, Precision Rectifiers-Half wave and Full wave rectifiers, Peak detectors, Monostable, Astable multivibrators, Sawtooth generator, Triangular waveform generator, Sine Wave Generators-RC Phase Shift Oscillator, Wein Bridge oscillator.

MODULE III FILTERS. **12 Hours**

Introduction- Analog Filters, Active Filters and Passive Filters, First order and Second order Low Pass Filters, High Pass Filters, Band Pass Filters- Narrow Band Pass, Wide band Pass Filters, Band Reject Filters- Notch Filter, All Pass filters and higher Order Filters-Design and applications.

MODULE IV DATA CONVERTERS AND TIMERS **12 Hours**

Sample and Hold circuit - D/A converters: Resistive divider and R-2R ladder networks, inverted R-2R DAC. A/D converters: Counting type, Successive approximation, parallel comparator. Voltage to Current Converter, 555 Timer and its applications-Astable multivibrators and Monostable Multivibrator.

MODULE IV BIOMEDICAL AMPLIFIER **12 Hours**

Instrumentation amplifiers, Isolation Amplifiers –Optical and capacitive, Introduction to CMOS-CMOS instrumentation amplifier- voltage and power amplifier. Biomedical application of CMOS.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. Ramakant A Gayakwad, Operational Amplifiers & Linear Integrated Circuits. Prentice Hall, Fourth edition, 2015.
2. Joseph J. Carr & John M. Brown, Introduction to Biomedical Equipment Technology, 4th edition, Pearson Education Pvt. Ltd, 2001.
3. Roy Choudhary &Shail Bala Jain, Linear Integrated Circuits, New Age International (P) Ltd, 2018.

4. DA Bell, Operational Amplifiers and Linear ICs 3rd Edition, 2021.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the working of linear and non-linear applications of operational amplifiers.
CO2 - Analyze waveform generation using operational amplifier.
CO3 - Evaluate the bio filters and isolation circuits used in signal conditioning.
CO4 - Design ADC and DAC using Operational Amplifiers.
CO5 - Examine the construction and working of CMOS and Instrumentation bio amplifiers.
CO6 - Recognize various bio amplifier for Biosignal acquisitions using opamps.

BMH243	BIO VIRTUAL INSTRUMENTATION	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To introduce the concept of virtual instrumentation.
- To enable them to design applications in the field of biomedicine.

MODULE I INTRODUCTION **12 Hours**

Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, data types and data structures, graphical programming in data flow, comparison with conventional programming, Front Panel, and block diagram objects.

MODULE II PROGRAMMING TECHNIQUES **12 Hours**

VIS and sub-VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula modes, local and global variable, string & file input. Publishing measurement data in the web. Flat and Stacked sequence structures - Event structures- Formula Node.

MODULE III DATA COMMUNICATION & SYNCHRONIZATION. **12 Hours**

Local, global, and shared variables – Data Socket - TCP and UDP – Synchronization – Notifiers – Queues - VI Server - configuring the VI Server - Error handling VIs and functions - Debugging tools and techniques.

MODULE IV DESIGN OF INTEGRATED REAL-TIME BIOMEDICAL SYSTEMS

12 Hours

Getting started with LabVIEW Field-Programmable gate array (FPGA) 2 7. Programming using LabVIEW FPGA - Synchronizing FPGA loops and I/O 2 8. Sharing physiological data like ECG, EEG etc, on FPGA.

MODULE V APPLICATION OF VI **12 Hours.**

Fourier Transforms, Power spectrum, Correlation methods, windowing & flittering. Temperature data acquisition system, VI based ECG monitor, ECG and EEG signal Processing, Image acquisition and processing, – ON/OFF controller – P-I-D controller – Emulation of CRO - Simulation of a simple second order system – Generation of HTML page.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. Kevin James, P.C. Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.
2. Gupta S., Gupta J.P., PC Interfacing for Data Acquisition and Process Control, ISA, 2nd Edition, 2004.
3. Technical Manuals for DAS Modules of Advantech and National Instruments, 2008.
4. Jerome, Virtual Instrumentation Using LabView, PHI, 2010.
5. Jon B. Olansen, Eric Rosow, Virtual Bio-Instrumentation: Biomedical, Clinical, and Healthcare Applications in LabVIEW, 200.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basic concepts of virtual instrumentation.
CO2 - Acquire knowledge about the programming techniques in LabVIEW.
CO3 - Apply the knowledge in acquiring real time data.
CO4 - Analyse the integrated real-time design of biomedical systems using LabVIEW.
CO5 - Explore the techniques used to process and analyse bio signals.
CO6 - Develop LabVIEW based real time biomedical devices.

BMH244	ANALYTICAL INSTRUMENTATION	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- The course offers a wide portfolio of study programs in the areas of technology, engineering and sophisticated analytical instrument application in biomedical fields
- It provides an introduction to the fundamental principles, and characterization of various samples by analytical techniques used in medical diagnosis, quality assurance, and research studies.

MODULE I SPECTROPHOTOMETER 12 Hours

The electromagnetic spectrum, the interaction of radiations with the matter, absorption spectra beer Lamberts law, spectrophotometer UV and visible ranges, single and double beam instruments, FTIR, and Raman spectra. Spectrofluorometer, flame photometry, flame emission, atomic absorption spectrometer. Basic principles and biomedical applications.

MODULE II MASS SPECTROPHOTOMETER AND RADIOCHEMICAL INSTRUMENTS 12 Hours

Mass spectrometer, Magnetic detection, Time of flight, quadrupole mass spectrophotometer, GCMS, LCMS, Basic principle, biomedical applications. Radiochemical analytical instruments Radiation types Ionization chamber, GM counter, proportional counter, Liquid scintillation and applications.

MODULE III AUTOMATED BIOCHEMICAL ANALYZERANDELECTROPHORESIS.

12 Hours

System concept, system components, sampler control units, sampling mechanism, dialyzer, SAMAC II Principle of electrophoresis paper electrophoresis agarose gel electrophoresis Iso electric focusing, SDS page, pulse field electrophoresis and its applications.

MODULE IV GAS ANALYZER&POLLUTION MONITORING INSTRUMENTS

12 Hours

Types of gas analyzers-oxygen, NO2, H2S types, IR analyzers, thermal conductivity analyzers. Air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides, Sulphur dioxide estimation, Dust and smoke measurements.

MODULE V CHROMATOGRAPHY 12 Hours

Principles types of chromatography, paper chromatography, thin layer chromatography, column chromatography, ion exchange chromatography, gel permeation chromatography, high-pressure liquid chromatography, HPTLC and applications in biomedical.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. D.A. Skoog, F.J. Holler & T.A. Nieman, Principles of Instrumental Analysis, 7th Edition, 2016.

2. Williard H.H., Merrit, Dean J.A, Seattle F.L, CBS, Instrumental Methods of Analysis 7th Edition, 2005.

3. Ewing G.W., Instrumental Methods of Analysis, McGraw Hill,5th Edition, 2002.

4. Robert D. Braun Introduction to Instrumental Analysis, McGraw Hill, Second Edition 2012.

5. R.S. Khandpur, A Handbook of Analytical Instrumentation, 3rd Edition, Tata McGraw Hill Publication, 2014.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand the elements of UV visible radiation and characterize their spectrum analysis

CO2 - Illustrates the working principle, emission of mass spectrum and radiation chamber

CO3 - Explore the knowledge of electrophoresis and analyzer to separate the constituents from a complex mixture

CO4 - Analyse the analytical methods of industrial gases and pollution monitoring instruments

CO5 - Determines the oxygen level using a gas analyzer by applying both electrostatic and magnetic properties

CO6 - Compares the types of chromatography and their importance and applications in the biomedical field.

BMH351	PATIENT SAFETY STANDARDS AND ETHICS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE:

- To understand the importance of patient safety against electrical hazards
- To explain the patient safety laws and regulations
- To understand the standards and testing of patient
- To know the patient safety specialities in clinical
- To know about the health care organization

MODULE I EFFECTS OF ELECTRICITY **12 Hours**

Physiological effects of electricity - important susceptibility parameters – microshock macroshock hazards -patients electrical environment - isolated power system - conductive surfaces

MODULE II PATIENT SAFETY LAWS AND REGULATIONS **12 Hours**

Mandatory Reporting systems. Anatomy of a patient safety Law: Compliance Tips, Federal patient safety Legislation Initiatives, Medical Device Reporting, Clinical trials and Adverse-Event Reporting, Patient safety Goals and standards, The Quality Assessment and performance Improvement rule.

MODULE III STANDARDS AND TESTING **12 Hours**

Guidelines and safety practices to improve patient safety, Electrical safety codes and standards - IEC 60601-1 2005 standard, Basic Approaches to protection against shock, protection equipmen design, Electrical safety analyser - Testing the electric system

MODULE IV PATIENT SAFETY IN MAIN CLINICAL SPECIALITIES **12 Hours**

Intensive care and Anaesthesiology, safety surgery save lives, Emergency department clinical risk, Obstetric safety patient, Patient safety in internal medicine, Patient safety in Radiology.

MODULE V MEDICAL ETHICS **12 Hours**

Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and the Profession, Professional Independence, The Doctor And Society, Case Studies.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. John G.Webster, “Medical Instrumentation Application and design”, 4th edition, Wiley India PvtLtd, New Delhi, 2015.
2. Liam Donaldson,Walter Ricciardi, “Textbook of patient safety and clinical Risk management”, Springer.
3. Fay A. Rozovsky, James R. Woods, Jr, “ The Handbook of Patient Safety Compliance”, 2016.

