**FACULTY OF ENGINEERING**

# DEGREE OF BACHELOR OF ENGINEERING IN BIOMEDCAL ENGINEERING

**DEPARTMENT OF BIOMEDICAL ENGINEERING**

**(REGULAR PROGRAMME)**

## CURRICULUM & SYLLABI
## (2024-2025)


**KARPAGAM ACADEMY OF HIGHER EDUCATION**

**(Deemed to be University)**

**(Established UnderSection3of UGCAct1956)**

**(Accredited with $A^+$ Grade by NAAC in the Second Cycle)**

**Pollachi Main Road, Eachanari Post, Coimbatore– 641021, Tamil Nadu, India.**

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# KARPAGAM ACADEMY OF HIGHER EDUCATION

*(Deemed to be University Established under Section 3 of UGC Act 1956)*

**Eachanari, Coimbatore-641 021. INDIA**

**FACULTY OF ENGINEERING**

**DEGREE OF BACHELOR OF ENGINEERING / TECHNOLOGY**

**REGULAR PROGRAMME**

**REGULATIONS 2024**

**CHOICE BASED CREDIT SYSTEM**

**These regulations are effective from the academic year 2024 – 2025 and applicable to the candidates admitted to B. E. / B. Tech programmes. during 2024 - 2025 and onwards.**

## 1. ADMISSION

**1.1** Candidates seeking admission to the first semester of the eight semesters B. E./B.Tech Degree Programme:

Should have passed the Higher Secondary Examination (10+2) prescribed by the State Government / Central Government with Mathematics/ Physics/ Chemistry/ Computer Science/ Electronics/ Information Technology/ Biology/ Informatics Practices/ Biotechnology/ Technical Vocational subject/ Agriculture/ Engineering Graphics/ Business Studies/ Entrepreneurship. (Any of the above three subjects) or any similar Examination of any other institution/ University or authority accepted by the Karpagam Academy of Higher Education as equivalent thereto).

Should have obtained at least 45% marks (40% marks in case of candidates belonging to reserved category) in the above subjects taken together. **(OR)**

Passed min. 3 years Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) subject to vacancies in the First Year, in case the vacancies at lateral entry are exhausted. (The University will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)

### 1.2 Lateral Entry Admission

Candidates who possess Diploma in Engineering / Technology (10+3 or 10+2+2) awarded by the Directorate of Technical Education with passed minimum THREE years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) in ANY branch of Engineering and Technology are eligible to apply for admission to the third semester of B. E./B. Tech.

**OR**

Passed B.Sc. Degree from a recognized University as defined by UGC, with at least 45% marks (40% marks in case of candidates belonging to reserved category) and passed 10+2 examination with Mathematics as a subject.

**OR**

Passed D.Voc. Stream in the same or allied sector.
(The University will offer suitable bridge courses such as Mathematics, Physics, Engineering

drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)

**Eligibility criteria for admission in the third semester is given in the table below.**

<table>
<tr><th>S. No.</th><th>Programme</th><th>Eligibility criteria</th></tr>
<tr><td>1.</td><td>B.E Bio Medical Engineering</td><td rowspan="10">Passed Minimum THREE years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) in ANY branch of Engineering and Technology.<br><br>OR<br>Passed B.Sc. Degree from a recognizedUniversity as defined by UGC, with at least 45%marks (40% marks in case of candidates<br>belonging to reserved category) and passed 10+2 examination with Mathematics as a subject.<br><br>OR<br>Passed D.Voc. Stream in the same or allied sector.<br>(The Universities will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)</td></tr>
<tr><td>2</td><td>B. E. Civil Engineering</td></tr>
<tr><td>3.</td><td>B. E. Computer Science and Engineering</td></tr>
<tr><td>4.</td><td>B. E. Computer Science and Engineering (Cyber security)</td></tr>
<tr><td>5.</td><td>B. E. Electrical and Electronics Engineering</td></tr>
<tr><td>6.</td><td>B. E. Electronics and Communications Engineering</td></tr>
<tr><td>7.</td><td>B. E. Mechanical Engineering</td></tr>
<tr><td>8.</td><td>B. Tech. Artificial Intelligence and Data Science</td></tr>
<tr><td>9.</td><td>B. Tech Bio - Technology</td></tr>
<tr><td>10.</td><td>B. Tech Food Technology</td></tr>
</table>

### 1.3 Migration from other University

Candidates who are willing to migrate to Karpagam Academy of Higher Education for admission to their next semester of B. E./B. Tech programme may get admitted from 2nd semester onwards upto 7th semester. The student will be exempted from appearing for Examination of the equivalent courses passed in the earlier programme and will have to appear for courses which he/she has not done during the period of his/her earlier programme. Along with the request letter and mark sheets, he/she has to submit a copy of syllabus of the programme duly attested by the Competent authority, he/she has undergone. Equivalence Certificate shall be provided by the respective Head of the Department of Karpagam Academy of Higher Education.

## 2 . PROGRAMMES OFFERED

A candidate may undergo a programme in any one of the branches of study approved by the University as given below.

**List of B. E. and B. Tech. Degree Programmes**

1. B.E Bio Medical Engineering
2. B. E. Civil Engineering
3. B. E. Computer Science and Engineering
4. B. E. Computer Science and Engineering (Cyber Security)
5. B. E. Electrical and Electronics Engineering
6. B. E. Electronics and Communications Engineering
7. B. E. Mechanical Engineering
8. B.Tech. Artificial Intelligence and Data Science
9. B. Tech. Bio-Technology
10. B. Tech Food Technology

## 3. MODE OF STUDY

### 3.1 Full-Time:

In this mode of study, the candidates are required to attend classes regularly on the specified working days of the University.

**3.2** Change from one programme to another is not permitted.

## 4. STRUCTURE OF PROGRAMMES

**4.1** Every programme will have a curriculum with syllabus consisting of theory and practical courses such as:

(i) General core courses comprising Mathematics, Basic Sciences, Engineering Sciences and Humanities.

(ii) Core courses of Engineering/Technology.

(iii) Elective courses for specialization in related fields.

(iv) Workshop practice, computer practice, engineering graphics, laboratory work, internship, seminar presentation, project work, industrial visits, camps, etc.

Every student is encouraged to participate in at least any one of the following programmes

- NSS / Sports/Physical exercise/NCC/YRC.
- Other Co-Curricular and Extra Curricular activities

## (V) **Choice Based Credit System**

CBCS is introduced for students admitted in the academic year 2017-18. As per AICTE guidelines, CBCS is an approach in which students opt for courses of their choice. CBCS provides greater flexibility with multiple courses and enable students to undergo additional courses. CBCS is applicable to Full Time Undergraduate & Post Graduate Programmes of study. It provides a choice for students to select from the prescribed courses (Professional core, Professional Electives, Open Electives, Value added courses, Humanity Sciences, Basic sciences & Engineering sciences). A course designated as hard core for a particular programme of study must invariably be completed by the student to receive the degree in the programme. The Hardcore courses cannot be substituted by another courses. Students can exercise their choice among a set of soft-core courses from the list of Soft core courses specified for each Programme of study. The student should meet the criteria for prerequisites to become eligible to register for that course. The student should request for the course for every semester within the first week of semester. Maximum no of students to be registered in each course shall depend on availability of physical facilities, classroom availability and lab capacity. Registration of already requested courses by students in previous semester is not allowed.

**4.2** Each course is normally assigned certain number of credits.

| | |
|---|---|
| No. of credits per lecture period per week | 1 |
| No. of credits per tutorial period per week | 1 |
| No. of credits for 3 periods of laboratory course per week | 2 |
| No. of credits for 3 periods of project work per week | 2 |
| No. of credits for 2 weeks of field project/internship training during semester vacations | 1 |

**4.3** In every semester, the curriculum shall normally have a blend of theory courses not exceeding 6 and practical courses not exceeding 4.

**4.4** The prescribed credits required for the award of the degree shall be within the limits specified below.

| PROGRAMME | PRESCRIBED CREDIT RANGE |
|---|---|
| B. E./B. Tech. | 160– 165 |

**4.5** The medium of instruction for all Courses, Examinations, Seminar presentations and Project/Thesis reports is English except Tamil/French.

### 4.6 Value Added Course

Besides core courses and elective courses, value added course is introduced. The blend of different courses is so designed that the interested students would be trained, for the holistic development to enhance employment opportunity.

**4.7** Evaluation of the courses comprises of two parts, one is the Continuous Internal Assessment (CIA) and the other one is the End Semester Examination (ESE). Evaluation in a mandatory course may be by Internal Assessment only.

## 5. DURATION OF THE PROGRAMME

**5.1**The prescribed duration of the programme shall be

| Programme | Min. No. of semesters | Max. No. of semesters |
|---|---|---|
| B. E./B. Tech. (HSC Candidates) | 8 | 14 |
| B. E./B. Tech. (Lateral Entry Candidates) | 6 | 12 |

**5.2** Each semester shall normally consist of 90 working days or 540 hours.

**5.3** Additional classes for improvement, conduct of model test, etc., over and above the specified periods shall be arranged, if required. But for the purpose of calculation of attendance requirement for eligibility to appear for the end semester Examinations (as per Clause 11) by the students, 540 hours conducted within the specified academic schedule alone shall be taken into account and the overall percentage of attendance shall be calculated accordingly.

## 6. REQUIREMENTS FOR COMPLETION OF THE SEMESTER

**6.1** Ideally every student is expected to attend all classes and secure 100% attendance. However, in order to allow for certain unavoidable circumstances, the student is expected to attend at least 75% of the classes and the conduct of the candidate has been satisfactory during the course.

**6.2** A candidate who has secured attendance between 65% and 74% (both included), due to medical reasons (Hospitalization / Accident / Specific Illness) shall be given exemption from prescribed minimum attendance requirements and shall be permitted to appear for the Examination on the recommendation of the Head of the Department concerned and Dean to condone the lack of attendance. The Head of the Department has to verify and certify the genuineness of the case before recommending to the Dean concerned. However, the candidate has to execute a one-time bond (Stamp paper) with an undertaking from the parent and the student that this situation never arises in the future.

**6.3** Candidates who are not recommended for condonation and those who have less than 65% attendance will not be permitted to proceed to the next semester and have to redo the course. However, they are permitted to write the arrear Examinations, if any.

## 7. CLASS ADVISOR

To help the students in planning their courses of study and for general advice on theacademic programme, the Head of the Department will attach a certain number of students to a teacher of the Department who shall function as Class Advisor for those students throughout their period of study. Such Class Advisors shall advise the students and monitor the courses undergone by the students, check the attendance and progress of the students and counsel them periodically.If necessary, the Class Advisor may display the cumulative attendance particulars in the Department notice board and also discuss with or inform the Parents/Guardian about the progress of the students. Each student shall be provided with course plan for each course at the beginningof each semester.

## 8. CLASS COMMITTEE

**8.1.** Every class shall have a class committee consisting of teachers of the class concerned, Maximum of six student representatives [boys and girls] and the concerned Head of the Department. It is like the 'Quality Circle' with the overall goal of improving the teaching-learning process. The functions of the class committee include

- Clarifying the regulations of the degree programme and the details of rules therein particularly Clause 4 and 5 which should be displayed on Department Notice-Board.
- Informing the student representatives, the details of Regulations regarding weightage used for each assessment. In the case of practical courses (laboratory / drawing / project work / seminar, etc.) the breakup of marks for each experiment / exercise /module of work, should be clearly discussed in the class committee meeting and informed to the students.
- Solving problems experienced by students in the class room and in the laboratories.
- Informing the student representatives, the academic schedule, including the dates of assessments and the syllabus coverage for each assessment.
- Analyzing the performance of the students of the class after each test and finding the ways and means of solving problems, if any.
- Identifying the weak students, if any and requesting the teachers concerned to provide some additional academic support.

**8.2** The class committee for a class under a particular branch is normally constituted by the Head of the Department. However, if the students of different branches are mixed in a class (like the first semester which is generally common to all branches), the class committee is to be constituted by the Dean.

**8.3** The class committee shall be constituted within the first week of each semester.

**8.4** The Chairperson of the Class Committee may convene the meeting of the class committee.

**8.5** The Dean may participate in any Class Committee of the Faculty.

**8.6** The Chairperson is required to prepare the minutes of every meeting, submit the same to Dean through the HOD within two days of the meeting and arrange to circulate it among the students and teachers concerned. If there are some points in the minutes requiring action by the

Management, the same shall be brought to the notice of the Registrar by the HOD through Dean.

**8.7** The first meeting of the Class Committee shall be held within one week from the date of commencement of the semester, in order to inform the students about the nature and weightage of assessments within the framework of the regulations. Two subsequent meetings may be held in a semester at suitable intervals. During these meetings the student members representing the entire class, shall meaningfully interact and express their opinions and suggestions of the other students of the class in order to improve the effectiveness of the teaching-learning process.

## 9. COURSE COMMITTEE FOR COMMON COURSES

Each common theory course offered to more than one discipline or group, shall have a "Course Committee" comprising all the teachers handling the common course with one of the nominated as Course Coordinator. The nomination of the Course Coordinator shall be made by the Dean depending upon whether all the teachers teaching the common course belong to a single department or to several departments. The 'Course Committee' shall meet to arrive at a common scheme of evaluation for the test and shall ensure a uniform evaluation of the tests. Where ever feasible, the Course Committee may also prepare a common question paper for the Internal Assessment test(s).

## 10. PROCEDURE FOR AWARDING MARKS FOR INTERNAL ASSESSMENT

**10.1** Every teacher is required to maintain an 'ATTENDANCE AND ASSESSMENT RECORD'(Log book) which consists of attendance marked in each theory or practical or project work class, the test marks and the record of class work (topic covered), separately for each course.

**10.2** Continuous Internal Assessment (CIA): The performance of students in each course will be continuously assessed by the respective teachers as per the guidelines given below:

### a. THEORY COURSES

| S. No. | CATEGORY | MAXIMUM MARKS |
|---|---|---|
| 1. | Assignment | 5 |
| 2. | Seminar * | 5 |
| 3. | Attendance | 5 |
| 4. | Test – I | 12.5 |
| 5. | Test – II | 12.5 |
| **Continuous Internal Assessment: TOTAL** | | 40 |

*Evaluation shall be made by a committee.

**PATTERN OF TEST QUESTION PAPER (Test I & II)**

**a. THEORY COURSES:**

| INSTRUCTION | REMARKS |
|---|---|
| **Maximum Marks** | 100 |
| **Duration** | 3 Hours |
| **Part – A** | Question no. 1 to 10 Two Mark Questions, covering 2.5 units of the syllabus.<br>**(10 x 2= 20 Marks)** |
| **Part- B** | Question 11 to 15 will be of either-or type, covering 2.5 units of the syllabus. Each Question may have subdivision.<br>**(5 x 16=80 Marks).** |

**b. PRACTICAL COURSES:**

| S. No | CATEGORY | MAXIMUM MARKS |
|---|---|---|
| 1. | Attendance | 5 |
| 2. | Observation work | 5 |
| 3. | Record work | 5 |
| 4. | Internal Practical Assessment | 15 |
| 5. | Viva – Voce [Comprehensive] | 10 |
| **Continuous Internal Assessment: TOTAL** | | 40 |

Every practical exercise / experiment shall be evaluated based on the conduct of exercise/ experiment and records maintained.