COURSE OUTCOME:

At the end of this course, the student will be able to

CO1: Outline the importance of patient safety against electrical hazards.

CO2: Brief out the patient safety laws and regulations

CO3: Explain the standards and testing of patient

CO4: Understand the concept of the patient safety specialities in clinical

CO5: To know about various health care organization

BMH352	MEDICAL DEVICE REGULATIONS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVES:

The objective of this course is to enable the student to

- To study the regulation of medical devices, process of development, ethical and quality considerations.
- To learn the various ISO standards of quality and risk management for regulatory purposes
- To explore the process of approval and marketing of medical devices.
- To comprehend the regulatory process for medical devices in India, US, and EU.
- To familiarize with clinical evaluation and investigation of medical devices.

MODULE I MEDICAL DEVICE REGULATIONS 12 Hours

History of medical device regulation, regulatory affairs professional's roles, required competencies, medical device classification: scope, definitions, main classifications, Risk based classification, practical examples, labelling of medical devices: definition, elements, risk management, clinical evaluation and labelling, language level and intended users. Differentiating medical devices IVDs and combination products from that of pharmaceuticals.

MODULE II ISO STANDARDS 12 Hours

ISO 13485:2016: Requirements for regulatory purposes: Quality Management Systems, certification process. ISO 14971: Application of Risk management to medical Devices.

MODULE III EC, REGULATORY SYSTEMS IN USA & EU 12 Hours

IEC international standards and conformity assessment for medical devices, Good submission process, medical device regulatory system in the USA and European Union.

MODULE IV INDIAN REGULATORY SYSTEM 12 Hours

India: Medical device regulatory system: market environment, functions undertaken by DGGI, central government, FDA and state governments, guidance documents, details of key regulators, IMDRF and CDSCO, regulatory overview in India, product registration on conformity assessment, quality system regulation, technical material and labelling requirements, commercial aspects, upcoming regulation changes.

MODULE V CLINICAL TRIALS AND DIGITAL REGULATIONS 12 Hours

Regulatory strategy and competitive advantage, Preclinical and Clinical Trial Design for Medical Devices in India; FDA approved devices, post-market surveillance/vigilance, Digital health regulations: Connected care, intelligent design control, reducing design time and cost with silico clinical trials

TOTAL: 60 PERIODS

TEXTBOOKS:

1. Medical Regulatory Affairs: An International Handbook for Medical Devices and Healthcare Products, 3rd Edition, Taylor & Francis Group, 2021

REFERENCES:

1. Reliable Design of Medical Devices, Second Edition by Richard Fries, CRC Press, 2006

2. Medical Device Quality Assurance and Regulatory Compliance by Richard C Fries, CRCPress, 1998.

3. Product Safety in the European Union by GaborCzitan, Attila Gutassy, Ralf Wilde, TUVRheinl and Akademia, 2008.

ONLINE RESOURCES

1. Regulatory requirements for medical devices including in vitro diagnostics in India (Version 2.0), IIT Madras, Prof. Arun B.Ramteke, Prof. Aseem Sahu, Prof. Malay Mitra. https://nptel.ac.in/courses/127106136

2. World Health Organization. (2003). Medical device regulations : global overview and guiding principles. World Health Organization. https://apps.who.int/iris/handle/10665/42744

3. FOOD AND DRUG ADMINISTRATION USA, http://www.fda.gov/medicaldevices/deviceregulationandguidance/default.htm

COURSE OUTCOMES:

On completion of the course, the student should be able to:

CO1: Define and explain the basic concepts of medical device regulations.

CO2: Decipher the meaning of ISO standards from a regulatory perspective.

CO3: Explain US-FDA, IEC and European regulations.

CO4: Discuss regulations in India

CO5: Explain the regulatory aspects of clinical trials and digital alternatives.

BMH353	BIOMEMS AND NANOTECHNOLOGY	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- The students should be made to acquire knowledge about the basic principles of MEMS and its fabrication
- To understand the concepts of nanotechnology and its applications.

MODULE I MEMS & MICROSYSTEMS **12 Hours**

Fundamentals and basics of MEMS and Microsystems, the origin of MEMS, Types of MEMS materials and their properties, working principles of Microsystems, Microsensors, Microactuators Integrated MEMS, Applications of MEMS the in the health care industry, MEMS&NEMS technology.

MODULE II MEMS FABRICATION TECHNOLOGY **12 Hours**

Lithography, Etching Dry-wet etching, Electrochemical etching thin film deposition, LPCVD, Sputtering, evaporation, electroplating, wafer bonding, coating technology, Bulk and Surface Micromachining, LIGA process, Intelligent materials.

MODULE III MOEMS & MICROFLUIDICS **12 Hours**

Fundamentals of MOEMS Technology-light modulators Beam splitter, Micro lens Micro-mirrors –Digital Micro mirror Devices, Light detectors. Fundamentals of Microfluidics, LAB-ON-A-Chip devices, Silicon and glass micromachining for Micro total analysis system

MODULE IV NANOMATERIALS& ITS CHARACTERIZATION **12 Hours**

Nanomaterials –Introduction- synthesis of nanomaterials physical, chemical & Biological method Nanomaterial characterization, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, X-ray diffraction, Raman Analysis, Nanorobotics for surgery.

MODULE V NANO BIOSENSORS AND ITS APPLICATIONS **12 Hours**

Nano biosensors for living cells, carbon nanotubes. Synthesis & monitoring antigen-antibody reactions. DNA chips, cantilever-based Nanosensors, nanotoxicology, and medical applications for nanotechnology.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. Tai-Ran Hsu, MEMS & Microsystem, Design and manufacture, and Nanoscale Engineering John Wiley & Sons,2nd edition 2008.
2. Wanjun Wang & Steven. A. Aopers BioMEMS-Technologies and Applications CRC Press, First edition 2007.
3. Marc J. Madou, Fundamentals of Microfabrication and Nanotechnology, 3rd Edition, Three-Volume Set, CRC Press 2011.
4. Mohamed Gad-el-Hak, The MEMS Handbook, CRC Press, Second Edition 2019.

5. Gerald A. Urban BioMEMS Springer, First Edition 2006.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understands the concepts of MEMS and its integration process.

CO2 - Analyze the fabrication of MEMS devices and micromachining technology.

CO3 - Examine the basic principles, synthesis of MOEMS, and micro total analysis system.

CO4 - Design a protocol for synthesizing nanoparticles by various methods.

CO5 - Interpret the methods adopted to characterize the nanomaterials by analytical techniques.

CO6 - Create a nano biosensor device in a miniaturized form for the well-being to society.

BMH354	3D PRINTING FOR BIOMATERIALS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To provide opportunities for training and research in all aspects of 3D printing. To educate the students in the development of high-quality printing technology to provide a satisfactory environment to the manufacturing sector.
- To implement 3D printing in the health care industry for the future betterment of society.

MODULE I DIGITAL MANUFACTURING FOR 3D PRINTIN 12 Hours

Introduction- Definition of 3D Printing, Terminologies, Types additive manufacturing operations- Stereolithography (SLA), Digital Light Processing (DLP), Fused Deposition Modeling (FDM), Selective laser sintering (SLS), Selective Laser Melting (SLM), Electron Beam Melting (EBM), Details of Laminated Object Manufacturing (LOM); Granular Materials Binding, 3D innovative printers and application.

MODULE II DESIGN FOR 3D PRINTING 12 Hours

DESIGN FOR 3D PRINTING Design criteria, Design consideration, Types of fast filament fusion support, Top-Down support structures, designing for selective Laser Sintering, Designing for material Jetting, OBJ-VRML files, CAD-STL files, Rules for STL format.

MODULE III 3D PRINTING EVOLVING. 12 Hours

Introduction, Development of physical goods, Nomenclature; milestones of 3D systems, Nontraditional manufacturing innovative technique, shorter lead time and design freedom, 3D printing possibilities, The digital model, CAD software- 3D scanners process, 3D printing pen, 3D printing geometry restrictions, STL file, Professional and home 3D printers, 3D printers improvements, Phases of rapid prototyping to home fabrication.

MODULE IV ADDITIVE MANUFACTURING 12 Hours

Limited prototyping, Hazards of printing materials, 3D printing state and federal laws, Steps towards AM cybersecurity, 3D printing in forensic science, ethics and legality of 3D printing, Intricacy of 3D printing, Impact of 3D printing, 3D printing impact on global manufacturing, Revolutionizing mass manufacturing, Advance perception of additive manufacturing.

MODULE V 3D PRINTING IN HEALTH CARE 12 Hours

Bone reconstructive surgery, living tissues- Bio printing 2D and 3D tissues Bio ink components, Hydrogels for Bio printing; Implants of printed organs- Human Ear, Kidneys artificial liver, Bio printing skin, Bio printing nerves, 3D printed ovaries, obstacles to bio printing organs, 3D Bio-Printing, 3D Printing for implant and medical device- Hearing Aid, sensor arm, Knee replacement, Aorta, dental implants, 3D print future medical implants.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. Sabrie Soloman,3D printing and design, Khanna Book Publishing Co., (P) Ltd., 2020.

2. Ad van Wijk and Iris van Wijk, 3D PRINTING WITH BIOMATERIALS TOWARDS A SUSTAINABLE AND CIRCULAR ECONOMY, Published by IOS Press, under the imprint Delft

3. University Press. 2020.

4. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2nd Edition. 2015

5. Andreas Gebhadt, Julia Kessler, and Laura Thurn, 3D Printing Understanding Additive Manufacturing, Second Edition, Science Direct, 2019.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand the basic principles of 3D printing.