### c. INTEGRATED THEORY AND PRACTICAL COURSES:

The Continuous Internal Assessment for Integrated Theory and Practical Course is awarded for 40 Marks with mark split up similar to regular theory course. But Assignment and Seminar components are replaced by Observation and Record marks.

| S.No. | CATEGORY | MAXIMUM MARKS |
|---|---|---|
| 1. | Observation | 5 |
| 2. | Record | 5 |
| 3. | Attendance | 5 |
| 4. | Test –I | 12.5 |
| 5. | Test –II | 12.5 |
| **Continuous Internal Assessment: TOTAL** | | 40 |

The external evaluation of integrated practical component from End semester Examination is conducted for 50 Marks and later scaled down to 15 Marks and similarly the external evaluation for integrated theory from End semester Examination is awarded for 100 Marks and later scaled down to 45 Marks. Hence the external assessment for integrated theory and practical components contribute to 60 Marks.

### 10.3 ATTENDANCE

**Attendance carries a maximum of 5 marks and the distribution is as under:**

| S. No. | Attendance % | Marks |
|---|---|---|
| 1 | 91 and above | 5.0 |
| 2 | 81-90 | 4.0 |
| 3 | 76-80 | 3.0 |

### 10.4 PROJECT WORK/ INTERNSHIPS:

Final year project work will be normally in-house. However, as a special case, if a student is able toget a project from a government organization or private or public sector company, the student may be permitted to do his/her project work in that institution/research organization/industry.

## 11. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION (ESE)

A candidate shall normally be permitted to appear for the ESE of any semester commencing from I semester if he/she has satisfied the semester completion requirements (Subject to Clause 5) and has registered for Examination in all courses of the semester. Registration is mandatory for Semester Examinations as well as arrear Examinations failing which the candidate will not be permitted to attend the next semester. A candidate already appeared for a course in a semester and passed the Examination is not entitled to reappear in the same course of the semester for improvement of grade.

## 12. END SEMESTER EXAMINATION

ESE will be held at the end of each semester for each course, for 100 marks, later scaled down to 60 marks.

**PATTERN OF ESE QUESTION PAPER:**

| INSTRUCTION | REMARKS |
|---|---|
| **Maximum Marks** | 100 |
| **Duration** | 3 Hours |
| **Part – A** | Question no. 1 to 10 Two Mark Questions, covering all the 5 units.<br>**(10 x 2= 20 Marks)** |
| **Part- B** | Question 11 to 15 will be of either or type, covering Five units of the syllabus. Each Question may have subdivision.<br>**(5 x 16=80 Marks).** |

## 13. PASSING REQUIREMENTS

**13.1** Minimum marks to pass: The minimum marks to pass for CIA is 20 (i.e. out of 40 marks). The minimum marks to pass for ESE is 30 (i.e. out of 60 marks). The overall minimum marks to pass for theory/laboratory course is 50 (Sum of his/her score in CIA and ESE) out of 100 marks.

**13.1.1** The minimum marks to pass for Value Added Course /Skill Development is 50 marks out of 100marks. There will be two tests, the first covering 50% of syllabus for 50 marks and the other for 50 marks.

**13.2** If the candidate fails to secure a pass in ESE of a particular course, it is mandatory that candidate shall register and reappear for the Examination in that course during the subsequent semester when Examination is conducted in that course. Further the candidate should continue to register and reappear for the Examination till a pass is secured in such supplementary Examination within the stipulated maximum duration of the programme (Clause 5.1).

The CIA marks obtained by the candidate in his/her first or subsequent appearance were nhe/she secures a pass shall be retained by the office of the Controller of Examinations and considered valid for all remaining attempts till the candidate secures a pass in his/her ESE.

**13.3** If the candidate fails to secure a pass in CIA of a particular course, it is mandatory that candidate shall register and reappear for the CIA in that course during the subsequent semester when CIA is conducted in that course by the faculty member assigned for that particular course during that semester by the concerned HOD. Further, the candidate should continue to register and reappear for the CIA till a pass is secured in such subsequent Examination within the stipulated maximum duration of the programme (Clause 5.1).

**13.3.1** If a candidate fails to secure a pass in Value Added Course /Skill Development course, he/she has to appear for the tests when course is conducted subsequently.

### 13.4 CREDIT TRANSFER THROUGH MOOC

The MOOC coordinator shall assist the students for the online courses offered by the SWAYAM platform periodically and also monitor their course.

Open Elective Courses shall be considered for the credit transfer. Only courses available in SWAYAM platform (which are totally beyond the scope of the programme under consideration) shall be considered as open elective courses and get completed at any time within the duration of the Programme before the last semester. This is a mandatory requirement for completion of the programme. At least 2 Open Electives (3 credits each) to be completed for the credit transfer.

## 14. AWARD OF LETTER GRADES

**14.1** All assessments of a course will be done on absolute mark basis. However, for the purpose of reporting the performance of a candidate letter grades, each carrying certain number of points will be awarded as per the range of total marks (out of 100) obtained by the candidate in each subject as detailed below:

| Letter grade | Marks Range | Grade Point | Description |
|---|---|---|---|
| O | 91 - 100 | 10 | OUTSTANDING |
| A+ | 81- 90 | 9 | EXCELLENT |
| A | 71-80 | 8 | VERY GOOD |
| B+ | 66- 70 | 7 | GOOD |
| B | 61 – 65 | 6 | ABOVE AVERAGE |
| C | 55 - 60 | 5 | AVERAGE |
| D | 50 - 54 | 4 | PASS |
| RA | <50 | - | REAPPEARANCE |
| AB | | 0 | ABSENT |

### 14.2 GRADE SHEET

After results are declared, Grade sheet will be issued to each student which will contain the following details:

i. The list of courses enrolled during the semester and the grade scored,

ii. The Grade Point Average (**GPA**) for the semester and

iii. The Cumulative Grade Point Average (**CGPA**) of all courses enrolled from first semester onwards.

**GPA** is the ratio of the sum of the products of the number of Credits (**C**) of courses enrolled and the Grade Points (**GP**) corresponding to the grades scored in those courses, taken for all the courses to the sum of the number of credits of all the courses in the semester.

$$GPA = \frac{\text{Sum of } [C*GP]}{sum\ of\ c}$$

**CGPA** will be calculated in a similar manner, considering all the courses enrolled from First semester. **RA** grade and value added course will be excluded for calculating **GPA** and **CGPA**.

### 14.3 REVALUATION

Revaluation and Re-totaling are allowed on representation. A candidate can apply for revaluation of his/her semester Examination answer paper in a theory course, within 2 weeks from the declaration of results, on payment of a prescribed fee through proper application to the Controller of Examinations through the Head of the Department and Dean. A candidate can applyfor revaluation of answer scripts for not exceeding 5 subjects at a time. The Controller of Examinations will arrange for the revaluation and the results will be intimated to the candidate through the Head of the Department and Dean. Revaluation is not permitted for Supplementary Examinations, Practical Examinations, Technical Seminars, In-plant Training and Project Work.

### 14.4 TRANSPARENCY AND GRIEVANCE COMMITTEE

A student may get the Photostat copy of the answer script on payment of prescribed fee, if he/she wishes. The students can represent the grievance, if any, to the Grievance Committee, which consists of Dean of the Faculty, (if Dean is HoD, the Dean of another Faculty nominated by the University), HoD of the Department concerned, the faculty of the course and Dean from other discipline nominated by the University and the CoE. If the Committee feels that the grievance is genuine, the script may be sent for external valuation; the marks awarded by the External Examiner will be final. The student has to pay prescribed fee for the same.

## 15. ELIGIBILITY FOR AWARD OF DEGREE

**A student shall be declared to be eligible for award of Degree if he/she has**

- Successfully gained the required number of total credits as specified in the curriculum corresponding to his/her programme within the stipulated time.

The award of the degree must be approved by the Board of Management of Karpagam Academy of Higher Education.

## 16. CLASSIFICATION OF THE DEGREE AWARDED

**16.1** A candidate who qualifies for the award of the Degree (vide Clause 15) having passed the Examination in all the courses in his/her first appearance within the specified minimum number of semesters (vide Clause 5.1) securing a CGPA of not less than **7.5** shall be declared to have passed the Examination in First Class with Distinction.

**16.2** A regular candidate or a lateral entrant is eligible to register forBE(Honors), B.Tech.(Honors). If, he / she has passed all the courses in the first appearance and holds / maintains a CGPA of 7.5 upto VIII Semester, he / she has to take an additional 20 credits by studying online courses through Swayam/NPTEL. Such a candidate is eligible for the award of BE(Honors), B.Tech.(Honors). However, if he / she fails in securing 20 additional credits but maintains CGPA of 8 and above is not eligible for Honors degree but eligible for First class with Distinction.

**16.3** A candidate who qualifies for the award of the Degree (vide Clause 15) having passed the Examination in all the courses within the specified minimum number of semesters (vide Clause 5.1) plus one year (two semesters), securing CGPA of not less than **6.5** shall be declared to have passed the Examination in First Class.

**16.3** All other candidates (not covered in Clauses 17.1 and 17.2) who qualify for the award of the degree (vide Clause 15) shall be declared to have passed the Examination in Second Class.

**17. SUPPLEMENTARY ESE:** After the publication of VIII semester results, if a student has **ONE** arrear in any theory course of the entire programme, he/she will be permitted to apply within 15 days of the publication of results, and appear for supplementary Examination.

**18. DISCIPLINE**

Every student is required to observe discipline and decorous behavior both inside and outside the University and not to indulge in any activity which will tend to bring down the prestige of the University. The erring student will be referred to the Disciplinary Committee constituted by the University, to enquire in to acts of indiscipline and recommend to the University about the disciplinary action to be taken.

If a student indulges in malpractice in any of the ESE/CIA he/she shall be liable for punitive action as prescribed by the University from time to time.

**19. ADVANCED LEARNERS, ON-DEMAND EXAMINATION**

Students

1. Who secure 7.5 CGPA and maintain an attendance of 75% in every semester
2. Clear all the courses in their first appearance itself are referred to as advanced learners. When a student fails to maintain any of the above conditions at any given time, he cannot be an advanced learner further.

When a student fails to maintain any of the above conditions at any given time, he cannot be an advanced learner further. These students can request for an on-demand examination for the courses in their forthcoming semester(s). These students on prior permission can appear for such examinations well in advance and complete the entire courses well before the prescribed period of study and can progress for a full time Research Project/Internship/Minor Project during the remaining prescribed period of study. The Internal and External examinations will be conducted for these courses as like the other courses. One or more faculty mentors will be allocated based on the number of students/courses enrolled for the on-demand examination.

Also, these advanced learners can also register for online courses from NPTEL/SWAYAM/SWAYAM Plus portals on prior and proper approval from the department. The credits earned from those courses will be transferred to the mark statement of the students.

## 20. REVISION OF REGULATION AND CURRICULUM

The University may from time-to-time revise, amend or change the Regulations, Scheme of Examinations and syllabi, if found necessary on the recommendations of Board of Studies, Academic Council and Board of Management of Karpagam Academy of Higher Education.

## 21. CREDIT TRANSFER THROUGH ONLINE / INTERNATIONAL STUDIES

Students are encouraged to enroll in courses offered by MOOC platforms and international institutions of higher learning, either virtually or in person. The equivalent credits for these courses will be determined by a committee named Subject Equivalency Committee comprising the Dean, Head of Department (HoD), and one faculty member nominated by the Vice Chancellor. The committee's decision will be submitted for ratification/approval by the Board of Studies (BoS) and the Academic Council. Additionally, the equivalent grade points for marks/grades/grade points awarded by various MOOC platforms and international institutions of higher learning will be determined by a committee named Grade Equivalency Committee duly constituted by the Vice-Chancellor. The decisions of this committee will also be submitted for ratification/approval by the Academic Council. This shall be approved to be implemented from the even semester of the academic year 2024-25.

## 22.KARPAGAM INNOVATION AND INCUBATION COUNCIL (KIIC)
## (A Section 8 Company)

Based on the 2019 National Innovation and Startup Policy and the 2019–2023 Tamil Nadu Startup Policy, KIIC has recommended to the KAHE students who are affiliated with the KIIC that it be incorporated in the university Program Regulations 2023-24 and implement from this academic year.

### 22.1 Norms to Student Start-Ups

a) Any (UG/PG /(Ph.D.) Research scholars, student, right from the first year of their programme is allowed to set a startup (or) work part time/ full time in a startup or work as intern in a startup

b) Any (UG/PG / (Ph.D.) Research scholars) student right from the first year of their programme is allowed to earn credit for working on Innovative prototypes/business Models/ Pre incubation(case to case basis). Start Up activities will be evaluated based on the guidelines being given by the expert committee of the KIIC

c) Student Entrepreneurs may use the address of incubation center (KIIC) to register their venture while studying in KAHE.

d) Students engaged in startups affiliated with the KIIC or those who work for them may be exempted from KAHE's attendance requirements for academic courses under current regulations, up to a maximum of 30% attendance per semester, including claims for ODs and medical emergencies Potential Students who have been incubated at KIIC may be permitted to take their University semester exams even if their attendance is below the minimum acceptable percentage, with the proper authorization from the head of the institution.

(On case-to-case basis depends upon the applicability strength, societal benefits and quality of the Innovation and Subsequent engagement of the students with the/ her business)

e) Any Students Innovators/entrepreneurs are allowed to opt their startup in place mini project /major project, /seminar and summer training etc. (In plant training, Internship, value added Course.). The area in which the student wishes to launch a Startup may be interdisciplinary or multidisciplinary.

f) Student's startups are to be evaluated by Expert committee, formed by KIIC and KAHE.