CO2 - Outline the problem encountered during the design for 3D printing.

CO3 - Recognize the importance and future scope of 3D printing and evolve.

CO4 - Demonstrate the types of additive manufacturing in 3D printing technology.

CO5 - Application of 3D printing in the health care system.

CO6 - Identify the importance of 3D printing in health care systems.

BMH461	BIO –TELEMETRY	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE:

- To gain basic knowledge of different transmission techniques for analog and digital signals and to provide information about the modulation techniques.

MODULE I TELEMETRY **12 Hours**

Basic system - Classification - Non electrical telemetry systems - Mechanical and Pneumatic type, Voltage and Current telemetry systems - Local transmitters and Converters - Frequency telemetry system - Power Line carrier communication (PLCC) .

MODULE II AMPLITUDE MODULATION **12 Hours**

Modulation - Need of modulation Mathematical representation of AM (AM, DSB - SC - AM, SSB - SC AM, VSB AM) - Frequency spectrum - Bandwidth - power relation - Generation of FM - square law modulator and Balanced modulator - AM transmitter - Detection of AM: square law detector - envelope detector - AM receiver – TRF and super heterodyne receiver.

MODULE III ANGLE MODULATION **12 Hours**

Mathematical representation of Frequency modulation- Frequency spectrum - Band Width , Generation of frequency modulation - Varactor Diode modulator - Armstrong modulator , FM transmitter , FM detection- Foster Seely discriminator - Ratio detector - FM receiver.

MODULE IV DIGITAL MODULATION AND MULTIPLEXING **12 Hours**

Sampling - Quantization - Pulse Modulation: Overview of Pulse amplitude modulation, Pulse position modulation, Pulse width modulation and Delta modulation - Data Transmission: Overview of Amplitude shift keying, Frequency shift keying, Phase shift keying and QPSK - Multiplexing: Overview of Time Division Multiplexing, Frequency Division Multiplexing -.

MODULE V APPLICATION OF BIOTELEMETRY **12 Hours**

Wireless Telemetry - Single Channel Telemetry systems - Multi channel Telemetry systems - Multi Patient Telemetry - Implantable Telemetry Systems - Ambulatory patient monitoring, remote monitoring

TOTAL PERIODS: 60

TEXT / REFERENCE BOOKS

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1. R. S. Khandpur, Hand Book of Biomedical instrumentation, Tata McGraw Hill Publication, 2005.
2. 2. Taub and Schilling, Principles of Communication, Tata McGraw Hill Publication, 3rd edition, 2008.
3. 3. D. Patranabis, Telemetry Principles, Tata McGraw Hill Publication, 1999.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

CO1. Apply the concepts and the principles in Telemetry system.
CO2. Build the blocks to make a telemetry system.
CO3. Know the transmission and reception of a system.
CO4. Know about how optical fibers are used in signal transmission.

BMH462	HUMAN ASSIST DEVICE	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVES:

- To study the role and importance of machines that takes over the functions of the heart and lungs,
- To study various mechanical techniques that help a non-functioning heart.
- To learn the functioning of the unit which does the clearance of urea from the blood
- To understand the tests to assess the hearing loss and development of electronic devices to compensate for the loss.
- To study about recent techniques used in modern clinical applications

MODULE I HEART LUNG MACHINE AND ARTIFICIAL HEART 12 Hours

Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and

Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Schematic for temporary bypass of left ventricle.

MODULE II CARDIAC ASSIST DEVICES 12 Hours

Assisted through Respiration, Right and left Ventricular Bypass Pump, Auxiliary ventricle, Open Chest and Closed Chest type, Intra-Aortic Balloon Pumping, Prosthetic Cardiac valves, Principle of External Counter pulsation techniques.

MODULE III ARTIFICIAL KIDNEY 12 Hours

Indication and Principle of Haemodialysis, Membrane, Dialysate, types of filter and membranes,

Type.

MODULE IV RESPIRATORY AND HEARING AIDS 12 Hours

Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, SISI, masking techniques, wearable devices for hearing correction.

MODULE V RECENT TRENDS 12 Hours

Transcutaneous electrical nerve stimulator, bio-feedback, Diagnostic and point-of-care platforms.

TOTAL PERIODS: 60

TEXT BOOKS:

1. Gray E Wnek, Gray L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering –Marcel Dekker Inc New York 2004.

2. John. G . Webster – Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd - 2004

3. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006

REFERENCES:

1. Andreas.F. Von racum, “Hand book of bio material evaluation”, Mc-Millan publishers, 1980.

2. Gray E Wnek, Gray L Browlin, “Encyclopedia of Biomaterials and Biomedical Engineering” Marcel Dekker Inc New York 2004.

COURSE OUTCOMES:

At the end of this course the students will be able to:

CO1: Explain the principles and construction of artificial heart

CO2: Understand various mechanical techniques that improve therapeutic technology

CO3: Explain the functioning of the membrane or filter that cleanses the blood.

CO4: Describe the tests to assess the hearing loss and development of wearable devices for the same.

CO5: Analyze and research on electrical stimulation and biofeedback techniques in rehabilitation and physiotherapy.

BMH463	ERGONOMICS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To get exposed to principles of visual capabilities.
- To learn the mechanics of muscle physiology and significance of rest cycle.
- To learn spatial compatibility and the relation between control orders and control response.
- To know about the measurements and proportions of the human body.
- To be familiar with the mathematical models, analysis and design of biomedical devices using case studies.

MODULE I VISUAL AND AUDITORY ERGONOMICS 12 Hours

Process of seeing – visual capabilities – factors affecting visual acuity and contrast sensitivity – human factor aspects of hard copy text and computer screen text, factors in selecting graphic representations symbols, qualitative visual display – process of hearing – principles of auditory display. Measures for monitoring control & mitigation.

MODULE II MUSCLE PHYSIOLOGY 12 Hours

Muscle physiology – muscle metabolism – respiratory response – joint motion study – measure of physiological in-efficiency and energy consumption – work rest cycles – aspects of manual and posture study, material handling (MMH) Bio-mechanical recommended limits of MMH.

MODULE III CONTROLS AND DISPLAYS 12 Hours

Spatial compatibility and physical arrangement of displays and controls - Design of displays and controls – movement capability – rotary controls and rotor displays movement of displays orientation of the operator and movement relationships control orders and control responses – human limitations in tracking task

MODULE IV ANTHROPOMETRY 12 Hours

Anthropometry – anthropometric design principles – Physical work load and energy expenditure - work space envelope – factors in design of work space surfaces – principles of seat design – principles of control panel. Ergonomic implications. Organization classification of human errors theories of accident causation-reducing accidents by altering behaviour.

MODULE V CASE STUDIES 12 Hours

Case Study 1: computer design, control panel design of an electronic instrument, computer key board, hand drill etc.

Case Study 2: Biomedical Application, Design optimization of Medical Equipment.

TOTAL PERIODS: 60

TEXT BOOKS:

1. Pascale Carayon, “Handbook of Human Factors and Engineering”, Second Edition, CRC Press, 2011

2. Martin Helander, “Guide to Human Factors and Ergonomics”, Second Edition, CRC

Press,2005

3. Benjamin W.Niebel, “Motion and Time Study”, Richard, D. Irwin Inc., Seventh Edition, 2002

REFERENCES:

1. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press2007.

2. George Kanawaty, “Introduction to work study”, ILO, 3rd edition, Oxford & IBH publishing, 2001

3. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, 2005.

COURSE OUTCOMES:

At the end of the course student will be able to,

CO1: Understand principles of ergonomics.

CO2: Understand the significance of posture

CO3: Learn about tracking tasks.

CO4: Learn about ergonomics and its implications to various domain

CO5: Perform case studies on electronic instruments and medical equipment.

BMH464	MEDICAL ETHICS & IPR	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- Achieve familiarity with some basic ethical frameworks & understand how these ethical frameworks can help us to think through contemporary questions in medical ethics.
- Know about the legal and ethical principles and application of these principles in health care settings.

MODULE I INTRODUCTION TO MEDICAL ETHICS 12 Hours

Definition of Medical Ethics, Scope of Ethics in Medicine, American Medical Association Code of Ethics, CMA Code of Ethics- Fundamental Responsibilities, The Doctor and the Patient, The Doctor and the Profession, Professional Independence, The Doctor, and Society.

MODULE II ETHICAL THEORIES AND MORAL PRINCIPLES 12 Hours

Theories - Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Principles Non- Maleficence, Beneficence, Autonomy, Veracity, Justice. Autonomy & Confidentiality issues in medical practice, Ethical Issues in biomedical research, and Bioethical issues in Human Genetics & Reproductive Medicine.

MODULE III UNDERSTANDING AND OVERVIEW OF IPR REGIME 12 Hours

Introduction to IPR, types of intellectual property, need for intellectual property rights, the rationale for the protection of IPR, the impact of IPR on the protection of development, health, agriculture, and genetic resources, IPR in India – Genesis and development, IPR in abroad – Some important examples of IPR, International organizations, agencies.

MODULE IV PATENTS 12 Hours

Definition, kind of inventions protected by patents - Patentable and non-patentable inventions, Process, and product patents, legal requirements for patents, granting of a patent – rights of patent – exclusive right, the patent application process, searching a patent, drafting of a patent, filing of a patent, types of patent applications, patent documentation - specification and claims, Management of IP assets and IP portfolio.