**22.2 Guide lines to award Credits/ Marks to a Student startup**

Student's startup stages are divided into five phases and these startup phases can be considered equally in place of the course title as mentioned below with the same credits allotted to the course title in a university curriculum.

| Sl. No. | Description/Startup phases | In place of the Subject / Course title | Grades/Credits /Marks |
|---|---|---|---|
| 1 | Idea stage/Problem Identification | Seminar | Same Marks/Credits can be awarded that are listed in the course title's curriculum for the respective startup phases. |
| 2 | Proof of Concept (POC) /Solution development | In-plant training /Internship | |
| 3 | Product Development (Lab scale) /Prototype Model/ Company Registered | Mini Project/ Value added Course | |
| 4 | Validation/Testing | Main Project phase I | |
| 5 | Business Model/Ready for Commercialization/Implementation | Main Project phase II | |

**B.E BIOMEDICAL ENGINEERING**

| POs | PROGRAM OUTCOMES (POs) |
|---|---|
| **PO1** | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| **PO2** | **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. |
| **PO3** | **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. |
| **PO4** | **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| **PO5** | **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. |
| **PO6** | **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| **PO7** | **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| **PO8** | **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| **PO9** | **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| **PO10** | **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| **PO11** | **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| **PO12** | **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

| PSOs | PROGRAM SPECIFIC OUTCOMES (PSOs) |
|---|---|
| **PSO1** | To design and implement assistive and rehabilitative system to improve end user quality of life |
| **PSO2** | To develop clinical algorithms for solving theranostic problems |

**KARPAGAM ACADEMY OF HIGHER EDUCATION**
**(Deemed to be University Established Under Section 3 of UGC Act 1956)**
**FACULTY OF ENGINEERING**
**B.E -BIOMEDICAL ENGINEERING**
**COURSE OF STUDY AND SCHEME OF EXAMINATION**
**(2024 BATCH ONWARDS)**

| Semester – I | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course code** | **Course Title** | **Category** | **Outcomes** | | **Instruction hours/wee k** | | | **Credit(s)** | **Maximum Marks** | | | **Page No.** |
| | | | **PO** | **PSO** | **L** | **T** | **P** | | **CIA** | **ESE** | **TOTAL** | |
| 24BECC101 | Technical English I | HS | 5,8,9,10,12 | - | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 1 |
| 24BECC102 | Matrices and Calculus | BS | 1,2,3,12 | 1 | 3 | 1 | 0 | 4 | 40 | 60 | 100 | 3 |
| 24BEBME103 | Biology for Engineers | ES | 1,2,9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 5 |
| 24BEBME141 | Engineering Chemistry | BS | 1,2,3, ,6,7,8,9, ,12 | 1 | 3 | 0 | 2 | 4 | 40 | 60 | 100 | 7 |
| 24BECC142 | Python Programming | ES | 1,2,3,4,5, 9, 10,12 | 1,2 | 3 | 0 | 2 | 4 | 40 | 60 | 100 | 10 |
| 24BEMC151 | Women Safety And Security | MC | - | - | 1 | 0 | 0 | 0 | 100 | - | 100 | 145 |
| 24BEMC152 | தமிழர் மரபும் பண்பாடும் | MC | - | - | 1 | 0 | 0 | 0 | 100 | - | 100 | 146 |
| | | | | Total | **17** | **1** | **4** | **18** | **400** | **300** | **700** | |

| Semester -II | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course code** | **Course Title** | **Category** | **Outcomes** | | **Instruction hours/wee k** | | | **Credit(s)** | **Maximum Marks** | | | **Page No.** |
| | | | **PO** | **PSO** | **L** | **T** | **P** | | **CIA** | **ESE** | **TOTAL** | |
| 24BECC201 | Technical English II | HS | 5,8,9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 13 |
| 24BECC202C | Transforms and its Applications | BS | 1,2,3,12 | 1,2 | 3 | 1 | 0 | 4 | 40 | 60 | 100 | 15 |
| 24BECC203 | Environmental Studies | BS | 1,2,6,7,8,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 17 |
| 24BEBME204 | Introduction to Biomedical Engineering | ES | 1,2,6,8,9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 20 |
| 24BEBME241 | Engineering Physics | ES | 1,2,3,6,9,10,12 | 1 | 3 | 0 | 2 | 4 | 40 | 60 | 100 | 22 |
| 24BECC242 | Electronic Devices and Circuits | ES | 1,2,3,9,10,12 | 1 | 3 | 0 | 2 | 4 | 40 | 60 | 100 | 24 |
| 24BECC211 | Communication Skills Lab | HS | 5,8,9,10,12 | - | 0 | 0 | 2 | 1 | 40 | 60 | 100 | 26 |
| 24BEMC251 | Yoga | MC | - | - | 0 | 0 | 4 | 2 | 100 | - | 100 | 148 |
| | | | | **SEMESTER TOTAL** | **18** | **1** | **10** | **24** | **380** | **420** | **800** | |

**SEMESTER-III**

| Course Code | Course Title | Category | Outcomes | | Instruction Hours/week | | | Credit(s) | Maximum Marks | | | Page No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PO | PSO | L | T | P | | CIA | ESE | Total | |
| **THEORY** | | | | | | | | | | | | |
| 24BEBME301A / 24BEBME301B | Discrete Mathematics and Stochastic Process / Numerical Methods | BS | 1,2,3,9, 10, 12 | 2 | 3 | 1 | 0 | 4 | 40 | 60 | 100 | 28/30 |
| 24BEBME302 | Human Anatomy and Physiology | PC | 1,2,3,6,9 ,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 32 |
| 24BEBME303 | Biosensors and Measurements | PC | 1,2,3,6,8 ,9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 34 |
| 24BEBME304 | Signals and Systems | PC | 1,2,3,4,9 ,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 36 |
| 24BEBME305 | Analog and Digital Electronics | PC | 1,2,3,9, 10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 38 |
| 24BEBME341 | Data Structures and Algorithms | ES | 1,2,3,5, 9,10,12 | 2 | 3 | 0 | 2 | 4 | 40 | 60 | 100 | 40 |
| **PRACTICALS** | | | | | | | | | | | | |
| 24BEBME311 | Biosensors and Measurements Laboratory | PC | 1,2,3,4,5 ,6,8,9,10 ,12 | 1 | 0 | 0 | 2 | 1 | 40 | 60 | 100 | 42 |
| 24BEBME312 | Analog and Digital Electronics Laboratory | PC | 1,2,3,4,5 9,10,12 | 1 | 0 | 0 | 2 | 1 | 40 | 60 | 100 | 43 |
| 24BEBME313 | Skill Development -I Medical Coding | PC | 1,2,5,6, 9,10,12 | 2 | 0 | 0 | 2 | 1 | **100** | - | 100 | 44 |
| **MANDATORY COURSE** | | | | | | | | | | | | |
| 24BEMC351 | Aptitude and Reasoning | MC | - | | 1 | 0 | 0 | 0 | 100 | - | 100 | 149 |
| **INTERNSHIP** | | | | | | | | | | | | |
| 24BEBME391 | Internship / Field Project- I | MC | - | | 0 | 0 | 2 | 1 | 100 | 0 | 100 | 45 |
| **SEMESTER TOTAL** | | | | | **19** | **1** | **10** | **24** | **620** | **480** | **1100** | |

**SEMESTER-IV**

| Course Code | Course Title | Category | Outcomes | | Instruction Hours/week | | | Credit(s) | Maximum Marks | | | Page No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PO | PSO | L | T | P | | CIA | ESE | Total | |
| **THEORY** | | | | | | | | | | | | |
| 24BEBME401 | Biomaterials and Artificial Organs | PC | 1,2,9,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 46 |
| 24BEBME402 | Biomedical Signal Processing | PC | 1,2,3,9,10,12 | 1,2 | 3 | 1 | 0 | 4 | 40 | 60 | 100 | 48 |
| 24BEBME403 | Biomedical Instrumentation | PC | 1,2,3,9,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 50 |
| 24BEBME404 | Embedded systems | PC | 1,2,3,9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 52 |
| 24BEBME405 | Quality Control for Biomedical Devices | PC | 1,2,3,6,8,9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 54 |
| 24BEBME441 | Java Programming | PC | 1,2,3,9,10,12 | - | 3 | 0 | 2 | 4 | 40 | 60 | 100 | 56 |
| **PRACTICALS** | | | | | | | | | | | | |
| 24BEBME411 | Biomedical Signal Processing Laboratory | PC | 1,2,3,4,5,6,8,9,10,12 | 1,2 | 0 | 0 | 2 | 1 | 40 | 60 | 100 | 59 |
| 24BEBME412 | Biomedical Instrumentation Laboratory | PC | 1,2,3,8,9,10,12 | 1,2 | 0 | 0 | 2 | 1 | 40 | 60 | 100 | 60 |
| 24BEBME413 | Skill Development -II Medical Device Calibration | PC | 1,2,5,6,8,9,10,12 | 1,2 | 0 | 0 | 2 | 1 | **100** | - | 100 | 61 |
| **MANDATORY COURSE** | | | | | | | | | | | | |
| 24BEMC451 | Foundation of Entrepreneurship | MC | - | | 1 | 0 | 0 | 0 | 100 | 0 | 100 | 151 |
| 24BEMC452 | Essence of Indian Traditional knowledge and Heritage | MC | - | | 1 | 0 | 0 | 0 | 100 | 0 | 100 | 152 |
| **SEMESTER TOTAL** | | | - | | **20** | **1** | **8** | **23** | **620** | **480** | **1100** | |

**SEMESTER-V**

| Course Code | Course Title | Category | Outcomes | | Instruction Hours/week | | | Credit(s) | Maximum Marks | | | Page No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PO | PSO | L | T | P | | CIA | ESE | Total | |
| **THEORY** | | | | | | | | | | | | |
| 24BEBME501 | Internet of MedicalThings (IoMT) | PC | 1,2,3,5,6, 9,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 62 |
| 24BEBME502 | Biomedical Image Processing | PC | 1,2,3,9,10,1 2 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 64 |
| 24BEBME503 | Bio Control System | PC | 1,2,3,9, 10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 66 |
| 24BEBME541 | Business Data Processing | PC | 1,2,3,4,9,10 ,12 | 2 | 3 | 0 | 2 | 4 | 40 | 60 | 100 | 68 |
| 24BEBME5E-- | Professional Elective-I | PE | - | - | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 75 |
| 24BEBME5E-- | Professional Elective-II | PE | - | - | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 75 |
| **PRACTICALS** | | | | | | | | | | | | |
| 24BEBME511 | Biomedical Image Processing Laboratory | PC | 1,2,3,5, 9,10,12 | 2 | 0 | 0 | 2 | 1 | 40 | 60 | 100 | 71 |
| 24BEBME512 | Internet of Medical Things Laboratory | PC | 1,2,3,5, 9,10,12 | 1,2 | 0 | 0 | 2 | 1 | 40 | 60 | 100 | 72 |
| 24BEBME513 | Community Engagement and Social Responsibility | HS | - | - | 0 | 0 | 4 | 2 | 100 | - | 100 | 74 |
| **MANDATORY COURSE** | | | | | | | | | | | | |
| 24BEMC551 | Cyber Security | MC | - | | 1 | 0 | 0 | 0 | 100 | 0 | 100 | 153 |
| **INTERNSHIP** | | | | | | | | | | | | |
| 24BEBME591 | Internship/Field Project - II | MC | - | | 0 | 0 | 2 | 1 | 100 | 0 | 100 | 75 |
| **SEMESTER TOTAL** | | | | | **19** | **0** | **12** | **24** | **620** | **480** | **1100** | |

**SEMESTER-VI**

| Course Code | Course Title | Category | Outcomes | | Instruction Hours/week | | | Credit(s) | Maximum Marks | | | Page No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PO | PSO | L | T | P | | CIA | ESE | Total | |
| **THEORY** | | | | | | | | | | | | |
| 24BECC601 | Universal Human Values | HS | 1,2,3,8,9, 10,12 | - | 2 | 0 | 0 | 2 | 40 | 60 | 100 | 76 |
| 24BEBME602 | Biomechanics | PC | 1,2,3,6,7,8, 9,10,12 | 1,2 | 3 | 1 | 0 | 4 | 40 | 60 | 100 | 78 |
| 24BEBME603 | Medical Diagnostic and Therapeutic Equipment | PC | 1,2,3,6,7,8, 9,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 80 |
| 24BEBME604 | Assistive Technology & Rehabilitation | PC | 1,2,3,6,8,9, 10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 82 |
| 24BEBME6E_ | Professional Elective-III | PE | - | - | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 85 |
| 24BEBME6E- | Professional Elective-IV | PE | - | - | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 85 |
| 24BEBMEOE-- | Open Elective-I | OE | - | - | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 85 |
| **PRACTICALS** | | | | | | | | | | | | |
| 24BEBME611 | Medical Diagnostic and Therapeutic Equipment Laboratory | PC | 1,2,3,4,5,6, 8,9,10,12 | 1,2 | 0 | 0 | 2 | 1 | 40 | 60 | 100 | 84 |
| 24BEBME612 | Medical Equipment Trouble shooting Laboratory (Industry Curriculum) | PC | 1,2,3,4,5,6, 8,9,10,12 | 1 | 0 | 0 | 2 | 1 | 40 | 60 | 100 | 86 |
| **MANDATORY COURSE** | | | | | | | | | | | | |
| 24BEBME691 | Mini Project | MC | - | | 0 | 0 | 2 | 1 | 100 | 0 | 100 | 85 |
| | | | **SEMESTER TOTAL** | | **20** | **1** | **6** | **24** | **460** | **540** | **1000** | |

**SEMESTER-VII**

| Course Code | Course Title | Category | Outcomes | | Instruction Hours/week | | | Credit(s) | Maximum Marks | | | Page No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PO | PSO | L | T | P | | CIA | ESE | Total | |
| **THEORY** | | | | | | | | | | | | |
| 24BEBME701 | Artificial Intelligence in Healthcare | PC | 1,2,3,6,7, 8,9,10,12 | 2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 87 |
| 24BEBME702 | Medical Regulatory Affairs | PC | 1,2,3,6,7, 8,9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 89 |
| 24BEBME703 | Biomedical waste and Hospital Management | PC | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 91 |
| 24BEBME7E_ _ | Professional Elective-V | PE | - | - | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 94 |
| 24BEBME7E_ _ | Professional Elective -VI | PE | - | - | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 94 |
| 24BEBMEOE-- | Open Elective-II | OE | - | - | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 94 |
| **PRACTICALS** | | | | | | | | | | | | |
| 24BEBME711 | Artificial Intelligence Laboratory | PC | 1,2,3,4,5, 9,10,12 | 2 | 0 | 0 | 2 | 1 | 40 | 60 | 100 | 93 |
| **PROJECT WORK** | | | | | | | | | | | | |
| 24BEBME791 | Project Work Phase-I / Internship / Field project - III | PW | - | | 0 | 0 | 8 | 4 | 80 | 120 | 200 | 94 |
| **SEMESTER TOTAL** | | | | | **18** | **0** | **10** | **23** | **360** | **540** | **900** | |

**SEMESTER-VIII**

| Course Code | Course Title | Category | Instruction Hours/week | | | Credit(s) | Maximum Marks | | | Page No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | CIA | ESE | Total | |
| **PROJECT** | | | | | | | | | | |
| 24BEBME891 | Project Work Phase - II | PW | 0 | 0 | 16 | 8 | 120 | 180 | 300 | 95 |
| **SEMESTER TOTAL** | | | **0** | **0** | **16** | **8** | **120** | **180** | **300** | |
| **PROGRAMME TOTAL** | | | **131** | **5** | **76** | **168** | **3580** | **3420** | **7000** | |

**Professional Electives:**

| Bio Engineering | Biowearable Systems |
|---|---|
| Modeling of Physiological Systems | Analog And Digital Communication |
| Cell Biology | Wearable Devices |
| BIOMEMS | Body Area Networks |
| Biomedical Informatics | Virtual Reality and Augmented Reality In Healthcare |
| Micro Fluidics | Telemedicine |
| Biomimetics | Medical Sensors - Mems & Nems |
| Biofluid Mechanics | Laser In Medicine |
| Robotics and Automation in Medicine | Biometric Systems |
| Intellectual Property Rights | Speech Processing |
| Bioergonomics | Brain Computer Interface |
| Genetic Engineering | Cognitive Engineering |
| Clinical Engineering | Cognitive Psychology |

**Elective I**

| Course Code | Course Title | Category | Outcomes | | Instruction Hours/week | | | Credit(s) | Maximum Marks | | | Page No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PO | PSO | L | T | P | | CIA | ESE | Total | |
| 24BEBME5E01 | Modeling of Physiological Systems | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 96 |
| 2BEBME5E02 | Cell Biology | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 98 |
| 24BEBME5E03 | Analog and Digital Communication | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 120 |
| 24BEBME5E04 | Wearable Devices | PE | 1,2,3, 8,9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 122 |
| **Elective II** | | | | | | | | | | | | |
| 24BEBME5E05 | BIOMEMS | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 100 |
| 24BEBME5E06 | Biomedical Informatics | PE | 1,2,3, 9,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 102 |
| 24BEBME5E07 | Body Area Networks | PE | 1,2,3, 8,9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 124 |
| 24BEBME5E08 | Virtual Reality and Augmented Reality in Healthcare | PE | 1,2,3, 9,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 126 |
| **Elective III** | | | | | | | | | | | | |
| 24BEBME6E01 | Micro Fluidics | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 104 |
| 24BEBME6E02 | Biomimetics | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 106 |
| 24BEBME6E03 | Telemedicine | PE | 1,2,3, 6,9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 128 |
| 24BEBME6E04 | Medical Sensors - MEMS & NEMS | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 130 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Elective IV** | | | | | | | | | | | | |
| 24BEBME6E05 | Biofluid Mechanics | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 108 |
| 24BEBME6E06 | Robotics and Automation in Medicine | PE | 1,2,3, 9,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 110 |
| 24BEBME6E07 | Laser in Medicine | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 132 |
| 24BEBME6E08 | Biometric Systems | PE | 1,2,3, 9,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 134 |
| **Elective V** | | | | | | | | | | | | |
| 24BEBME7E01 | Intellectual Property Rights | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 112 |
| 24BEBME7E02 | Bioergonomics | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 114 |
| 24BEBME7E03 | Speech Processing | PE | 1,2,3, 6,9,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 136 |
| 24BEBME7E04 | Brain Computer Interface | PE | 1,2,3, 9,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 138 |
| **Elective VI** | | | | | | | | | | | | |
| 24BEBME7E05 | Genetic Engineering | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 116 |
| 24BEBME7E06 | Clinical Engineering | PE | 1,2,3, 9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 118 |
| 24BEBME7E07 | Cognitive Engineering | PE | 1,2,3, 9,10,12 | 1,2 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 140 |
| 24BEBME7E08 | Cognitive Psychology | PE | 1,2,3, 8,9,10,12 | 1 | 3 | 0 | 0 | 3 | 40 | 60 | 100 | 142 |

**KARPAGAM ACADEMY OF HIGHEREDUCATION**

***(Deemed to be University Established Under Section 3 of UGC Act 1956)***

**Pollachi Main Road, Eachanari Post, Coimbatore – 641 021. INDIA**

**FACULTY OF ENGINEERING**

**DEPARTMENT OF BIOMEDICAL ENGINEERING**

| S.No. | Course work - subject area | Credits/Semester | | | | | | | | Credits Total | No. of courses | Percentage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VII | VIII | | | |
| 1 | Humanities and Social Sciences **(HS)** | 3 | 4 | - | - | 2 | 2 | - | - | 11 | 5 | 6.5 |
| 2 | Basic Sciences **(BS)** | 8 | 7 | 4 | - | - | - | - | - | 19 | 5 | 11.3 |
| 3 | Engineering Sciences **(ES)** | 7 | 11 | 4 | - | - | - | - | - | 22 | 6 | 13.1 |
| 4 | Professional Core **(PC)** | - | - | 14 | 23 | 15 | 11 | 10 | - | 73 | 30 | 43.5 |
| 5 | Professional Electives**(PE)** | - | - | - | - | 6 | 6 | 6 | - | 18 | 6 | 10.7 |
| 6 | Open Electives **(OE)** | - | - | - | - | - | 3 | 3 | - | 6 | 2 | 3.6 |
| 7 | Project Work **(PW)** | - | - | - | - | - | - | 4 | 8 | 12 | 2 | 7.1 |
| 8 | Mandatory Courses **(MC)** | - | 2 | 1 | 2 | 1 | 1 | - | - | 7 | 10 | 4.2 |
| 9 | Total | 18 | 24 | 23 | 25 | 24 | 23 | 23 | 8 | **168** | 66 | 100 |
| **TOTAL CREDITS 168** | | | | | | | | | | | | |

**SEMESTER I**

**B.E Biomedical Engineering** **2024-2025**

| **24BECC101** | **TECHNICAL ENGLISH – I** | **SEMESTER – I**<br>**3H-3C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** English at 10+2 or equivalent level

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Acquire the fundamental reading and writing skills, proper grammar usage, listening, and speaking
- Understand and improve skills in listening and speaking, in expressing oneself formally in writing, and in deducing meaning from what one reads
- Apply one's receptive (reading and listening) and productive (writing and speaking) language skills

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Replicate grammar usage in reading, speaking, and writing skills. P2
- Describe precise transitions while reading, writing, and speaking to enhance communication coherence and clarity. A2
- Report the interpretation of linguistic parameters in day-to-day reading, listening, and speaking interactions. A2
- Point out errors to restructure paragraphs, compose, compile, and synthesize documents for presentations. P2
- Demonstrate proficiency in reading, writing, and critical listening and the ability to interpret and articulate complex ideas persuasively in written and oral forms. A3

***P- Psychomotor skills, A-Affective Domain Skills**

**UNIT I** **09**

**Grammar** **:** Parts of Speech – Gerunds and infinitives – Sentence Pattern
**Reading** **:** Reading comprehension: (vocabulary, referents, and inferences/conclusions)
**Writing** **:** Business letter – e-mail Writing
**Listening** **:** Listening to different short recordings – Listen to a longer recording
**Speaking** **:** Introduction to Phonetics, Diphthongs

**UNIT II** **09**

**Grammar** **:** Tenses: Simple Tenses – Concord – Types of Sentences
**Reading** **:** Identifying main and secondary information
**Writing** **:** Check lists – Building Itineraries
**Listening** **:** Listening Comprehension – Job Description
**Speaking** **:** Pronunciation – Describing people, places, jobs and things – Asking and answering questions

**UNIT III** **09**

**Grammar** **:** Tenses: Progressive Tenses – Direct and Indirect speech – Concord
**Reading** **:** Identifying, organizing, comparing and Interpreting information
**Writing** **:** Writing Articles – Paragraph Writing
**Listening** **:** Telephonic conversation

**Speaking** : Stress, Intonation – Self Introduction

**UNIT IV** **09**

**Grammar** : Tenses: Perfect Tenses – Active and Passive voice
**Reading** : Reading Comprehension (Reconstruction, Rewording)
**Writing** : Memo – Notice – Agenda
**Listening** : Critical Listening
**Speaking** : Oral presentation

**UNIT V** **09**

**Grammar** : Tenses: Perfect Continuous Tenses – Reported Speech
**Reading** : Reading Comprehension (Cause and Effect identification)
**Writing** : Creative writing – Copy Writing
**Listening** : Listening and Interpretation of ideas
**Speaking** : Group Discussion

**TOTAL: 45**

**TEXT BOOKS:**

1. Richards J C, Hull J, et al., "Interchange 2 Student's Book", 5th Edition, Cambridge University Press, 2022.
2. Kumar Sanjay and Pushp Latha, "English Language and Communication Skills for Engineers", 1st Edition, Oxford University Press, 2018.

**REFERENCE BOOKS:**

1. Swan Michael and Walter Catherine, "Oxford English Grammar Course", 1st Edition, Oxford University Press, 2019.
2. Sudharshana N P and Savitha C, "English for Engineers", 1st Edition, Cambridge University Press, 2018.
3. Brook-Hart G, "Business Benchmark: Upper intermediate: Business Vantage: Student's Book", 2nd Edition, Cambridge University Press, 2021.

**WEBSITES:**

1. www.onestopenglish.com
2. www.britishcouncil.org
3. www.cambridgeenglish.org/learning-english/

**CO, PO PSO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | 2 | - | - | 2 | 2 | 3 | - | 2 | - | - |
| CO2 | - | - | - | - | 2 | - | - | 2 | 2 | 3 | - | 2 | - | - |
| CO3 | - | - | - | - | 2 | - | - | 2 | 2 | 3 | - | 2 | - | - |
| CO4 | - | - | - | - | 2 | - | - | 2 | 2 | 3 | - | 2 | - | - |
| CO5 | - | - | - | - | 2 | - | - | 2 | 2 | 2 | - | 2 | - | - |
| **Average** | **-** | **-** | **-** | **-** | **2** | **-** | **-** | **2** | **2** | **2.8** | **-** | **2** | **-** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BECC102** | **MATRICES AND CALCULUS** | **SEMESTER – I**<br>**4H-4C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** Nil

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Provide sufficient knowledge in calculus and matrix algebra in the respective fields
- Find an extremum value for a function of several variables subject to a given constraint.
- Apply mathematical tools to solve second and higher order ODE and PDE with constant coefficients

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Make use of orthogonal transformation to reduce the quadratic form to canonical form **(K3)**
- Utilize differential calculus of multivariable to optimization problems **(K3)**
- Apply multiple integrals for finding area and volume **(K3)**
- Solve the $n^{th}$ order Ordinary Differential Equations (ODE) and Homogeneous equation of Euler's type **(K3)**
- Solve the $n^{th}$ order Partial Differential Equations **(K3)**

**UNIT I MATRICES 12**

Eigenvalues and Eigenvectors of a real matrix– Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms

**UNIT II DIFFERENTIAL CALCULUS OF MULTIVARIABLE FUNCTIONS 12**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions –Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers

**UNIT III MULTIPLE INTEGRALS 12**

Definite and Indefinite Integrals – Double integrals – Change of order of integration – Double integrals in polar coordinates – Area using double integrals – Evaluation of Triple Integrals- Volume of Solids.

**UNIT IV ORDINARY DIFFERENTIAL EQUATIONS 12**

Linear differential equation of second and higher order with constant coefficients –Cauchy-Euler linear differential equation – Method of Variation of parameters

**UNIT V PARTIAL DIFFERENTIAL EQUATIONS 12**

Homogeneous linear partial differential equations of second and higher order with constant coefficients – Classification of partial differential equations.

**TOTAL: 45+15**

**TEXT BOOKS:**

1. Hass, Heil and Weir, "Thomas Calculus", 14th Edition, Pearson Education, 2018.
2. Dennis G. Zill, "Advanced Engineering Mathematics", 7th Edition, Jones & Bartlett Learning, 2022.

**REFERENCE BOOKS:**

1. Rogawski, Adams and Franzosa, "Calculus", 4th Edition, W. H. Freeman, 2019.
2. Boyce, DiPrima and Meade, "Elementary Differential Equations and Boundary Value Problems", 12th Edition, John Wiley & Sons, 2021.
3. Alexander Graham, "Matrix Theory and Applications for Scientists and Engineers", 1st Edition, Dover Publications Inc.,2018.
4. Grewal, B. S.,Higher engineering mathematics. 2018, Khanna Publishers, New Delhi.

**WEBSITES:**

1. www.classcentral.com/course/matrix-methods-13644
2. www.classcentral.com/course/brilliant-calculus-ii-59290
3. www.classcentral.com/course/differential-equations-engineers-13258

**CO, PO PSO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 2 | - |
| CO2 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 2 | - |
| CO3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 2 | - |
| CO4 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 2 | - |
| CO5 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **Average** | **3** | **2** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **2** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**B.E Biomedical Engineering** **2024-2025**

| 24BEBME103 | BIOLOGY FOR ENGINEERS | SEMESTER – I<br>3H-3C |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** Nil

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Relate biological concepts and their engineering applications
- Compare the biodesign principles to create novel devices and structures
- Show that the biological systems can be re-designed as substitute products for natural systems

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the structure and functions of cell (K2)
- Outline the applications of biomolecules (K2)
- Demonstrate the need of adaptation of anatomical principles for bioengineering design(K2)
- Interpret the nature inspired materials and mechanisms (K2)
- Summarize the trends in bioengineering (K2)

**UNIT I CELL 09**

Introduction. Structure and functions of a cell. Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules: Properties and functions of enzymes, vitamins and hormones.

**UNIT II BIOMOLECULES 09**

Carbohydrates in cellulose-based water filters production, PHA and PLA in bioplastics production, Nucleic acids in vaccines and diagnosis, Proteins in food production, lipids in biodiesel and detergents production, Enzymes in biosensors fabrication, food processing, detergent formulation and textile processing.

**UNIT III ANATOMICAL PRINCIPLES FOR BIOENGINEERING 09**

Brain as a CPU system. Eye as a Camera system. Heart as a pump system. Lungs as a purification system. Kidney as a filtration system.

**UNIT IV BIOINSPIRED MECHANISMS 09**

Echolocation, Photosynthesis. Bird flying, Lotus leaf effect, Plant burrs, Shark skin, Kingfisher beak. Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).

**UNIT V ADVANCEMENTS IN BIOENGINEERING FOR DISEASE DIAGNOSIS 09**

Muscular and Skeletal Systems as scaffolds, scaffolds and tissue engineering, Bioprinting techniques and materials. Electronic tongue and nose, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis

**Total: 45 Hours**

**TEXT BOOKS:**


1. Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.
2. Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
3. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
4. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
5. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.


**REFERENCE BOOKS:**


1. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
2. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.


**WEBSITES:**

1. https://nptel.ac.in/courses/121106008
2. https://www.coursera.org/courses?query=biology
3. https://onlinecourses.nptel.ac.in/noc19_ge31/preview
4. https://www.classcentral.com/subject/biology
5. https://www.futurelearn.com/courses/biology-basic-concepts

**CO, PO PSO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | - | - |
| CO2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | - | - |
| CO3 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME141** | **ENGINEERING CHEMISTRY** | **SEMESTER – I**<br>**5H-4C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** Nil

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Summarize water treatment process and engineering materials.
- Acquire knowledge on fuels, lubricants and principles of corrosion.
- Explain the concepts of analytical techniques and its applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Identify the quality of water and its treatment methodologies (K3)
- Interpret the basics of engineering materials and its applications (K2)
- Outline the methods to enhance the quantity & quality of fuels and Lubricants (K2)
- Illustrate the types of corrosion and its prevention techniques (K2)
- Demonstrate the principle and working of analytical techniques (K3)

**UNIT I WATER TECHNOLOGY 09**

Sources-Characteristics - Specification for drinking water, BIS &WHO-Alkalinity- Types of alkalinities and determination - Hardness - Types and estimation by EDTA method - Domestic water treatment - Disinfection methods (Chlorination, Ozonation. UV treatment) - Boiler feed water - Requirements - Disadvantages of using hard water in boilers - Internal conditioning(Phosphate, Calgon and Carbonate conditioning methods) - External conditioning - Demineralization process - Desalination - Reverse osmosis

**UNIT II ENGINEERING MATERIALS 09**

Plastics – Thermoplastics & Thermosets. Preparation, properties and engineering applications of Poly vinyl chloride and Bakelite. Alloys – Introduction – Definition – Properties of alloys – Significance of alloying, functions and effect of alloying elements – Nichrome and stainless steel (18/8) – Heat treatment of steel. Refractories – Definition, classification, properties (refractoriness, refractoriness under load, porosity and thermal spalling), failure of refractories. Composites– Properties and applications of Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites.

**UNIT III FUELS AND LUBRICANTS 09**

Fuels – Introduction- Analysis of coal (proximate and ultimate), Carbonization- Manufacture of metallurgical coke (Otto Hoffmann method) – Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking – Octane number– Cetane number- Power alcohol and biodiesel. Lubricants – Introduction – Characteristics of a good lubricant – Classification, Physical and Chemical Properties – Mechanism of lubricants – Applications

**UNIT IV CORROSION AND ITS CONTROL 09**

Chemical and Electrochemical corrosion - Galvanic corrosion - Differential aeration corrosion- Factors influencing the rate of corrosion - Corrosion control - Sacrificial anode and Impressed current cathodic methods - Corrosion inhibitors - Protective coatings - Organic coatings-Paints - Constituents and functions Inorganic coatings- Metallic coatings - Electroplating (Au) and Electro less plating (Ni) - Surface conversion coating - Hot dipping.