MODULE V COPYRIGHTS 12 Hours

Rights and protection covered by copyrights - law of copyrights, fundamentals of copyright law, originality of materials, rights of reproduction, rights to perform the work, copyright ownership issues, obtaining copyright registration, a notice of copyright, international copyright law, Infringement of copyright under the copyright act, Related rights – the difference between related rights and copyrights, celebrity rights

TOTAL PERIODS: 60.

TEXT BOOK / REFERENCE BOOK

1. Nils Hoppe and Jose Miola, “Medical law and Medical Ethics”, Cambridge University Press 2014.
2. Robert M Veatch,” Basics of Bio-Ethics”, Second Edition. Prentice-Hall, Inc, 2018

3. Fundamentals of IP for engineers K. Bansal and P. Bansal

4. Intellectual Property rights Deborah E Bouchoux, Cengage learning

5. Intellectual property rights – NPTEL resource

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Identify the scope of medical ethics

CO2 - Illustrate the concepts of ethical theories and moral principles for the health professions

CO3 - Identify criteria to fit one own intellectual works in a particular form of IPRs

CO4 - Apply statutory provisions to protect particular forms of IPRs

CO5 - Identify procedures to protect different forms of IPRs national and international level

CO6 - Analyze rights and responsibilities of the holder of patents, copyrights, and industrial designs.

BMH571	VR AND AR IN BIOMEDICAL APPLICATIONS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To understand virtual reality, and augmented reality and use them to build Biomedical engineering applications.
- To know the intricacies of these platforms to develop PDA applications with better optimality.

MODULE I INTRODUCTION **12 Hours**

Introduction to AR and VR. Difference between AR and VR. The three I 's of virtual reality-Components of AR and VR technology - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers navigation and manipulation interfaces and gesture interfaces. Output Devices: Graphics displays-sound displays.

MODULE II VR DEVELOPMENT PROCESS AND CONTENT CREATION CONSIDERATIONS FOR VR **12 Hours**

Geometric modeling-kinematics modeling-physical modeling, behavior modeling, model Management. Methodology and terminology-user performance studies-VR health and safety issues-Usability of virtual reality system-cyber sickness effects of exposures to virtual reality environment

MODULE III STEREOSCOPIC VISION & HAPTIC RENDERING **12 Hours**

The human optical system, Depth cues, Stereopsis, Retinal disparity, Haptic sense, Haptic devices, Haptic rendering and parallax algorithms, Stereo pairs Synthesis, and Stereo images pipelines.

MODULE IV SOFTWARES FOR AR AND VR **12 Hours**.

AR software, Camera parameters and calibration, AR based on markers, and AR Toolkit. JS-pros and cons-building blocks (WebVR, WebGL), Three.js, device orientation events) frameworks (A-frame, React VR)-Google VR for Android-Scripts, mobile device configuration, building to android-cameras and interaction-teleporting-spatial audio-Assessing human parameters device development and drivers-Design Haptics.

MODULE V APPLICATIONS **12 Hours**

Medical applications-military applications-robotics applications-Advanced Realtime Tracking of other applications-games, movies, simulations, therapy

TOTAL PERIODS: 60.

TEXTBOOK / REFERENCE BOOK

1. C. Burdea & Philippe Coiffet, Virtual Reality Technology, Second Edition, Gregory, John Wiley & Sons, Inc., 2008
2. Jason Jerald, 2015.TheVRBook: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA,.2015.

3. Augmented Reality: Principles and Practice (Usability)by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016.

4. Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, Tony Parisi, O'Reilly Media;1edition, 2015.

5. Vasanth Mohan, Creating Augmented and Virtual Realities: Theory and Practice for Next-Generation Spatial Computing, Shroff/O'Reilly, 2019.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understands the system or process to meet given specifications with realistic engineering constraints

CO2 - Identify problem statements and function as a member of an engineering design team.

CO3 - Examine the Stereoscopic vision and haptic rendering

CO4 - Explore the various software used for the development of AR and VR

CO5 - Apply the concepts of AR and VR to medical and industrial applications

CO6 - Design various medical applications based on augmented reality.

BMH572	AI FOR HEALTHCARE	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To develop fundamental knowledge in the area of artificial intelligence and to establish useful applications for it
- To organize and model a complex issue as a state space, then use intelligent search techniques to identify the most effective solutions
- To design and create methods for making decisions in challenging, unpredictable situations.

MODULE I INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND PROBLEM-SOLVING AGENT 12 Hours

Introduction–Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem-Solving Approach to Typical AI Problems.

MODULE II INFORMED SEARCH ALGORITHMS. 12 Hours

Informed Search - Introduction to Heuristics – Greedy Breadth First Search, A* - Local Search Optimization Algorithms - Hill Climbing, Simulated Annealing.

MODULE III OPTIMAL SEARCH ALGORITHMS. 12 Hours

Global optimization algorithms - Genetic Algorithms, Particle Swarm Optimization Algorithm, Ant Colony Optimization, Gravitational Search Algorithm - Games – Optimal Decisions in Games - Minimax Algorithm, Alpha-Beta Pruning Algorithm.

MODULE IV KNOWLEDGE REPRESENTATION AND REASONING. 12 Hours

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation – Ontological Engineering-Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories – Reasoning with Default Information.

MODULE V DECISION THEORY AND PLANNING. 12 Hours

Basics of utility theory, decision theory, sequential decision problems, decision networks, elementary game theory, Planning: planning as search, partial order planning, construction and use of planning graph.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. Russell S and Norvig P, Artificial Intelligence – A Modern Approach, 3rd Edition, Prentice Hall, 2015.
2. Elaine Rich, Kevin Knight, Shivashankar B Nair., “Artificial Intelligence”, 3rd Edition, McGraw Hill Education, 2017.
3. Wolfgang Ertel,” Introduction to Artificial Intelligence”, Second Edition, Springer, 2017.

4. Stephen Lucci and Danny Kopec," Artificial Intelligence in the 21st Century, Second Edition, Mercury Learning and Information, 2015.

5. David L. Poole and Alan K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Second Edition, Cambridge University Press, 2017.

6. Saroj Kaushik, "Logic & Prolog Programming", New Age International, Ist edition, 2002.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Demonstrate a fundamental understanding of the evaluation of Artificial Intelligence (AI) and its foundations.

CO2 - Elucidate the basic knowledge representation, problem-solving, and learning methods of Artificial Intelligence

CO3 - Apply basic principles of AI in solutions that require problem-solving through Optimal Search Algorithms

CO4 - Demonstrate working knowledge of reasoning in the presence of uncertain information and show how search algorithms are essential for problem-solving

CO5 - Illustrate the importance of artificial intelligence and planning in solving real-world problems

CO6 - Design applications for healthcare that use Artificial Intelligence.

BMH573	DEEP LEARNING FOR BIOMEDICAL APPLICATIONS	L	T	P	Credits
		3	1	0	4

COURSE OBJECTIVE

- To gain knowledge on the concepts of deep learning
- To provide insight into recent CNN architectures and deep models
- To enable the students to know deep learning techniques to support real-time applications.

MODULE I FOUNDATION OF NEURAL NETWORKS AND DEEP LEARNING. 12 Hrs

Neural Networks-Training neural networks, Activation Functions, Loss functions, Hyperparameters, Fundamentals of Deep Networks-Defining Deep Learning, Common Architectural Principles of Deep Networks, Parameters, Layers, Activation Functions, Loss Functions, Optimization Algorithms, Hyperparameters.

MODULE II CONVOLUTION NEURAL NETWORKS. 12 Hours

Architectural Overview – Input Layers, Convolutional Layers, Pooling Layers, Fully Connected Layers – Filters – Parameter sharing – Regularization, Popular CNN Architectures: ResNet, AlexNet.

MODULE III RECURRENT AND RECURSIVE NETS - SEQUENCE MODELLING.

12 hours

Recurrent Neural Networks, Bidirectional RNNs, Encoder-decoder sequence to sequence architectures - BPTT for training RNN, Long Short-Term Memory Networks

MODULE IV AUTO ENCODERS AND DEEP GENERATIVE MODELS. 12 Hours

Introduction to Android, Creating Android Activities, Android User interface design, Access Wi-fi and Bluetooth with mobile applications-Web based App for e-health applications.

MODULE V RECENT TRENDS IN DEEP LEARNING. 12 Hours

Recent Models of Deep Learning, Genomics, Predictive Medicine, Clinical Imaging, Lip Reading, Visual Reasoning.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
2. Wei Di, Anuragh Bharadwaj, “Deep Learning Essentials”, Jianing Wei, Packt Publishers, 2018.
3. Nikhil Buduma, Nicholas, “Fundamentals of Deep Learning”, O Reilly Media, 2017.
4. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016. Suraj Sawant. “Deep Learning”, IGI Global, 2018.
6. Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” A press, 2018.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Ability to differentiate the concept of machine learning with deep learning techniques

CO2 - Understand and visualize Convolutional Neural Networks for real-world applications

CO3 -Demonstrate the use of Recurrent Neural Networks and Transformer based for time series prediction

CO4 -Illustrate autoencoder and deep generative models to solve problems with high dimensional data

CO5 - Design and develop an application-specific deep-learning model

CO6 - Analyse the latest trends in deep learning

BMH574	MEDICAL BIG DATA ANALYTICS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To understand the underlying concepts of Big Data.
- To study the various tools used for Big Data Analytics
- To apply Big Data in the field of health care systems and Biomedical Data.