**UNIT V ANALYTICAL TECHNIQUES AND APPLICATIONS 09**

Introduction-Instrumentation and applications of Colorimetry, Flame Photometry, Potentiometry, Conductometry (Strong acid with strong base, Mixture of acids with strong base, precipitation titrations)-Electronic spectroscopy- Vibrational spectroscopy-Atomic Absorption spectroscopy

**Total: 45 Hours**

**TEXT BOOKS:**


1. P C Jain & Monica Jain, Engineering Chemistry, 18th edition, Dhanpat Rai Publishing Company, 2022
2. Shivani Jaggi Guleria, "Engineering Chemistry", Concept for engineers, 1st Edition, Atlantic, 2021.
3. S S Dara, S S Umare, "A Text book of Engineering Chemistry", 12th Edition, S Chand, 2015.
4. B. H. Mahan, University chemistry, Pearson Education, 2010
5. R V Gadag, A Nithyananda Shetty, "Engineering Chemistry", 3rd Edition, Wiley India Pvt, 2019.


**REFERENCE BOOKS:**


1. M. J. Sienko and R. A. Plane, Chemistry: Principles and Applications. 5th edition, McGraw-Hill Higher Education, 1976
2. C. N. Banwell, Fundamentals of Molecular Spectroscopy, McGraw-Hill, 2001
3. P. W. Atkins, Physical Chemistry, Oxford University Press, 2022
4. B. L. Tembe, Kamaluddin and M. S. Krishnan, Engineering Chemistry (NPTEL Web- book)
5. K. P. C. Volhardt and N. E. Schore, 5th Edition, Organic Chemistry: Structure and Function, W.H. Freeman Publications, 2014


**WEBSITES:**

1. https://www.bspublications.net/downloads/0523ff2e4a5331_chemistry_ch_01_JNTUK.pdf
2. https://www.uobabylon.edu.iq/eprints/publication_10_31957_6172.pdf
3. https://www.researchgate.net/publication/265602506_chapter_engineering_materials_and_engineering_plastics

**LIST OF EXPERIMENTS**

1. Determination of Ca / Mg using complexometric titration
2. Determination of chloride content of water
3. Determination of the rate of corrosion by weight loss method
4. Conductometry - Determination of conductance of solutions (strong acid Vs strong base)
5. pH Metry - Determination of Acid/Base
6. Potentiometry - Estimation of iron content in a water sample.
7. Estimation of Copper and Zinc in Brass

**CO, PO PSO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | - | 1 | 1 | 1 | 1 | - | - | 1 | 1 | - |
| CO2 | 2 | 1 | - | - | - | 1 | 1 | 1 | 1 | - | - | 1 | 1 | - |
| CO3 | 2 | 1 | - | - | - | 1 | 1 | 1 | 1 | - | - | 1 | 1 | - |
| CO4 | 2 | 1 | - | - | - | 1 | 1 | 1 | 1 | - | - | 1 | 1 | - |
| CO5 | 3 | 2 | 1 | - | - | 1 | 1 | 1 | 1 | - | - | 1 | 1 | - |
| **Average** | **2.4** | **1.4** | **1** | **-** | **-** | **1** | **1** | **1** | **1** | **-** | **-** | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BECC142** | **PYTHON PROGRAMMING** | **SEMESTER – I**<br>**5H-4C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** Nil

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Learn about basic python syntax and semantics like control structures and functions.
- Develop logical thinking abilities and to propose novel solutions for real world problems through object-oriented programming concepts.
- Model the empirical knowledge on applying programming on business domains

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Interpret the basic representation of the data structures and sequential programming (K2)
- Solve the problems using list, dictionaries, tuples, and sets core data structures (K3)
- Build applications using functions, modules and packages (K3)
- Examine the error-handling constructs for unanticipated states/inputs. (K4)
- Analyze the applications on real-world problems using object-oriented concepts (K4)

**UNIT I INTRODUCTION TO PYTHON BASICS 09**

Fundamentals of Computing - Building blocks of algorithms - Introduction to Programming - Elements of python - Variables - Data Types - Operators - Operator Precedence - Expressions - Conditional statement - Loops - Break, Continue and Pass - Illustrative problems: square root, GCD, LCM, Sum an array of numbers, Linear search, Binary search.

**UNIT II PYTHON DATA STRUCTURES 09**

Mutable vs immutable data types - String - Indexing and slicing - String functions - List - List slices - List methods - Iterate over a list - Mutability - Aliasing - Cloning lists - List parameters - List comprehension- Tuples- Tuple assignment - Tuple as return value - Dictionaries - Operations and methods - Set - Set operations - Illustrative programs: Simple sorting, pattern matching, Fibonacci, Factorial, Prime numbers.

**UNIT III FUNCTIONS, MODULES AND PACKAGES 09**

Mutable vs immutable data types - String - Indexing and slicing - String functions - List - List slices - List methods - Iterate over a list - Mutability - Aliasing - Cloning lists - List parameters - List comprehension- Tuples- Tuple assignment - Tuple as return value - Dictionaries - Operations and methods - Set - Set operations - Illustrative programs: Simple sorting, pattern matching, Fibonacci, Factorial, Prime numbers.

**UNIT IV FILE HANDLING, CLASS AND OBJECT 09**

Built-in functions - User defined functions - Creating function - Calling functions - Types of function arguments - Recursion and lambda or anonymous functions - Packages: Defining - Creating and accessing a package - Python libraries NumPy, pandas, Matplotlib - Flask/Django

**UNIT V** **ERROR HANDLING, TESTING** **09**

Exception handling with try, except, finally - Exception handling: Errors vs exceptions - Handling exceptions - Raising exception - Creating user defined exception - Debugging techniques- Unit testing with unit test - Writing test cases - web scraping - Data analysis project - Automation script

**Total: 45 Hours**

**TEXT BOOKS:**


1. P C Jain & Monica Jain, Engineering Chemistry, 18th edition, Dhanpat Rai Publishing Company, 2022
2. Shivani Jaggi Guleria, "Engineering Chemistry", Concept for engineers, 1st Edition, Atlantic, 2021.
3. S S Dara, S S Umare, "A Text book of Engineering Chemistry", 12th Edition, S Chand, 2015.
4. B. H. Mahan, University chemistry, Pearson Education, 2010
5. R V Gadag, A Nithyananda Shetty, "Engineering Chemistry", 3rd Edition, Wiley India Pvt, 2019.


**REFERENCE BOOKS:**


1. Allen B Downey,Jeffrey Elkne, Chris Meyers ,"How to Think Like a Computer Scientist: Learning with Python 3 Documentation",3rd Edition, Green Tea Press,2020.
2. Steven F. Lott ,Dusty Phillips,"Python Object-Oriented Programming: Build robust and maintainable object-oriented Python applications and libraries"4th Edition , Packt Publishing Limited ,2021.


**WEBSITES:**

1. R https://realpython.com/
2. www.programiz.com/python-programming
3. https://www.geeksforgeeks.org/python-programming-language/
4. https://www.pythonspot.com/

**LIST OF EXPERIMENTS:**

1. Write conditional and looping statements in Python.
2. Create and manipulate strings using indexing, slicing, and various string functions.
3. Create and manipulate lists using operations, slices, methods, list comprehension, and looping.
4. Create and manipulate tuples, dictionaries, and sets, and understand the differences between mutable and immutable types.
5. Implement user-defined functions and understand the different types of function arguments, such as positional, keyword, and default arguments.
6. Implement inheritance and understand the different types of inheritance.
7. Implement polymorphism through method overloading, overriding, and operator overloading.

**CO, PO PSO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 2 | - | - | - | 2 | 2 | - | 1 | 1 | 2 |
| CO2 | 3 | 2 | 1 | - | 2 | - | - | - | 2 | 2 | - | 1 | 1 | 2 |
| CO3 | 3 | 2 | 1 | - | 2 | - | - | - | 2 | 2 | - | 1 | 1 | 2 |
| CO4 | 3 | 3 | 2 | 1 | 2 | - | - | - | 2 | 2 | - | 1 | 1 | 2 |
| CO5 | 3 | 3 | 2 | 1 | 2 | - | - | - | 2 | 2 | - | 1 | 1 | 2 |
| **Average** | **2.8** | **2.4** | **1.4** | **1** | **2** | **-** | **-** | **-** | **2** | **2** | **-** | **1** | **1** | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**SEMESTER II**

| **B.E Biomedical Engineering** | | **2024-2025** |
|---|---|---|
| **24BECC201** | **TECHNICAL ENGLISH – II** | **SEMESTER – II**<br>**3H-3C** |

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** Technical English - I

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Acquire the context of grammar and the importance of Listening, Speaking, Reading and Writing
- Understand and develop critical Listening, Speaking, Reading, and Writing skills
- Apply students' capability to listen vigilantly, read proficiently, innovative writing, and speak fluently

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Demonstrate the aspects of writing, speaking, reading, and listening with grammar. **P2**
- Refine speaking, listening, reading, and writing skills in the social milieu. **P3**
- Justify the text critically in reading, writing, speaking, and listening. **A3**
- Differentiate grammatical structures in reading and listening and apply the structure in speaking and writing. **A3**
- Adapt writing, reading, listening, and speaking rules in formal and informal situations. **P3**

***P- Psychomotor skills, A-Affective Domain Skills**

**UNIT I** **09**

**Grammar** : Prepositions – Adjectives – Adverbs
**Reading** : Reading comprehension: Skimming and Scanning
**Writing** : Letter writing (Formal and Informal) – Letter to Editor
**Listening** : Listening to Business talks – TED Talks

**UNIT II** **09**

**Grammar** : Use of sequence words – Modal Verbs
**Reading** : Mind Mapping (Structured thinking and related ideas)
**Writing** : Interpreting visual materials – Note Making – Recommendations
**Listening** : Listening to specific tasks – Focused Listening – Note Taking.
**Speaking** : Making presentations on given topics – Speaking in formal Situations

**UNIT III** **09**

**Grammar** : Contextual usage of Tenses – Connectives
**Reading** : Cohesion and Coherence in Reading
**Writing** : Paragraph writing: Compare and Contrast – Cause and Effect – Jumbled Sentences
**Listening** : Listening and responding to video lectures
**Speaking** : Role-play – Group Interaction

.

**UNIT IV** **09**

**Grammar** : WH Questions – Identifying Common Errors
**Reading** : Critical Reading Shifting facts from opinions
**Writing** : Resume writing with cover letter – Free writing
**Listening** : Watching videos or documentaries and answering
**Speaking** : Responding to questions – Mock Interviews

**UNIT V** **09**

**Grammar** : Use of Imperatives – Confusing words in English
**Reading** : Reading and making inference
**Writing** : Essay writing – Report – Proposals
**Listening** : Listening to different accents – Listening to Speeches
**Speaking** : Impromptu Speeches – Describing a process

**Total: 45 Hours**

**TEXT BOOKS:**

1. Richards J C, Hull J, et al. "Interchange 3 Student's Book", 5th Edition, Cambridge University Press, 2022.
2. Harding, Keith, and Appleby, Rachel, "International Express: Pre-Intermediate: Student's Book", 3rd Edition, Oxford University Press, 2019.

**REFERENCE BOOKS:**

1. Swan, Michael and Walter Catherine, "Oxford English Grammar Course", 1st Edition, Oxford University Press, 2019.
2. Sudharshana N P and Savitha C, "English for Engineers", 1st Edition, Cambridge University Press, 2018.
3. Brook-Hart G, "Business benchmark: Upper intermediate: Business vantage: Student's book", 2nd Edition, Cambridge University Press, 2021.

**WEBSITES:**

1. www.myenglishpages.com
2. www.cambridgeenglish.org/learning-english/
3. www.eslvideo.com/index.php

**CO, PO PSO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | 2 | - | - | 2 | 2 | 3 | - | 2 | 1 | - |
| CO2 | - | - | - | - | 2 | - | - | 2 | 2 | 3 | - | 2 | 1 | - |
| CO3 | - | - | - | - | 2 | - | - | 2 | 2 | 3 | - | 2 | 1 | - |
| CO4 | - | - | - | - | 2 | - | - | 2 | 2 | 3 | - | 2 | 1 | - |
| CO5 | - | - | - | - | 2 | - | - | 2 | 2 | 2 | - | 2 | 1 | - |
| **Average** | **-** | **-** | **-** | **-** | **2** | **-** | **-** | **2** | **2** | **2.8** | **-** | **2** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**24BECC202C TRANSFORMS AND ITS APPLICATIONS** **SEMESTER – II**
**4H-4C**

**Instruction Hours/week:** L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
**End Semester Exam:**3 Hours

**PREREQUISITES:** Matrices and Calculus

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Understand the concept of periodic functions and represent it as Fourier series.
- Provide knowledge of Fourier series techniques in solving heat flow problems and wave equations.
- Impart the knowledge of Laplace Transforms and Inverse Laplace Transforms techniques and its applications.

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Illustrate Fourier series representation of periodic functions (K2)
- Apply Fourier series in one dimensional heat flow and wave equation (K3)
- Make use of Fourier transform for converting elementary functions into frequency domain (K3)
- Utilize Laplace Transform to convert time-domain systems into frequency-domain systems (K3)
- Apply Inverse Laplace Transform in linear differential equations (K3)

**UNIT I FOURIER SERIES 12**

Dirichlet's conditions – General Fourier series in the interval (0,2l) & (-l,l) – Half range sine series –Half range cosine series –Parseval's Identity – Harmonic analysis.

**UNIT II APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12**

Fourier series solution for one dimensional wave equation – Fourier series solution for one dimensional heat equation with zero end conditions

**UNIT III FOURIER TRANSFORMS 12**

Fourier Integral Theorem – Fourier transform pair –Fourier sine and cosine transforms –Properties – Convolution theorem – Parseval's identity of Fourier transform.

**UNIT IV LAPLACE TRANSFORM 12**

Transforms of standard functions – Properties of Laplace transform – Transforms of derivatives and integrals –Initial and final value theorem – Transforms of periodic functions.

**UNIT V INVERSE LAPLACE TRANSFORM 12**

Inverse Laplace transforms of standard functions – Inverse Laplace transform using second shifting theorem – Method of partial fractions– Convolution– Solution of ordinary differential equations with constant coefficients using Laplace transforms

**Total: 45 Hours**

**TEXT BOOKS:**

1. Boyce, Diprima and Meade, "Elementary Differential Equations and Boundary Value Problems", 12th Edition, John Wiley & Sons, 2021.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley and Sons, 2017

**REFERENCE BOOKS:**

1. T. Hillen, "Partial Differential Equations", 2nd Edition, Friesen Press, 2019.
2. Dennis G. Zill, "Advanced Engineering Mathematics", 7th Edition, Jones and Bartlett Publishers, 2020.
3. Richard Haberman, "Applied Partial Differential Equations with Fourier Series and Boundary Value Problems", 5th Edition, Pearson, 2021.
4. Grewal B.S., "Higher Engineering Mathematics", 44thEdition, Khanna Publishers, New Delhi, 2018.

**WEBSITES:**

1. www.infocobuild.com/education/audio-video-courses/mathematics/Transform TechniquesForEngineers-IIT-Madras/lecture-01.html
2. www.infocobuild.com/education/audio-video-courses/mathematics/ordinary-and-partial-differential-equations-iit-roorkee.html
3. www.electrical4u.com/laplace-transformation/

**CO, PO PSO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 | 2 | 1 |
| CO2 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 2 | 1 |
| CO3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 2 | 1 |
| CO4 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 2 | 1 |
| CO5 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 2 | 1 |
| **Average** | **2.8** | **1.8** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **2** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**24BECC203** **SEMESTER-II**

**ENVIRONMENTAL STUDIES** **3H-3C**

**Instruction Hours/week: L:3 T:0 P:0** **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:** 3 Hours

**PRE REQUESTE : Nil**

**COURSE OBJECTIVES:**

The goal of this course is for students to:

- Create a basic understanding about ecosystem and natural resources.
- Acquire knowledge on biodiversity conservation and pollution eradication.
- Introduce the roles and responsibilities about social issue and improvement in the interconnected world

**COURSE OUTCOMES:**

Upon completion of this course, the student will be able to:

- Outline the ecological processes supporting the life system (K2)
- Infer the importance of environment and impact of human activities on natural resources (K2)
- Demonstrate the levels and values of biodiversity and its conservation (K2)
- Summarize the problems of environmental pollution and its control measures (K2)
- Interpret the remediation methods for social issues and degraded environment (K2)

**UNIT I – ENVIRONMENT & ECOSYSTEMS** **9**

Environment Definition, Scope and importance; layers of atmosphere-Ecosystem, Structure and functions of ecosystem. Energy flow, Food chains and food webs, Ecological succession. Classification of ecosystem. Forest ecosystem, Grassland Ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

**UNIT II - NATURAL RESOURCES** **9**

Natural resources - Renewable and Non - Renewable resources. Land resources and land use change, Land degradation, soil erosion and desertification. Forest resources- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water resources- Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water. Use of alternate energy sources, growing energy needs, case studies. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

**UNIT III - BIODIVERSITY AND ITS CONSERVATION** **9**

Levels of biological diversity – genetic, species and ecosystem diversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. Bio-geographical classification of India. Biodiversity patterns (global, National and local levels). Hot-spots of biodiversity. India as a mega-diversity nation. Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

**UNIT IV -ENVIRONMENTAL POLLUTION** **9**

Definition, causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, E-pollution. Nuclear hazards and human health risks. Solid waste management and control measures of urban, industrial and e-wastes. Role of an individual in prevention of pollution. Case studies.

**UNIT V - SOCIAL ISSUES AND THE ENVIRONMENT** **9**

Concept of sustainability, Goals and sustainable development-circular economy- Water conservation -Rain water harvesting, watershed management. Climate change, global warming, ozone layer depletion, acid rain and its impacts on human communities and agriculture. Disaster management (floods, earthquake, cyclones and landslides). Environmental Movements (Chipko Silent valley, Bishnois of Rajasthan). Environmental ethics: Human population growth- Impacts on environment, human health and welfare-Variation among nations.

**Total Hours: 45**

**TEXT BOOKS:**


1. Anubha Kaushik., and Kaushik, C.P. 7Th Edition, 2021. Perspectives in Environmental Studies. New Age International Pvt. Ltd. Publications, New Delhi.
2. Prabhakar S Mithra, "Methodologies for environmental studies", 1st Edition, Academic Aspirations, 2021.
3. Arvind Kumar. 2004. A Textbook of Environmental Science. APH Publishing Corporation, New Delhi.
4. Erach Bharucha, "A Textbook of Environmental Studies for UG Courses" 3rd Edition, University Press India ltd, 2021.
5. Uberoi, N.K. 2005. Environmental Studies. Excel Books Publications, New Delhi.


**REFERENCE BOOKS:**


1. G.Tyler Miller and Scott Spoolman, "Living in the Environment", 20th Edition, Cengage Learning, 2021.
2. Linda D Williams, "Environmental Science" 1st Edition, Tata McGraw Hill, 2017.
3. Sing, J.S., Sing. S.P. and Gupta, S.R. 2022. Ecology, Environmental Science and Conservation. S. Chand & Publishing Company, New Delhi.
4. Mishra, D.D. 2010. Fundamental Concepts in Environmental Studies. S. Chand& Company Pvt. Ltd., New Delhi.
5. Singh, M.P., Singh, B.S., and Soma, S. Dey. 2004. Conservation of Biodiversity and Natural Resources. Daya Publishing House, New Delhi.


**WEB REFERENCES:**

1. https://www.insightsonindia.com/2013/09/06/environment-biodiversity
2. https://www.nptelvideos.in/2012/11/energy-resources-and-technology.html
3. https://www.msubbu.in/ln/environment/

**CO, PO PSO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | - | 2 | 3 | 3 | - | - | - | 2 | 1 | - |
| CO2 | 2 | 1 | - | - | - | 2 | 3 | 3 | - | - | - | 2 | 1 | - |
| CO3 | 2 | 1 | - | - | - | 2 | 3 | 3 | - | - | - | 2 | 1 | - |
| CO4 | 2 | 1 | - | - | - | 2 | 3 | 3 | - | - | - | 2 | 1 | - |
| CO5 | 2 | 1 | - | - | - | 2 | 3 | 3 | - | - | - | 2 | 1 | - |
| **Average** | **2** | **1** | **-** | **-** | **-** | **2** | **3** | **3** | **-** | **-** | **-** | **2** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**24BEBME204 INTRODUCTION TO BIOMEDICAL ENGINEERING** **SEMESTER – II**
**3H-3C**

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
**End Semester Exam:**3 Hours

**PREREQUISITES:** Nil

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the structure and functions of human physiological systems
- Interpret the bio signals and imaging system
- Summarize the ethical principles in biomedical engineering

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the working principles of human physiological system (K2)
- Interpret the physiological signals (K2)
- Illustrate the functioning of medical imaging (K2)
- Relate the properties of biomaterials and biomechanical systems (K2)
- Summarize the ethical principles in biomedical engineering (K2)

**UNIT I BASIC BIOLOGY 09**

Engineering in modern medicine, Physiological Systems-Cell Structure, Structure of nerve cell and functions, Heart & Circulatory system, Respiratory Physiology, Kidney function, Brain & Central Nervous System

**UNIT II PHYSIOLOGICAL SIGNALS 09**

Signal representation, Signal in time and Frequency domain, Signal Estimation, Bioelectric Signals: ECG & EEG, Vital Signs, Biomagnetic Signals.

**UNIT III MEDICAL IMAGING SYSTEMS 09**

Principles and Applications - X-ray & CT, Ultrasound Imaging, MRI, Nuclear Medicine, Microscopy, Biophotonics.

**UNIT IV BIOMECHANICS& BIOMATERIALS 09**

Mechanical Properties of Tissue - Stress, Strain, Viscosity and Viscoelasticity, Applications of Sports Biomechanics, Biomaterials - Types, Properties, Applications - Artificial heart & Membrane Oxygenators.

**UNIT V SOCIAL AND ETHICAL ISSUES RELATED TO BIOMEDICAL ENGINEERING 09**

Principles of clinical research, randomized controlled trials, Technology and community, Environmental aspects of technology related to healthcare delivery, Healthcare economics and health rationing.

**Total: 45 Hours**

**TEXT BOOKS:**

1. R. S. Khandpur, Biomedical Instrumentation: Technology and Applications, TATA McGraw-Hill, 2011
2. Leslie Cromwell, Biomedical Instrumentation and Measurement, Prentice Hall of India 2018

**REFERENCE BOOKS:**

1. John D. Enderle and Susan M. BlanchardIntroduction to Biomedical Engineering, Elsevier International Projects Ltd , 2012
2. Laurence J. Street, Introduction to Biomedical Engineering Technology, CRC Press, 2008

**WEBSITES:**

1. www.nptel.ac.in/courses/102101068
2. www.nptel.ac.in/courses/102105090

**CO, PO PSO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | 2 | 1 | - | - | - | 1 | - | 2 | 1 | 1 | - | 1 | 1 | - |
| **Average** | 2 | 1 | - | - | - | 1 | - | 2 | 1 | 1 | - | 1 | 1 | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME241** | **ENGINEERING PHYSICS** | **SEMESTER – II**<br>**5H-4C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:2 Marks: Internal:40 External:60 Total:100
End Semester Exam:3 Hours

**PREREQUISITES:** Nil

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Introduce the concepts of quantum mechanics and crystal for diverse applications.
- Understand the basics of laser and optical fiber with appropriate applications.
- Inculcate the basics of properties of matter and its applications.

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Outline the basics of crystals, structures and its defects (K2)
- Examine the performance of light and laser (K3)
- Identify the numerical aperture and acceptance angle of an optical fibre (K3)
- Relate the quantum concepts in electron microscope (K2)
- Apply the elastic properties of the materials to understand the modulus of the material (K3)

**UNIT I CRYSTAL PHYSICS 09**

Classification of solids: Crystalline and amorphous solids – crystal structure - unit cell, primitive cell – seven crystal systems, Bravais lattices, Miller indices – inter-planar distances (Qualitative) - Coordination number and atomic packing factor for Simple Cubic, Body Centered Cubic, Face Centered Cubic– Defects in crystal: Point & Line defect.

**UNIT II LASERS 09**

LASER: Introduction - characteristics – Absorption- spontaneous emission- stimulated emission- Einstein's co-efficients derivation- principle of laser action- population inversion-pumping methods -Types of lasers - Nd: YAG, Semiconductor Laser (Homo Junction Laser)- Applications of LASER in industry and medicine .

**UNIT III FIBRE OPTICS 09**

Fiber optics – principle and propagation of light in optical fibers – numerical aperture and acceptance angle – types of optical fibers (Material, refractive index and mode) – types of losses in optical fibers -fiber optical communication system (block diagram).

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**UNIT IV QUANTUM PHYSICS 09**

Black body radiation - Energy Distribution laws (Qualitative): Stefan Boltzmann's law, Wein's Displacement law-Rayleigh Jeans Law. Photo electric effect (Qualitative) – Compton effect (Qualitative) – De Broglie hypothesis - uncertainty principle – physical significance of wave function - Schrödinger's Time dependent wave equation - Schrödinger's Time independent wave equation – Particle in one dimensional box-Scanning Electron Microscope and Transmission Electron Microscope

**UNIT V PROPERTIES OF MATTER ENGINEERING 09**

Elasticity – stress – strain – Hookes law- classification of elastic modulus -Poisson's ratio - Stress-Strain diagram and its uses - factors affecting elastic modulus and tensile strength - Moment, Couple and Torque– Twisting couple on a wire – bending moment – cantilever-young's modulus uniform bending – I- shaped girders and its applications.

**Total: 45 Hours**

**TEXT BOOKS:**


1. Bhattacharya D.K. & Poonam T., Engineering Physics, Oxford University Press, 2015.
2. Gaur R.K. and Gupta S.L, Engineering Physics, Dhanpat Rai Publications, 2012.
3. Pandey. B.K. & Chaturvedi. S, Engineering Physics, Cengage Learning India, 2012.
4. Charles Kittel, Kittel's Introduction to Solid State Physics, Wiley India Edition, 2019.
5. P.M. Mathews, K.Venkatesan, A text book of Quantum Mechanics, 2/e, Mc Graw Hill Education, 2017.
6. Laser Fundamentals, William T Silfvast, Cambridge Univ Press. 2012.
7. Fiber Optics and Optoelectronics, R P Khare, Oxford, 2012.
8. D.S. Mathur, Elements of properties of matter, S.Chand, 2010.


**REFERENCE BOOKS:**


1. Halliday.D. Resnick R. & Walker. J, Principles of Physics, Wiley, 2015.
2. Daniel V.Schroeder, An Introduction to Thermal Physics, Pearson, 2014.


**WEBSITES:**

1. www. nptel.ac.in/courses/122/103/122103011/
2. www.nptel.ac.in/courses/113/104/113104081/
3. www.hyperphysics.phy-astr.gsu.edu/hbase/optmod/lascon.html

**LIST OF EXPERIMENTS**

1. Determination of Band gap of a semiconductor.
2. Uniform bending – Determination of young's modulus.
3. Non-uniform Bending – Determination of young's modulus.
4. Laser - Determination of the wave length of the laser using grating
5. Laser – Determination of Particle size
6. Optical Fiber – Determination of Numerical Aperture and Acceptance angle of the optical fiber.
7. Air wedge – Determination of thickness of a thin sheet/wire.

**CO, PO PSO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | - | 1 | 1 | - |
| CO2 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | - | 1 | 1 | - |
| CO3 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | - | 1 | 1 | - |
| CO4 | 3 | 3 | 2 | - | - | 1 | - | - | 2 | 2 | - | 1 | 1 | - |
| CO5 | 2 | 1 | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - |
| **Average** | **2.8** | **2.0** | **2.0** | **-** | **-** | **1.0** | **-** | **-** | **2.0** | **1.8** | **-** | **1.0** | **1.0** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**B.E Biomedical Engineering** **2024-2025**

| | | |
|---|---|---|
| **24BECC242** | **ELECTRONIC DEVICES AND CIRCUITS** | **SEMESTER – II 5H-4C** |

**Instruction Hours/week:** L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** Nil

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Illustrate the principles of electronic devices
- Compare the characteristics of BJT and FET
- Develop the application using operational amplifiers
-

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Illustrate the principles of semiconductor diodes (K2)
- Explain the configurations and characteristics of BJT (K2)
- Infer the VI characteristics of FET (K2)
- Compare the specifications of voltage regulators (K2)
- Construct an operational amplifier for the biomedical applications (K2)

**UNIT I** **SEMICONDUCTOR DIODES AND SPECIAL PURPOSE DIODES** **09**

Semiconductors: Intrinsic semiconductor – extrinsic semiconductor – Fermi level in an intrinsic semiconductor, Semiconductor diodes : Formation of PN junction – working principle – VI characteristics – diode current equation – diode resistance – transition and diffusion capacitance. Special purpose diodes: Tunnel, Varactor, Pin contact, Zener diode, Schottky diode- Clippers and clampers

**UNIT II** **BIPOLAR TRANSISTORS** **09**

Bipolar Transistors: NPN-PNP- Construction – working – transistor currents –transistor configurations (CB,CE,CC) and input- output characteristics – Early effect (base width modulation) – transistor as an amplifier Transistor as a switch.

**UNIT III** **FIELD EFFECT TRANSISTORS** **09**

Field-Effect Transistors: construction, working principle and VI characteristics of JFET – comparison of BJT and JFET – MOSFET : working principle and VI characteristics, enhancement MOSFET, depletion MOSFET - comparison of MOSFET with JFET.