MODULE I INTRODUCTION. 12 Hoirs

Introduction to Big Data – Issues and Challenges in the traditional systems - Evolution of Big Data – Four V's of Big Data – Big Data Use Cases and Characteristics – Intelligent Data Analysis – Data Analytic Tools – Big Data Storage Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error – Random Sampling.

MODULE II HADOOP AND NoSQL. 12 Hour

Introduction to Hadoop – Hadoop Distributed File System – Analyzing data with Hadoop – Scaling – Streaming – Clustering: Single Node and Multi-Node – Working with Hadoop Commands – Working with Apache Oozie- Introduction to NoSQL- NoSQL business drivers-; NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores - Variations of NoSQL architectural patterns; Big data NoSQL solution- Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer.

MODULE III BIG DATA TOOLS AND MAP REDUCE. 12 Hour

Big Data Applications using Pig and Hive – Fundamentals of HBase and ZooKeeper – IBM Infosphere Big Insights – Introduction to FLUME – KAFKA. Algorithms using map-reduce - Matrix-Vector – Multiplication – Word Count - Understanding inputs and outputs of MapReduce, Data Serialization – Introduction to YARN – MapReduce Vs YARN – YARN Architecture – Scheduling in YARN – Fair Scheduler – Capacity Scheduler.

MODULE IV MINING DATA STREAM AND FRAMEWORKS 12 Hour

Mining Data Stream: Introduction to Streams Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, estimating moments, counting oneness in a Window, Decaying Window, Real-time Analytics Platform (RTAP) applications, - Using Graph Analytics for Big Data: Graph Analytics.

MODULE V SOURCES AND TECHNIQUES FOR BIG DATA IN HEALTHCARE

12 Hour

Motivation for Big data analytics in Health care-Structured EHR Data – Unstructured Clinical Notes – Medical Imaging Data – Genetic Data – Epidemiology & Behavioral data analysis. TOTAL **PERIODS: 60**

TEXT BOOK / REFERENCE BOOK

1. Chris Eaton, Dirk deroos et al., "Understanding Big data", McGraw Hill, 2012.
2. Tom White, "HADOOP: The Definitive Guide", O Reilly 2012.

3. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packet Publishing 2013.

4. Jimeng Sun, Chandan K. Reddy, Big Data Analytics for Healthcare, IBM Wayne State, http://dmkd.cs.wayne.edu/TUTORIAL/Healthcare.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand the fundamentals of Big Data

CO2 - Analyze the usage of HADOOP and NoSQL in Big data

CO3 - Familiarize tools used for Big Data

CO4 - Comprehend the data mining concepts and Frameworks.

CO5 - Apply the concepts of Big Data in the field of healthcare

CO6 - Develop Big data solutions for healthcare applications

COURSES FOR MINOR DEGREE (MEDICAL INSTRUMENTATION)

BMM001	PHYSIOLOGICAL CONTROL SYSTEMS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVES:

1. To discuss the mathematical modeling of systems.
2. To distinguish physiological and engineering control system.
3. Learn the time response of feedback control systems.
4. Learn the different methods of stability analysis (in time domain and frequency domain).

MODULE I **12 Hours**

MODELING OF SYSTEMS: The control system, Mathematical models of physical systems – Introduction, Differential equations of physical systems – Mechanical systems, Friction, Translational systems (Mechanical accelerometer, Levered systems excluded), Rotational systems, Electrical systems, Analogous systems.

MODULE II **12 Hours**

INTRODUCTION TO PHYSIOLOGICAL CONTROL SYSTEMS: Preliminary considerations, Historical Background, System analysis, Physiological systems-A simple example, Differences between engineering & physiological control systems.

MATHEMATICAL MODELING: Generalized system properties, Models with combination of system elements, Linear models of physiological systems-respiratory and muscle mechanics. Linearized respiratory mechanics.

MODULE III **12 Hours**

TIME RESPONSE OF FEEDBACK CONTROL SYSTEMS: Standard test signals, Unit step response of First and second order systems, Time response specifications, Time response specifications of second order systems, steady – state errors and error constants.

STATIC ANALYSIS OF PHYSIOLOGICAL SYSTEMS: regulation of cardiac output, regulation of glucose, chemical regulation of ventilation.

MODULE IV **12 Hours**

STABILITY ANALYSIS: Concepts of stability, Necessary conditions for Stability, Routh- stability criterion, Relative stability analysis; More on the Routh stability criterion..

ROOT–LOCUS TECHNIQUES: Introduction, The root locus concepts, Construction of root loci and its plots.

MODULE V **12 Hours**

STABILITY IN THE FREQUENCY DOMAIN: Mathematical preliminaries, Nyquist Stability criterion, Assessment of relative stability using Nyquist criterion

FREQUENCY DOMAIN ANALYSIS: Introduction, Correlation between time and frequency response, Bode plots.

Verifying the parameters computed for numerical examples using MATLAB for Root locus, Bode Plot and Nyquist Plot.

TOTAL PERIODS: 60

COURSE OUTCOMES: The students will be able to

CO1: Understand and develop mathematical modeling of mechanical & electrical systems.

CO2: Mathematically model the physiological systems & relate it to the Engineering control system.

CO3: Understand and determine the time domain parameters of first and second order system.

CO4: Apply the different methods of stability analysis in time domain.

CO5: To understand the stability in frequency domain

TEXT BOOK :

1. Control Systems Engineering, J. Nagarath and M.Gopal, New Age International (P) Limited, Fourth edition ,2005.

2. Physiological Control Systems – Analysis, Simulation & Estimation, Michael C Khoo, Wiley IEEE press.

REFERENCE BOOKS:

1. Modern Control Engineering , K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002.

2. Concepts of Control Systems, P. S. Satyanarayana; Dynaram publishers, 2001.

BMM002	BIOMEDICAL EQUIPMENTS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVES:

1. To study spectrophotometer, clinical flame photometer.
2. To study different blood gas analyzers
3. To study different types of Audiometers
4. To understand the working principle of surgical diathermy.
5. To study hemodialysis and different ventilators

MODULE I **12 Hours**

CLINICAL LABORATORY INSTRUMENTS: Medical diagnosis with clinical tests, spectrophotometry-components, clinical flame photometer, and ion-selective electrode based analyzers.

MODULE II **12 Hours**

BLOOD GAS ANALYZERS: Acid-base balance, blood pH measurement, measurement of blood pCO2, measurement of blood pO2, intra-arterial blood gas monitoring, and complete blood gas analyzer. BLOOD **CELL COUNTERS**: Types of blood cells, Coulter counter, automatic recognition and differential counting of cells.

MODULE III **12 Hours**

AUDIOMETER AND HEARING AIDS:

Mechanism of hearing, measurement of sound, basic audiometer, pure-tone audiometer, speech audiometer, audiometer system Bekesy, evoked response audiometer system, hearing aids-digital hearing aid, cochlear implants.

MODULE IV **12 Hours**

INSTRUMENTS OF SURGERY:

Principles of surgical diathermy, surgical diathermy machine, automated electro-surgical systems, electrodes used with surgical diathermy, safety aspects in electrosurgical units, surgical diathermy analyzer.

PHYSIOTHERAPY AND ELECTROTHERAPY EQUIPMENTS:

High frequency ,heat therapy, short wave diathermy, microwave diathermy, ultrasound therapy unit, electro diagnostic therapeutic apparatus, pain relief through electrical stimulation ,bladder and cerebral stimulators

MODULE V **12 Hours**

HAEMODIALYSIS MACHINE:

Function of kidney, artificial kidney, dialyzer, membranes for hemodialysis, portable kidney machine.

VENTILATORS: Mechanics of respiration, artificial ventilation, ventilators, types of ventilators, ventilator terms, classification of ventilators, pressure volume flow diagrams, modern ventilators, high frequency ventilators, humidifiers, nebulizers and aspirators

TOTAL PERIODS: 60

COURSE OUTCOMES: On the completion of the course the students will be able to

CO1: Understand the working & application of clinical lab instruments.

CO2: Understand the measurement of blood gas analyzers, blood cell counters.

CO3: Understand the human hearing mechanism, identify the defects in hearing mechanism and adapt the hearing aids.

CO4: Understand the working of surgical equipments and the functioning of various physiotherapy equipments.

CO5: Understand the functioning of kidney and working of artificial kidney and the functioning of breathing mechanism and ventilators

TEXT BOOK:

1. Handbook of Biomedical Instrumentation – by R.S.Khandpur, 2nd Edition, Tata McGraw Hill, 2003

REFERENCE BOOK:

1. Biomedical Instrumentation and Measurement – by Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, Prentice-Hall India Pvt. Ltd.

BMM003	INFRARED IMAGING & APPLICATIONS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVES: To enable the student learn

1. To Understand the scope and practice of the field of infrared imaging system

2. To Understand the basic techniques used in thermography

3. To Examine and grasp the principle of camera and image acquisition techniques

4. To identify and Demonstrate proficiency in developing applications

MODULE I **12 Hours**

INTRODUCTION TO THERMOGRAPHY: Principles of black body radiation laws: Blackbody, Plank's law, Wien's displacement law, Stefan Boltzmann Law, Emissivity, IR absorption characteristics, Radiometric measurements.

MODULE II **12 Hours**

HEAT TRANSFER MECHANISMS AND MEASUREMENTS: Heat and Temperature, Heat Transfer Mechanism, Principle of Conduction, Convection and Radiation, Temperature measurements: Contact and Non contact.