**UNIT IV** **DC POWER SUPPLIES** **09**

Rectifiers – Half wave, full wave and Bridge -Block schematic of a typical DC power supply, single phase HWR, FWR, filters - ripple factor and efficiency analysis , Voltage regulators: voltage regulation, Zener diode shunt regulator, transistor series regulator, transistor shunt regulator, switching regulators. Low dropout Regulators (LDO)

**UNIT V OPERATION AMPLIFIER (OP-AMPS) 09**

Ideal Op-amp - Differential amplifier- differential and common mode operation-common mode rejection ratio (CMRR) - Practical op-amp circuits and its parameter – Compensated and uncompensated Op-amp- inverting amplifier, non -inverting amplifier, weighted summer, integrator, differentiator- Large signal operation of op-amps-Other applications of op-amps

**Total: 45 Hours**

**TEXT BOOKS:**

1. S. Salivahanan, Electronic Devices and Circuits, Tata Mcgraw Hill International, 2011
2. 2. G.K.Mithal, Electronic Devices and Circuits, Khanna Publishers , 2013

**REFERENCE BOOKS:**

1. Thomas L. Floyd, Electron Devices, Charles and Messil Publications, 2012
2. Gayakwad A R , Op-amps and Linear Integrated circuits, Pearson Education , 2011
3. Millman and Halkias Electronic devices and Circuits Tata McGraw Hill International, 2010

**WEBSITES:**

1. https://nptel.ac.in/courses/108108112
2. 2.https://nptel.ac.in/courses/108108122

**List of Experiments**

1. V-I Characteristics of PN diode
2. V-I Characteristics of Zener diode
3. Simulate the characteristics of Clippers and Clampers
4. Simulate the Input and Output Characteristics of BJT CB configuration
5. Input and Output Characteristics of BJT CE configuration
6. Drain and transfer characteristics of JFET
7. Simulate the characteristics of Inverting and non-inverting amplifier using Op-amp
8. Simulate the RC phase shift Oscillator using Op-amp
9. Half wave rectifier– with and without filter
10. Full wave rectifier – with and without filters

**CO, PO PSO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | **2.2** | **1.2** | **1** | **-** | **-** | **-** | **-** | | **1** | **1** | **-** | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BECC211** | **COMMUNICATION SKILLS LABORATORY** | **SEMESTER – II 2H-1C** |
|---|---|---|

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** Nil

**COURSE OBJECTIVES**

The goal of this course is for students to:

- To acquire different listening techniques for understanding different kinds of audio content, including lectures, conversations, videos, etc. and to effectively communicate their ideas using a variety of media
- To understand the "English language skills" by engaging them in listening and reading activities that are relevant to authentic contexts and to help learners use language effectively in academic /work contexts
- To apply the communicative competence of learners in listening, speaking, reading and writing

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Organize the context, topic, and pieces of specific information of English through all four skills. **P1**
- Identify the purpose and clarity of facts and reflect their thoughts, opinions, and knowledge through all the language skills. **A1**
- Put together skimming, scanning, and listening techniques effectively to acquire the gist from the context. **P2**
- Demonstrate in communication more effectively with their peers, instructors, and colleagues. **A2**
- Master public speaking techniques, business writing, and listening with professional speaking techniques. **P3**

***P-Psychomotor Skills, A- Affective Domain Skills**

**LIST OF EXPERIMENTS:**

| **S.No.** | **SKILLS** | **TOPICS** |
|---|---|---|
| 1 | Listening | Dialogues from TV/radio/Ted talk/Podcast |
| 2 | Listening | Listening for gist |
| 3 | Reading | Reading for detail, global understanding |
| 4 | Speaking | Presentations and interactive communication – Pair presentations |
| 5 | Listening | Listen and respond appropriately |
| 6 | Reading | Reading different genres |
| 7 | Writing | Documentary and Movie review |
| 8 | Writing | Informational or Analytical Reports |
| 9 | Speaking | Mock Interview |
| 10 | Speaking | Group Discussion |

**TOTAL: 30**

**CO, PO PSO Mapping**

| COPO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | 3 | - | - | 2 | 3 | 3 | - | 2 | - | - |
| CO2 | - | - | - | - | 2 | - | - | 2 | 3 | 3 | - | 3 | - | - |
| CO3 | - | - | - | - | 1 | - | - | 2 | 3 | 3 | - | 2 | - | - |
| CO4 | - | - | - | - | 1 | - | - | 3 | 2 | 3 | - | 2 | - | - |
| CO5 | - | - | - | - | 1 | - | - | 3 | 2 | 3 | - | 3 | - | - |
| **Average** | **-** | **-** | **-** | **-** | **3** | **-** | **-** | **3** | **3** | **3** | **-** | **2** | **-** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**SEMESTER – III**

| **B.E Biomedical Engineering** | | **2024-2025** |
|---|---|---|
| **24BEBME301A** | **DISCRETE MATHEMATICS AND STOCHASTIC PROCESS** | **SEMESTER – III 4H-4C** |

**Instruction Hours/week:** L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Inculcate the concepts of theories on Numbers
- Extend student's logical and mathematical maturity and ability to deal with abstraction
- Synthesize methods of solving problems in summation of series and recurrence relations

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Interpret the concepts of divisibility, prime number, congruence and number theorems (K2)
- Make use of propositional logic for solving problems (K2)
- Solve word problems using combinatorial analysis (K2)
- Explain major distributions of random variables and its applications (K2)
- Identify classes of states in Markov chains and characterize the classes (K3)

**UNIT I NUMBER THEORY 12**

Divisibility – Fundamental Properties – Euclidean algorithm – Euclid's lemma – Fundamental theorem of arithmetic – Congruence – Fermat's Little theorem (statement only) and the Chinese remainder theorem(statement only)

**UNIT II PROPOSITIONAL CALCULUS 12**

Propositional Calculus: Propositions – Logical connectives - compound propositions – conditional and biconditional propositions - Truth tables - Tautologies and contradictions – contrapositive – Logical equivalences and implications – Demorgan's Laws – Normal forms – Principal conjunctive and disjunctive normal forms.

**UNIT III COMBINATORICS 12**

Mathematical Induction – Permutations and combinations - Recurrence Relation – Formation of Recurrence relation – Solution of recurrence relation by Generating Functions – Concept of Probability – Conditional– Theorem of Total Probability – Baye's theorem.

**UNIT IV THEORETICAL DISTRIBUTIONS 12**

One dimensional Random Variables – Discrete and Continuous Random variables – Probability distribution function – Probability density function - Mathematical Expectations – Moments –. Mean and Variance – Moment generating function of Binomial, Poisson and Normal distributions

**UNIT V STOCHASTIC PROCESS 12**

Classification of Random Process – Discrete and Continuous cases — Auto Correlation Functions – Properties – Stationary Random processes – WSS and SSS processes – Power spectral density –

properties of power spectral density – Cross-power spectral density and properties – Auto-correlation function and power spectral density of a WSS random sequence.

**Total: 60 Hours**

**TEXT BOOKS:**

1. Ralph P Grimaldi, "Discrete and Combinatorial Mathematics: An Applied Introduction", 5th Edition, Pearson New International Edition 2016
2. Kenneth H. Rosen, "Discrete Mathematics and Applications", 7th Edition, Mcgraw Hill Education 2012
3. Peebles P Z, "Problems and solutions in probability, random variables and random signal principles (SIE)",1st Edition, McGraw Hill Education 2017
4. Roy D Yates, David J Goodman, "Probability and Stochastic processes ", 2nd Edition, Wiley India Pvt Ltd 2005
5. Douglas C. Montgomery, George C. Runger, "Applied Statistics and Probability for Engineers", John Wiley, Sixth Edition 2016

**REFERENCE BOOKS:**

4. Kenneth H Rosen, "Discrete Mathematics and its Applications with Combinatorics and Graph Theory", 7thRevised Edition, Tata McGraw – Hill Pub Co Ltd 2017
5. Kishor S Trivedi, "Probability and Statistics with reliability, Queueing and Computer Science Applications", 2nd Edition, Revised Paperbook, Prentice Hall of India 2016
6. Bernard Kolman, Robert C Busby, Sharon Ross, "Discrete Mathematical Structures", 6th Edition, Pearson publishers 2008
7. Henry Stark, John W Woods, "Probability and Random Processes with application to signal Processing", 3rd Edition, Pearson Education 2002

**WEBSITES:**

1. https://www.geeksforgeeks.org/proposition-logic/
2. www.tutorialspoint.com/discrete_mathematics/
3. https://nptel.ac.in/courses/108103185
4. https://nptel.ac.in/courses/108106083
5. www.mathworld.wolfram.com

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | - | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | - | 1 |
| CO3 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | - | 1 |
| CO4 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | - | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | - | 1 |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | **1** | **1** | **2** | **1** | **1** | **-** | **2** | **-** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME301B** | **NUMERICAL METHODS** | **SEMESTER – III**<br>**4H-4C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Inculcate the basic concepts of solving algebraic and transcendental equations.
- Understand the numerical techniques of interpolation in various intervals
- Provide the knowledge of numerical differentiation and integration

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Solve the systems of linear and nonlinear equations by iterative methods (K3)
- Make use of interpolation methods for finding the missing terms (K3)
- Apply numerical methods for finding differentiation and integration of a given function (K3)
- Solve ordinary differential equations using Euler's, Taylor's, Runge Kutta and Milne Thomson's method (K3)
- Utilize implicit and explicit methods in heat and wave equations (K3)

**UNIT I SOLUTION OF EQUATIONS 12**

Regula Falsi Method - Newton Raphson method for solving algebraic and transcendental equations -Solution of system of linear equations - Gauss elimination method - Gauss Jordan method -Gauss Seidel method

**UNIT II INTERPOLATION 12**

Interpolations with unequal intervals-Lagrange's interpolation -Newton's divided interpolation - Interpolation with equal intervals-Newton's forward and backward interpolation

**UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 12**

Approximation of derivatives using Newton's forward and backward interpolation - Numerical integration using Trapezoidal, Simpson's 1/3 and 3/8 rule

**UNIT IV NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12**

Single step method- Euler's method-Taylor's series method-Fourth order Runge – Kutta method – Multi step method-Milne's predictor corrector method

**UNIT V NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12**

Solutions of one dimensional heat equation by Bender-Schmidt and Crank Nicholson methods – Numerical solutions of one dimensional wave equation by explicit method

**Total: 60 Hours**

**TEXT BOOKS:**

1. Steven C.Chapra, Raymond P.Canale, "Numerical Methods for Engineers", McGraw Hill Education, Seventh Edition 2015
2. Curtis F. Gerald, Patrick O. Wheatley, "Applied Numerical Analysis", Addison Wesley, Thirteenth Edition 2004

**REFERENCE BOOKS:**

1. Richard L. Burden, J. Douglas Faires, "Numerical Methods Brooks/Cole", 4th edition ,2012
2. Erwin Kreyszig, "Advanced Engineering Mathematics" , John Wiley and Sons, Tenth Edition , 2011

**WEBSITES:**

1. https://archive.nptel.ac.in/courses/111/107/111107105/
2. https://ocw.mit.edu/courses/18-03-differential-equations-spring-2010/resources/lecture-2-eulers- numerical-method-for-y-f-x-y/
3. http://www.infocobuild.com/education/audio-video-courses/mathematics/numerical-analysis-iit- madras.html
4. http://www.infocobuild.com/education/audio-video-courses/mathematics/NumericalMethods- FiniteDifference-IIT-Roorkee/lecture-06.html

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | - |
| CO2 | K3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | - |
| CO3 | K3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | - |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | - |
| **Average** | | **3** | **2** | **1** | **-** | **-** | **-** | - | - | - | - | - | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME302** | **HUMAN ANATOMY AND PHYSIOLOGY** | **SEMESTER – III**<br>**3H-3C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: BIOLOGY FOR ENGINEERS**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the building blocks of human body
- Summarize the functions of cardiac, nervous, respiratory and musculoskeletal system of human body
- Identify the elements of the digestive, sensory and endocrine systems

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the structure and functions of cells and its organelles (K2)
- Outline the anatomy and physiology of cardiac and nervous system (K2)
- Illustrate the working mechanism of human respiratory and musculoskeletal system (K2)
- Infer the functions of digestive, excretory and lymphatic system (K2)
- Model the sensory and endocrine systems of human body (K3)

**UNIT I FUNDAMENTAL ELEMENT OF HUMAN BODY 09**

Structure of Cell - Description and function of cell components - Cell Membrane: Membrane and Action Potential - Generation and Conduction - Electrical Stimulation. Blood Cell: Composition - Origin of RBC - Blood Groups - Estimation of RBC, WBC and Platelet.

**UNIT II CARDIAC AND NERVOUS SYSTEM 09**

Heart, Major blood vessels - Cardiac Cycle - ECG - Blood Pressure - Feedback Control for Blood Pressure - Nervous Control of Heart - Cardiac output - Coronary and Peripheral Circulation - Structure and function of Nervous tissue: Neuron - Synapse - Reflexes – Receptors, Brain: Structure - Brainstem - Spinal cord - Reflex action - Conduction of Nerve Impulses – Electroencephalograph

**UNIT III RESPIRATORY SYSTEM AND MUSCULOSKELETAL SYSTEM 09**

Physiological aspects of respiration - Trachea and lungs - Exchange of gases - Regulation of respiration - Disturbance of respiration function - Pulmonary function test - Muscles - tissue - types structure of skeletal muscle - types of muscle and joints.

**UNIT IV DIGESTIVE, EXCRETORY AND LYMPHATIC SYSTEM 09**

Organisation of GI System, Digestion and absorption - Movements of GI tract - Intestine - Liver - Pancreas - Structure of Nephron - Mechanism of Urine formation - Urine Reflex - Skin and Sweat Gland - Temperature regulation, Lymphatic: Parts and Functions of Lymphatic systems - Types of Lymphatic organs and vessels.

**UNIT V** **SENSORY AND ENDOCRINE SYSTEMS** **09**

Optics of Eye - Retina - Photochemistry of Vision - Neurophysiology of eye - EOG, Structure of internal ear - Mechanism of hearing - Auditory Pathway, Hearing Tests - Endocrine - Pituitary and thyroid glands.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Prabhjot Kaur, "Text Book of Anatomy and Physiology", Lotus Publishers, 2014
2. Elaine.N. Marieb, "Essential of Human Anatomy and Physiology", Pearson Education, New Delhi, 2016

**REFERENCE BOOKS:**

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, "Fundamentals of Anatomy and Physiology", Pearson Publishers, 2014
2. Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology", W.B. Saunders Company, 2015
3. Gillian Pocock, Christopher D. Richards, "The human Body – An introduction for Biomedical and Health", Oxford University Press, USA, 2013

**WEBSITES:**

1. https://openstax.org/details/books/anatomy-and-physiology
2. https://www.visiblebody.com/anatomy-and-physiology-apps/anatomy-and-physiology

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | **1** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME303** | **BIOSENSORS AND MEASUREMENTS** | **SEMESTER – III**<br>**3H-3C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the classifications and the characteristics of transducers
- Illustrate the working principles of bio transducers and bio sensors
- Select the visual display devices used in biomedical measurements

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain static and dynamic characteristics of transducers (K2)
- Illustrate the working of biosensors (K2)
- Compare the methods for measuring electrical and nonelectrical parameters (K2)
- Interpret the sensor fabrication technique for biomedical applications (K2)
- Identify the visual display devices used in biomedical measurements (K3)

**UNIT I INTRODUCTION TO TRANSDUCERS AND ITS CHARACTERISTICS 09**

Introduction: Generalized Instrumentation System, General Properties of Input Transducer Static Characteristics: Accuracy, Precision, Resolution, Reproducibility, Sensitivity, Drift, Hysteresis, Linearity, Input Impedance and Output Impedance. Dynamic Characteristics: First Order and Second Order Characteristics, Time Delay, Error Free Instrument, Transfer Functions. Design Criteria, Generalized Instrument Specifications.

**UNIT II BIOSENSORS 09**

Chemical Sensors: Blood gas and Acid - Base Physiology Potentiometric Sensors, Ion Selective Electrodes, ISFETS. Ampero metric Sensors, Clark Electrode with examples - pH, pO2, pCO2 Electrodes, Transcutaneous Arterial Oxygen Tension, Carbon Dioxide measurements: capnostat. Biosensor: Classifications: Biological phenomenon, Transduction Phenomenon i.e. Enzyme Sensor and Electrode based: Affinity Sensors (Catalytic Biosensors), Two examples of each Biosensors and Immunosensor

**UNIT III MEASUREMENT 09**

Displacement, motion and Pressure Measurement: (with applications) Resistive: Potentiometers, Strain Gauges and Bridge Circuits. Inductive: Variable Inductance and LVDT Capacitive type, Piezoelectric Transducers. Types of Diaphragms, Bellows, Bourdon Tubes. Temperature Measurement: Thermistor, Thermocouple, Resistive Temperature Detector, IC based Temperature Measurement, Radiation Sensors and Applications.