MODULE III **12 Hours**

PRINCIPLE OF INFRARED CAMERA: Detector performance parameters: Responsivity, Noise Equivalent Power, Specific detectivity, System performance parameters: Temperature range, Accuracy, Thermal sensitivity,Minimum Resolvable Temperature Difference (MRTD), Calibration of IR camera.

MODULE IV **12 Hours**

PASSIVE AND ACTIVE TECHNIQUES: Passive Thermography, Active Thermography: Pulsed Thermography, Pulsed Phase Thermography, Vibro Thermography, Frequency Modulated Thermal Wave Imaging

MODULE V **12 Hours**

APPLICATIONS: Diagnosis and Monitoring of Pain-Acupuncture-Breast Thermography and Detection of Breast Cancer-Other Medical ApplicationsRaynaud's Phenomenon- Pressure Ulcers.

TOTAL PERIODS: 60

COURSE OUTCOMES: On completion of the course the student will be able to

CO1: Identify the objectives and background of infrared imaging

CO2: Apply the temperature measurements for various applications

CO3: Demonstrate the working operation of IR Camera

CO4: Analyze the various thermography calibration procedure.

CO5: Design of basic thermography imaging procedure for various clinical applications

TEXT BOOKS:

1. Infrared Thermal Imaging: Fundamentals, Michael Vollmer, Klaus-Peter Mollmann ,Research and Applications, John Wiley, 2010.

2. Common sense approach to thermal imaging, Holst, Gerald C. Washington, DC, USA: SPIE Optical Engineering Press, 2000.

3. Infrared Imaging: A casebook in clinical medicine, Francis Ring , Anna Jung , Janusz Zuber, IOP Publishing, Temple Circus, Temple Way, Bristol, BS1 6HG, UK 2015.

REFERENCE BOOKS:

1. Medical Infrared Imaging, Nicholas A. Diakides, Joseph D. Bronzino, CRC Press,2007

2. Nondestructive Evaluation of Materials by Infrared Thermography, Xavier P.V. Maldague, Springer Science & Business Media

BMM004	BIOMEDICAL SENSORS AND DATA ACQUISITION TECHNIQUES	L	T	P	Credits
		4	0	0	4

Course Objectives:

- To relate the principles of bio potential sensing and electrodes to biomedical applications
- To identify the type of signal conditioning needed and the data acquisition cards for a specific sensor output
- To acquaint the students with the communication standards and PC buses for data acquisition
- To introduce virtual instrumentation and the hardware interfacing.

MODULE I **12 Hours**

BIOELECTRODES: Origin of bio potential and its propagation. Electrode-electrolyte interface, Electrode–skin interface, Half-cell potential, Impedance, Polarization effects of electrode – Non-polarizable electrodes. Types of electrodes - Surface, Needle and Micro electrodes and their equivalent circuits. Recording problems - Measurement with two electrodes.

MODULE II **12 Hours**

PHYSIOLOGICAL TRANSDUCERS: Thermoresistive – Thermoelectric – Semiconductor - Piezoelectric sensors- Electrets in Capacitive transducers- Pyroelectric effect – Piezoresistive effect-strain gauges- Hall Effect-Magnetostrictive effect, SQUID – AC/DC bridges - Temperature compensation.

MODULE III **12 Hours**

FUNDAMENTALS OF BIOELECTRIC SIGNAL ACQUISITION:

Introduction to bioelectric signals- Configuration and structure- Interface systems- Review of quantization in amplitude and time axis.

MODULE IV **12 Hours**

BIOAMPLIFIERS

Need for bio-amplifier - Single ended bio-amplifier, Differential bio-amplifier – Right leg driven ECG amplifier- Band-pass filtering, Isolation amplifiers – Transformer and optical isolation - Isolated DC amplifier and AC carrier amplifier. Chopper amplifier- Power line interference, Macroshock and Micro shock, Preventive measures to reduce shock hazards

MODULE V **12 Hours**

DAQ CARDS

Analog to digital conversion and Data acquisition cards- Analog and digital inputs, Counter timer I/O-accuracy and dynamic range, Speed vs throughput-Acquisition of general waveforms and biosignals- Issues in online monitoring- Web-based online monitoring.

TOTAL PERIODS: 60

COURSE OUTCOME:

The student will be able

1. Perceive the origin of bio signals and their measurement

2. Prescribe a sensor type to measure a specific physiological parameter.

3. Describe the different Bio signals and their characteristics

4. Design signal conditioning circuit for specific biomedical signal.

5. Select a type of interface and data acquisition system for the given biomedical signal

TEXT BOOK

1. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, 2015, 2nd Edition, Pearson Education India, Bengaluru.

2. John G. Webster, “Medical Instrumentation Application and Design”, 2015, 4th Edition, John Wiley and sons, NewJersey.

REFERENCE BOOK

1. Robert H King, "Introduction to Data Acquisition with LabVIEW", 2012, 2nd Edition, McGraw Hill, NewYork.
2. Joseph Bronzino and Donal R. Peterson, Handbook of Biomedical Engineering, 2015, 4th Edition, CRC Press, Florida.

BMM005	MEDICAL ROBOTICS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVES:

1. To understand the drives and sensors required for robotics.
2. To study the kinematics, dynamics, motion planning and control of robotics.
3. To understand the importance of medical automation and medical robotics.
4. To compare the various future technologies being proposed.

MODULE I **12 Hours**

DRIVES AND SENSORS FOR ROBOTS: Basics - Component classification, Performance characteristics – Drives - Electric, Hydraulic and Pneumatic drives- Tactile sensors, Proximity and range sensors, Acoustic sensors, Vision sensor systems- Image processing and analysis - Image data reduction, Segmentation, Feature extraction and Object recognition.

MODULE II **12 Hours**

ROBOT KINEMATICS AND DYNAMICS

Kinematics of manipulators - Rotational, Translation and transformation, Homogeneous transformations, Denavat – Hartenberg representation - Inverse kinematics - Linearization of Robot Dynamics – State variable continuous and discrete models.

MODULE III **12 Hours**

PATH PLANNING AND PROGRAMMING OF ROBOTS

Types of trajectories - Trajectory planning and avoidance of obstacles, Path planning, Skew motion, Joint integrated motion and Straight line motion – Robot Programming - Languages and software packages.

MODULE IV **12 Hours**

ROBOT ASSISTED MINIMALLY INVASIVE SURGERY

Introduction- Minimally invasive surgery and robotic integration- Development of surgical robotics systems- Perceptual docking for synergistic control- Future scope

MODULE V **12 Hours**

ROBOTICS IN ORTHOPAEDIC AND KNEE REPLACEMENT SURGERY

Introduction- Existing orthopedic robotic systems, evaluation of impact of orthopedic surgical robots- Knee replacement surgery - Apex Robotic Technology (ART), Challenges and future scope

TOTAL PERIODS: 60

COURSE OUTCOME:

The student will be able to:

1. Have an understanding of the basics of robotics
2. Understand the kinematics and dynamic involved in design of robotic systems
3. Determine the path and plan a trajectory for a mobile system
4. Understand the importance of robotics in the field of surgery.
5. Focus on future trends on medical robotics.

TEXT BOOK

1. Paula Gomes, "Medical Robotics: Minimally Invasive Surgery", 2012, 1st Edition, Woodhead Publisher, Cambridge.

REFERENCE BOOK

1. Jocelyne Troccaz, "Medical Robotics", 2013, 1st edition, Wiley, London.
2. Mikell P Groover, "Industrial Robotics", 2017, 2nd Edition, Tata McGraw Hill, New Delhi

BMM006	INVASIVE AND NON-INVASIVE MEDICAL DIAGNOSTIC TECHNIQUES	L	T	P	Credits
		4	0	0	4

Course Objective: 1. To have an overview of Invasive and Non-Invasive diagnostic techniques

2. To study the principles and application of Invasive Medical Diagnostic techniques.

3. To study about principles and application of Invasive Medical Diagnostic techniques.

MODULE I **12Hours**

Introduction of non-invasive Medical Diagnostic Techniques: Definition of Invasive and Non-invasive technique and measurements, Minimally Invasive medical measurement.

MODULE II **12 Hours**

Invasive Medical Diagnostic Techniques: working principle and application of Transesophageal, Echocardiogram, Cardiac Catheterization, Balloon Angioplasty, atherectomy, Coronary Stent, Peripheral Angiogram, Endogenous Ablation, Ambulatory Phlebectomy and Sclerotherapy.

MODULE III **12 Hours**

Non-invasive Techniques: working principle and application of Electrocardiography, Radiography – routine and specialized areas like CT and MRI, Stress testing – tread mill test, stress related and other nuclear techniques, Holter monitoring for arrhythmias and ischemic disorders, Echocardiography – M-mode, two dimensional, Doppler, Color flow imaging, transesophageal echocardiography and echo directed hemodynamic studies.

MODULE IV **12 Hours**

Techniques related to Gynecology, ophthalmology, ENT, orthopedics etc., Rapid diagnostic tests and kits, Laboratory Measurements: Apparatus and Principles, Photometry, Laboratory Mathematics, Quality Assurance in the Clinical Laboratory, Automation in the Clinical Laboratory. ECG, EEG, EMG signal acquisition and interpretation, X-RAY, CTScan, MRI, USG imaging and image analysis **and interpretation.**

MODULE V **12 Hours**

Automation in the Clinical Laboratory: ECG, EEG, EMG signal acquisition and interpretation, X-RAY, CT scan, MRI, USG imaging and image analysis and interpretation.

TOTAL PERIODS: 60

TEXT BOOK

Course Outcomes: On completion of this course, students will be able to

CO 1. To Learn about Invasive and Non-Invasive diagnostic techniques
CO 2. To Learn about principles and application of Invasive Medical Diagnostic techniques.
CO 3. To Learn about principles and application of Invasive Medical Diagnostic techniques.
CO 4. To study the principles and application of Invasive Medical Diagnostic techniques.
CO 5. To study about principles and application of Invasive Medical Diagnostic techniques.

BMM007	BIOMEDICAL INSTRUMENTATION	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVES: The objectives of the course is to enable students to:

- To learn the nature of various physiological signals.
- To learn about the measurement of blood pressure, pulse rate etc. and cardiac pacemakers & defibrillators
- To learn basics of auditory mechanisms and the hearing aids.
- To learn the basics of surgical systems.
- To learn the medical imaging modalities such as ultrasonic and MRI

MODULE I FUNDAMENTAL CONCEPTS: 12 Hours

Sources of biomedical signals, Basic medical instrumentation system, performance requirements of medical instrumentation systems, General constraints in design of medical instrumentation systems.

Bioelectric Signals and Electrodes: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrodes for ECG, Electrodes for EEG, Electrodes of EMG. EOG, EGG,

MODULE II BIOMEDICAL RECORDERS: 12 Hours

Electrocardiograph-block diagram description, ECG leads, Artefacts, blood pressure measurement: korotkoff's method measurement of respiratory rate: Impedance Pneumograpy.

OXIMETERS: Principle, pulse oximeter Cardiac Pacemakers and Defibrillators: Need for cardiac pacemaker, Implantable Pacemaker, Types of implantable pacemaker, defibrillators: Need for defibrillators and dc defibrillators

MODULE III AUDIOMETER AND HEARING AIDS: 12 Hours

Mechanism of hearing, measurement of sound, basic audiometer, pure-tone audiometer, speech audiometer, hearing aids- conventional, digital hearing aid, cochlear implants. VENTILATORS: Mechanics of respiration, artificial ventilation, ventilators

MODULE IV INSTRUMENTS OF SURGERY: 12 Hours

Principles of surgical diathermy, surgical diathermy machine, automated electro-surgical systems, electrodes used with surgical diathermy

HAEMODIALYSIS MACHINE: Function of kidney, artificial kidney, dialyzer, membranes for hemodialysis, portable kidney machine

MODULE V ULTRASOUND IMAGING: 12 Hours

Fundamentals of acoustic propagation - Stress strain relationship, Characteristic impedance, Intensity, Reflection and refraction, Attenuation, absorption & scattering, Doppler effect, Generation and detection of Ultrasound-Piezoelectric effect, Ultrasonic transducers, ULTRASONIC DIAGNOSTIC METHODS:

Pulse echo systems- Amplitude mode (A-mode), Brightness mode (B-mode), Motion mode (M-mode), Constant depth mode (C-mode), , Colour Doppler flow imaging, BASICS OF MAGNETIC RESONANCE IMAGING:

fundamentals of nuclear magnetic resonance- Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Rotating frame of reference and RF magnetic field, Free induction decay (FID), Fourier spectrum of the NMR signal, Spin density, Relaxation times, Pulse sequences.

TOTAL PERIODS: 60

TEXT BOOK:

1. Handbook of Biomedical Instrumentation, R.S.Khandpur, Tata McGraw Hill, 2nd Edition, 2003.

2. Medical Instrumentation Application and Design, John G WebsterJohn Wiley and Sons, New York 2004 3. Principles of Medical Imaging, Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 1992

REFERENCE BOOK:

1. Biomedical Instrumentation and Measurement – by Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, Prentice-Hall India Pvt. Ltd.

2. Biomedical Transducers And Instruments, Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997. 3.Introduction to Biomedical Equipment Technology, Joseph J Carr and John M Brown , Pearson Education ,4th Edition , 2001 .

COURSE OUTCOMES:

The students would have learnt to

CO1: Interpret a typical biomedical measuring system, its constraints & precautions .

CO2: Understand the origin of biomedical signals and the sensor mechanisms

CO3: Apply the principles of audiometers, ventilators, haemodialysis etc. to evolve new devices

CO4: To study the fundamental of Ultrasound Imaging & Magnetic Resonance Imaging

BMM008	BASICS OF MICROBIAL TECHNOLOGY	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE:

- Enable the Non-biological student's to understand about the basics of life science and their pro and cons for living organisms.

MODULE I BASICS OF MICROBES AND ITS TYPES 12 Hours

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, and Fungi.

MODULE II MICROBIAL TECHNIQUES 12 Hours

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

MODULE III PATHOGENIC MICROBES 12 Hours

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengu, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

MODULE IV BENEFICIAL MICROBES 12 Hours

Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology,

Environmental Microbiology, Animal Microbiology, Marine Microbiology.

MODULE V PRODUCTS FROM MICROBES 12 hours

Fermented products – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, Pharmaceutical products - Antibiotics, Vaccines

TOTAL: 60 PERIODS

TEXT BOOKS

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.

2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi,

India.

3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers,

1996.

COURSE OUTCOME:

At the end of the course the students will be able to

CO1: Microbes and their types

CO2: Cultivation of microbes

CO3: Pathogens and control measures for safety

CO4: Microbes in different industry for economy

BMM009	RADIOIMAGING AND THERAPEUTICS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To provide the knowledge about the specialty of medicine in radiation therapy.
- To make the student understand about the application of imaging technology and effects of radiation.

MODULE I ELEMENTS OF RADIATION **12 Hours**.

Radioactive elements and Radioisotopes in medicine, Radioactivity, General properties of alpha, beta and gamma rays-Laws of radioactivity, Radioactive decay - alpha decay, beta decay, positron decay, decay energy and half-life. Radiation units-Roentgen, Rad-rem-sievert. Radiation sources-Natural and artificial radioactive sources.

MODULE II RADIATION GENERATORS **12 Hours.**

Particle Accelerators-Cyclotron, Klystron, Magnetron, Cascade generator, VanDeGraff generator Xray films, Xray film processing, Xray cassettes, Intensifying screens-new phosphor technology, Photo stimulable phosphor imaging, collimators, grids-Bucky grids.

MODULE III RADIODIAGNOSIS **12 Hrs.**

Fluoroscopy – Digital Fluoroscopy. Angiography, Cine Angiography, Digital subtraction Angiography. Mammography and Dentalx-rayunit, Digital radiography, Angiography, Image intensifier, PET, SPECT.

MODULE IV RADIOTHERAPHY **12 Hours.**

COBALT-60, Linac, Gamma camera, nuclear scintigraphy, Brachytherapy, Cyber Knife, Gamma knife, Intra operative radiotherapy, MRI system magnet (Permanent, Electromagnet and Super conductors), generations of gradient magnetic fields.

MODULE V RADIATION SAFETY MEASURES **12 Hours.**

Radiation Protection, Protective barrier-primary& secondary, Equivalent Dose, Biological effects of radiation, Somatic & genetic effects of radiation-LD 50/30, Effect of radiation on skin, blood forming organs, Personnel and area monitoring systems, Radiation measuring devices-dosimeter, survey meter.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. Thomas S. Curry, III, James E. Dowdey, Robert C. Murry JR., Christensen, The Physics of Diagnostic Radiology Lea & Febiger,6th Edition 2008.
2. Faiz M. Khan, The Physics of Radiation Therapy, 4th Edition,2009.
3. Gopal, B. Saha, Physics & Radiology of nuclear medicine, Springer 2nd Edition, 2006.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understanding the elements of radiation and radioactive decay involved in radiation therapy.

CO2 - Illustrate the working principle of radiation generators with the processing of X-ray machine and its application.

CO3 - Understandingthetechniqueoffluoroscopyandvariousradiodiagnosistechniques.

CO4 - Demonstrate the applications of radiotherapy.

CO5 Attain the adequate knowledge about radiation measurements and effect of radiation non body.

CO6 - Outline the methods of radiation safety.

BMM010	BIOVIRTUAL INSTRUMENTATION	L	T	P	Credits
		3	0	0	3

COURSE OBJECTIVE

- To introduce the concept of virtual instrumentation.
- To enable them to design applications in the field of biomedicine.

MODULE I INTRODUCTION **12 Hrs.**

Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, data types and data structures, graphical programming in data flow, comparison with conventional programming, Front Panel, and block diagram objects.

MODULE II PROGRAMMING TECHNIQUES **12 Hrs.**

VIS and sub-VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula modes, local and global variable, string & file input. Publishing measurement data in the web. Flat and Stacked sequence structures - Event structures- Formula Node.

MODULE III DATA COMMUNICATION & SYNCHRONIZATION **12 Hrs.**

Local, global, and shared variables – Data Socket - TCP and UDP – Synchronization – Notifiers – Queues - VI Server - configuring the VI Server - Error handling VIs and functions - Debugging tools and techniques.

MODULE IV DESIGN OF INTEGRATED REAL-TIME BIOMEDICAL SYSTEMS

12 Hrs.

Getting started with LabVIEW Field-Programmable gate array (FPGA) 2 7. Programming using LabVIEW FPGA - Synchronizing FPGA loops and I/O 2 8. Sharing physiological data like ECG, EEG etc, on FPGA.

MODULE V APPLICATION OF VI **12 Hrs.**

Fourier Transforms, Power spectrum, Correlation methods, windowing & flittering. temperature data acquisition system, VI based ECG monitor, ECG and EEG signal Processing, Image acquisition and processing, – ON/OFF controller – P-I-D controller – Emulation of CRO - Simulation of a simple second order system – Generation of HTML page.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. Kevin James, P.C. Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.
2. Gupta S., Gupta J.P., PC Interfacing for Data Acquisition and Process Control, ISA, 2nd Edition, 2004.
3. Technical Manuals for DAS Modules of Advantech and National Instruments, 2008.
4. Jerome, Virtual Instrumentation Using LabView, PHI, 2010.
5. Jon B. Olansen, Eric Rosow, Virtual Bio-Instrumentation: Biomedical, Clinical, and Healthcare Applications in LabVIEW, 2001.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basic concepts of virtual instrumentation.

CO2 - Acquire knowledge about the programming techniques in LabVIEW.

CO3 - Apply the knowledge in acquiring real time data.

CO4 - Analyse the integrated real-time design of biomedical systems using LabVIEW.

CO5 - Explore the techniques used to process and analyse bio signals.

CO6 - Develop LabVIEW based real time biomedical devices.

BMM011	MEDICAL EQUIPMENT MAINTENANCE AND TROUBLESHOOTING	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To identify and learn the troubleshooting of instruments used for diagnosis and therapy
- To understand how to maintain and service the overall working of any medical equipment.
- To acquire an idea about the basic troubleshooting procedures for biomedical equipment

MODULE I INTRODUCTION 12 Hrs.

Causes of Equipment Failure, testing of electrical equipment: AC, DC power supply, Grounding, shielding, Guarding, insulation testing, insulation resistance measurement, Types of Circuit Breakers, Rating - Testing of circuit breakers – Transformer testing- Earthing –Earth wires - Earthing of appliances – contactor, relay testing–CT and PT, Megger-Testing equipment and instruments.

MODULE II TESTING AND TROUBLESHOOTING 12 Hrs.

Testing of electronic components: Troubleshooting of PCB boards, Calibration of analog and digital sensor probes, Display interface, DC Power supply design, testing, Safe electrical practice, Cables, and standard, Fuse.

MODULE III TESTING OF MEDICAL EQUIPMENT 12 Hrs.

Testing of Surgical Equipment: Functions and operating procedure-Testing and maintenance of Heart lung machine, surgical lights, ventilator, patient monitor, anesthesia machine, dialyzer, and surgical tools.

MODULE IV TROUBLESHOOTING OF MEDICAL EQUIPMENT 12 Hrs.

Troubleshooting of equipments: X-ray machines, Troubleshooting of ECG recorders, Ultrasound machines incubator, baby warmer, infusion pumps, Patient Monitors, annual maintenance, contract requirements, vendor services, quality and safety standards.

MODULE V MAINTENANCE MANAGEMENT 12 Hrs.

Objectives, Maintenance Policy, Contracts and Provisions, Essentials of a Good Equipment Program, Installation Procedures, Service and Maintenance laboratory, Documentation, Professional Qualities, and Work Habits.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. Shakti Chatterjee, Aubert Miller, “Biomedical Equipment Repair”, Cengage Learning Technology & Engineering, 2018.

2. David Herres, “Troubleshooting and Repairing Commercial Electrical Equipment”, McGraw Hill Professional edition, 2016.

3. Rao S, “Testing, Commissioning, Operation and Maintenance of Electrical Equipment”, Khanna Publishers, New Delhi, 2014.

4. Francis Hegarty, John Amoore, “Health care technology management – A systematic approach” CRC Press, USA, 2017.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Identify the instruments used to recognize faults in equipment.

CO2 - Compare general testing and troubleshooting of equipment.

CO3 - Analyze faults occurring in operation theatre instruments.

CO4 - Discuss the troubleshooting of medical equipment and safety standards.

CO5 - Summarize how to manage the maintenance files and documents.

CO6 - Apply the tools in design, testing and developing medical equipment

BMM012	MEDICAL OPTICS AND LASER APPLICATIONS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To introduce the concept of optical properties of tissues and their measurements.
- To have knowledge of Lasers used in medicine.
- To analyze the applications of Lasers for diagnosis surgery and therapy.

MODULE I OPTICAL PROPERTIES **12 Hrs.**

Refraction, Scattering, Absorption, Instrumentation for absorption, Scattering and emission measurements, Light transport inside the tissue, Tissue properties Laser tissue Interaction-Chemical-Thermal Electromechanical.

MODULE II LASERS USED IN MEDICINE **12 Hrs.**

Types of lasers, construction and working principle of solid-state laser, atomic laser, Molecular laser, Liquid dye laser, Diode laser, Solid state dye laser.

MODULE II SURGICAL APPLICATIONS OF LASERS **12 Hrs.**

Lasers in ophthalmology-Dermatology–Types of lasers used in dermatology, Cosmetic dermatology–Dentistry-Types of Dental lasers-Urology–Surgical therapy in urology–Cardiology, Oxyhemoglobin-Tissue welding–Specifications.

MODULE IV NON-THERMAL DIAGNOSTIC APPLICATIONS **12 Hrs.**

Optical coherence tomography, Elastography, Laser induced fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM–Holo graphic and speckle application of lasers in biology and medicine.

MODULE V THERAPEUTIC APPLICATIONS **12 Hrs.**

Phototherapy, Photodynamic therapy (PDT)-Principle and Mechanism-Oncological and non-oncological applications of PDT-Bio stimulation effect–applications-Laser Safety Procedures.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. Abraham Katzir, Lasers and Optical Fibers in Medicine, Academic Press Edition,1998.

2. TuanVoDirh, Biomedical Photonics–Handbook, CRC Press, Bocaraton, 2003.

3. G. David Baxter, Therapeutic Lasers–Theory and practice, Churchill Livingstone Publications Edition-2001.

4. Helena Jelinkova, "Lasers for medical applications: Diagnostics, Therapy and Surgery", Woodhead Publishing,1st edition,2013.

5. MarkolfH. Neimz, "Laser tissue interactions-Fundamentals and applications", Springer,3rd edition,2014.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understandthebasicconceptsofopticalpropertiesandtheirinteractionwiththetissues

CO2 – Acquire knowledge about the various kinds of Lasers used in medicine

CO3 – Apply the lasers techniques in Surgery

CO4 – Analyse the application of Laser in diagnosis

CO5 – Explore the Laser techniques used in therapy

CO6 – Identify the use of Lasers that can be used for specific medical application

BMM013	ADVANCED BIOSIGNAL ANALYSIS	L	T	P	Credits
		4	0	0	4

COURSE OBJECTIVE

- To enable the students to analyze various Bio signals
- To analyze the Biosignals in Time, frequency, and Time-Frequency Analysis
- To analyze Non-Stationary and Multicomponent Analysis

MODULE I EVENT DETECTION **12 Hours**

Events and waves detection-Heart sound detection- Analysis of EEG Rhythms using correlation-Cross spectral Analysis-ECG Rhythm Analysis - Application: Identification of Heart Sounds, Detection of the Aortic Component of S2.

MODULE II WAVESHAPE AND WAVEFORM COMPLEXITY ANALYSIS 12 Hours.

Analysis of ERPs- Morphological Analysis of ECG Waves- Envelope Extraction and Analysis-Analysis of Activity. Application- Normal and Ectopic ECG Beats- Analysis of Exercise ECG-Analysis of the EMG in Relation to Force- Correlates of Muscular Contraction- Statistical Analysis of VAG Signals.

MODULE III TIME DOMAIN ANALYSIS **12 Hours.**

Statistical Parameters- Descriptive Statistics-Inferential Statistics-Predictive Analysis.

MODULE IV FREQUENCY-DOMAIN CHARACTERIZATION **12 Hours.**

Estimation of the PSD- Measures Derived from PSDs-Application- Evaluation of Prosthetic Valves- Fractal Analysis of VAG Signals- Spectral Analysis of EEG Signals- The effect of myocardial elasticity on heart sound spectra-Frequency analysis of murmurs to diagnose valvular defects.

MODULE V ANALYSIS OF NONSTATIONARY AND MULTICOMPONENT SIGNALS 12 Hours.

Wavelets and Time-frequency Analysis- Separation of Mixtures of Signals-Applications- Time-varying Analysis of HRV- Detection of Epileptic Seizures in EEG Signals- Analysis of Crying Sounds of Infants.

TOTAL PERIODS: 60

TEXT BOOK / REFERENCE BOOK

1. Rangaraj M. Rangayyan, Biomedical Signal Analysis, John Wiley Publication, Edition 2, 2015.

2. Willis J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2006.

3. Dr. P. Ramesh Babu, Digital Signal Processing SciTech Publications, 4th Edition 2010

4. D.C. Reddy, Biomedical Signal Processing–Principles and Techniques, TMH, New Delhi, 2005

5. Avtar Singh and S. Srinivasan, Digital Signal Processing, Thomson Publishing 2004, Singapore.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Comprehend the various events occurring in biosignals.

CO2 - Analyze the wave shape and waveform complexity of Biosignals

CO3 - Perform Time domain analysis on biosignals

CO4 - Characterize the biosignals based on frequency domain analysis

CO5 - Implement signal analysis procedures for non-stationary and multicomponent signals

CO6 - Develop a time, frequency, and time-frequency analysis models for biomedical signals