**UNIT IV SENSOR FABRICATION 09**

Sensor Fabrications - an overview, Fabrication Technique - Pressure sensor - Pizorestive pressure sensor - capacitive pressure sensor - Micro sensor - Biomedical Application.

**UNIT V** **VISUALIZATION DEVICES** **09**

CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder. Biosensors: transduction mechanism in a biosensor and Classification – Electronic nose

**Total: 45 Hours**

**TEXT BOOKS:**

1. Hermann K P. Neubert, "Instrument Transducer– An Intro to their performance and design", Oxford University Press, 2000
2. Harry N, Norton, "Biomedical sensors –fundamentals and application", Noyes Publications, 2001
3. Nandini K, "Electronics in Medicine and Biomedical Instrumentation", Jog PHI Second Edition, 2013

**REFERENCE BOOKS:**

1. Leslie Cromwell, Fred, J. Weibell and Pfeiffer, "Biomedical instrumentation and measurement", Prentice Hall of India, 2002
2. Jacob Fraden, "Handbook of Modern Sensors – Physics, Design and Application", AIP press, 2000

**WEBSITES:**

1. https://nptel.ac.in/courses/1081081471

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | 1 | - | 1 | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | 1 | - | 1 | 1 | 1 | - | 1 | 1 | - |
| CO4 | K2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | 1 | - | 1 | **1** | **1** | - | **1** | **1** | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME304** | **SIGNALS AND SYSTEMS** | **SEMESTER – III**<br>**3H-3C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: TRANSFORMS AND ITS APPLICATIONS**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the continuous and discrete time signals
- Make use of transforms to differentiate continuous and discrete time signals
- Analyse linear time invariant - continuous and discrete systems

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Classify the types of signals and systems (K2)
- Apply Fourier and Laplace transform for continuous signals (K3)
- Analyze the linear time invariant continuous systems (K4)
- Model the Z-transform for discrete time signals (K3)
- Examine the linear time invariant discrete systems (K4)

**UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 09**

Continuous time signals (CT signals) - Discrete time signals (DT signals) - Step, Ramp, Pulse, Impulse, Sinusoidal, Exponential, Classification of CT and DT signals - Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - CT systems and DT systems- Classification of systems – Static & Dynamic, Linear & Nonlinear, Time-variant & Time invariant, Causal & Noncausal, Stable & Unstable.

**UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 09**

Fourier series analysis-spectrum of Continuous Time (CT) signals- Fourier and Laplace Transforms in CT Signal Analysis - Properties.

**UNIT III LINEAR TIME INVARIANT- CONTINUOUS TIME SYSTEMS 09**

Differential Equation-Block diagram representation-impulse response, convolution integrals- Fourier and Laplace transform in analysis of CT systems.

**UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 09**

Baseband Sampling - DTFT – Properties of DTFT - Z Transform– Properties of Z Transform

**UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 09**

Difference Equations-Block diagram representation-Impulse response - Convolution sum-Discrete. Fourier and Z Transform Analysis of Recursive & Non-Recursive systems.

**Total: 45 Hours**

**TEXT BOOKS:**

1. S Salivahanan, "Instrument Transducer– An Intro to their performance and Design", McGraw Hill Education 2018
2. B.P. Lathi, "Principles of Linear Systems and Signals", Second Edition Oxford, 2009

**REFERENCE BOOKS:**


1. Allan V. Oppenheim, S.Wilsky and S. H. Nawab, "Signals and Systems", Pearson, 2007
2. R. E. Zeimer, W. H. Tranter and R. D. Fannin, "Signals & Systems Continuous and Discrete", Pearson, 2007
3. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007


**WEBSITES:**

1. https://nptel.ac.in/courses/117104074
2. https://nptel.ac.in/courses/117101055

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO2 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO3 | K4 | 3 | 3 | 2 | 1 | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO5 | K4 | 3 | 3 | 2 | 1 | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| **Average** | | **2.8** | **2.2** | **1.5** | **1** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **2** | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME305** | **ANALOG AND DIGITAL ELECTRONICS** | **SEMESTER – III**<br>**3H-3C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Illustrate the working of operational amplifier
- Explain the types of A/D, D/A converters and analog filters
- Outline the principles of logic gate and digital logic circuits

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the VI characteristics and applications of Op-Amp (K2)
- Compare the operations of A/D and D/A converters (K2)
- Classify the working of analog filters (K2)
- Interpret the Boolean theorems (K2)
- Develop the application using logic circuits (K3)

**UNIT I INTRODUCTION TO OPAMP 09**

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.

**UNIT II DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS AND PLL 09**

Analog switches, High speed sample and hold circuit and IC‘s, Types of D/A converter -Weighted resistor, R-2R ladder DAC, D/A Accuracy and Resolution. A/D converter - Flash, Dual slope, Successive approximation, A/D Accuracy and Resolution. Voltage controlled oscillator, Voltage to Frequency converters. PLL-Closed loop analysis of PLL, Frequency multiplication/ division, FSK demodulator

**UNIT III FILTERS 09**

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.

**UNIT IV DIGITAL FUNDAMENTALS 09**

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1’s and 2’s complements, Codes –Binary, BCD, Excess 3, Gray, Alphanumeric codes, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization.

**UNIT V** **DIGITAL LOGIC CIRCUITS** **09**

Combinational Circuits: Binary Adder-Subtractor, Decimal Adder, Binary Multiplier, Magnitude Comparator, Decoders, Encoders, Multiplexers. Sequential Circuits: Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Counters- Up/Down counter, Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Ramakant A Gayakwad, "Operational Amplifiers & Linear Integrated Circuits", Prentice Hall,2000
2. M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson, 2014
3. S.Salivahanan and S.Arivazhagan "Digital Electronics", 1st Edition, Vikas Publishing House pvt Ltd, 2012

**REFERENCE BOOKS:**

1. Roy Choudhary, "Linear Integrated Circuits", New Age International (P) Ltd, 2004
2. Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011

**WEBSITES:**

1. http://www.nptel.ac.in/courses/117106088
2. https://nptel.ac.in/courses/108102095
3. https://nptel.ac.in/courses/117106086

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME341** | **DATA STRUCTURES AND ALGORITHMS** | **SEMESTER – III 5H-4C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Understand the concepts of ADTs.
- Learn linear data structures – lists, stacks, and queues.
- Implement sorting, searching and hashing algorithms.

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Interpret the concepts of linear and non-linear data structures (K2)
- Identify appropriate linear/non–linear data structure operations for solving a given problem (K3)
- Experiment with linear and non-linear data structure operations to understand their implementation, performance, and practical applications (K3)
- Apply searching and sorting algorithms for solving a problem (K3)
- Develop the application using suitable data structures (K3)

**UNIT I LISTS 08**

Abstract Data Types (ADTs) – Elementary Data types – List ADT – Array-based implementation – Linked list implementation – Singly linked lists – Doubly-linked lists – Circularly linked lists – Applications of lists – Polynomial ADT – Multilists – Sparse Matrices.

**UNIT II STACKS AND QUEUES 08**

Stack ADT – Operations – Applications – Balancing symbols – Evaluating arithmetic expressions – Infix to Postfix conversion – Function calls – Queue ADT – Operations – Circular queue – Deque – Applications of queues.

**UNIT III TREES 08**

Tree ADT – Tree traversals – Binary tree ADT – Expression trees – Binary search tree ADT– AVL Trees – Red-Black trees – Priority queue (Heaps) – Binary heap.

**UNIT IV MULTIWAY SEARCH TREES AND GRAPHS 09**

B-Tree – B+ Tree – Tries – Graph definition – Representation of graphs – Types of graphs – Breadth-first traversal – Depth-first traversal – Bi-connectivity – Euler circuits – Topological sort – Dijkstra's algorithm – Minimum spanning tree – Prim's algorithm – Kruskal's algorithm

**UNIT V SEARCHING, SORTING AND HASHING TECHNIQUES 09**

Searching – Linear search – Binary search – Sorting – Bubble sort – Selection sort – Insertion sort – Shell sort – Quick sort – Merge sort – Heap sort – Radix sort – Hashing – Hash functions – Separate chaining – Open addressing – Rehashing – Extendible hashing

**CONTEMPORARY TOPICS 03**

**Total Periods: 45**

**LIST OF EXPERIMENTS:**

1. Implement array implementation of Stack, Queue, and Circular Queue ADTs.
2. Develop the implementation of a singly linked list.
3. Create linked list implementation of stack and linear queue ADTs.
4. Implement the evaluation of postfix expressions and infix to postfix conversion.
5. Develop the implementation of binary search trees and AVL Trees.
6. Implement insertion sort, merge sort and quick sort.
7. Create open addressing (Linear probing and Quadratic probing).

**Total Periods: 30**

**TEXT BOOKS:**

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 2019
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, "Introduction to Algorithms", 4th Edition, MIT Press, 2022

**REFERENCE BOOKS:**

1. Narasimha Karumanchi, "Data Structures and Algorithms Made Easy", 1st Edition, Career monk Publications, 2019
2. Langsam, Augenstein and Tanenbaum, "Data Structures Using C and C++", 2nd Edition, Pearson Education, 2020
3. Jan Wengrow, "A Common–Sense Guide to Data Structures and Algorithm", 2nd Edition, O'Reilly Publications, 2020
4. Yashavant Kanetkar, "Data Structures Through C", 4th Edition, BPB publications, 2022

**WEBSITES:**

1. https://nptel.ac.in/courses/106102064
2. www.coursera.org/learn/data-structures
3. www.cs.usfca.edu/~galles/visualization/Algorithms.html

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | 1 | - | - | - | 2 | 2 | - | 2 | - | 1 |
| CO2 | K3 | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 2 | - | 2 | - | 1 |
| CO3 | K3 | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 2 | - | 2 | - | 1 |
| CO4 | K3 | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 2 | - | 2 | - | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 2 | - | 2 | - | 1 |
| **Average** | | **2.8** | **1.8** | **1** | **-** | **1** | - | - | - | **2** | **2** | - | **2** | **-** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME311** | **BIOSENSORS AND MEASUREMENTS LABORATORY** | **SEMESTER – III 2H-1C** |
|---|---|---|

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Analyze transducers for measuring non-electrical parameters
- Examine the characteristics of bridge circuits
- Make use of biosensors for data acquisition of physiological signals

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Identify the applications of biological sensor and LVDT (K3)
- Experiment with thermistor, RTD and thermocouple (K3)
- Examine the characteristics of Flow transducer, photo diodes, phototransistor and Piezoelectric transducer (K3)
- Inspect the methods for data acquisition of physiological signals (K4)
- Analyze the characteristics of bridge circuits (K4)

**LIST OF EXPERIMENTS**

1. Simulate the performance of a bio-sensor
2. Simulate the performance of a chemical sensor
3. Simulate the performance of strain gauge sensor
4. Simulate the temperature sensor (Thermocouple)
5. Simulate the wheatstone bridge and Maxwell's bridge
6. Displacement measurement using LVDT
7. Characteristics of temperature sensors – thermistor and RTD.
8. Characteristics of photodiodes and phototransistor
9. Characteristics of Piezoelectric Transducers.
10. Data acquisition of physiological signals

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K3 | 3 | 2 | 1 | - | 1 | 2 | - | 2 | 2 | 2 | - | 1 | 2 | - |
| CO2 | K3 | 3 | 2 | 1 | - | 1 | 2 | - | 2 | 2 | 2 | - | 1 | 2 | - |
| CO3 | K3 | 3 | 2 | 1 | - | 1 | 2 | - | 2 | 2 | 2 | - | 1 | 2 | - |
| CO4 | K4 | 3 | 3 | 2 | 1 | 1 | 2 | - | 2 | 2 | 2 | - | 1 | 2 | - |
| CO5 | K4 | 3 | 3 | 2 | 1 | 1 | 2 | - | 2 | 2 | 2 | - | 1 | 2 | - |
| **Average** | | **3** | **2.6** | **1.6** | **1** | **1** | 2 | - | 2 | **2** | **2** | - | **1** | **2** | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME312** | **ANALOG AND DIGITAL ELECTRONICS LABORATORY** | **SEMESTER – III 2H-1C** |
|---|---|---|

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Experiment with amplifier, oscillator and filter circuits
- Build the combinational circuits using logic gates
- Inspect the operation of sequential circuits using logic gates

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Construct amplifier and oscillator circuits (K3)
- Analyze the characteristics of analog filter circuits (K4)
- Simplify the combinational circuits using logic gates (K4)
- Examine the truth table of JK and SR flipflops (K4)
- Develop shift register and synchronous up/down counter (K3)

**LIST OF EXPERIMENTS**

1. Design and realize the transfer characteristic and CMRR of differential amplifiers
2. Design and realize the characteristics of an Op-amp under inverting and non inverting configuration
3. Design and verify the output waveform of an Op-amp RC phase shift Oscillator
4. Construct differentiator and Integrator using an Op-amp
5. Design and develop analog filters (LPF, HPF)
6. Solve Boolean expressions using logic gates
7. Design and implementation of adders and Subtractors using logic gates.
8. Design and implementation of SR and JK Flip Flop
9. Design and implementation of shift registers.
10. Design and implementation of 3 bit Synchronous up/down counter.

**Total: 30 Hours**

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K3 | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 2 | - | 1 | 1 | - |
| CO2 | K4 | 3 | 3 | 2 | 1 | 1 | - | - | - | 2 | 2 | - | 1 | 1 | - |
| CO3 | K4 | 3 | 3 | 2 | 1 | 1 | - | - | - | 2 | 2 | - | 1 | 1 | - |
| CO4 | K4 | 3 | 3 | 2 | 1 | 1 | - | - | - | 2 | 2 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 2 | - | 1 | 1 | - |
| **Average** | | **3** | **2.6** | **1.6** | **1** | **1** | - | - | - | **2** | **2** | - | **1** | **1** | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| 24BEBME313 | SKILL DEVELOPMENT-I<br>MEDICAL CODING | SEMESTER – III<br>2H-1C |

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Interpret the terminologies related to human anatomy and physiology
- Summarize the commonly used codes for medical coding
- Translate the medical data into EHR using state of the art tools and methods

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the basic anatomy and physiology of human body (K2)
- Outline the common terms used in the medical field (K2)
- Summarize the ICD-10-CM, CPT, HCPCS codes used in medical coding (K2)
- Relate the medical coding terminologies with conditions related to digestive and circulatory system (K2)
- Illustrate the process of medical coding using case studies with state of art tools (K2)

**LIST OF EXPERIMENTS**

1. Basic anatomy and physiology
2. Common medical terms and abbreviations
3. ICD-10-CM (International Classification of Diseases, 10th Revision, Clinical Modification)
4. CPT (Current Procedural Terminology).
5. CPT Codes
6. HCPCS Codes
7. Digestive system and its disease coding.
8. Circulatory system and its disease coding
9. Introduction to coding software and electronic health records (EHR)
10. Case Studies and Practical Application

**Total: 30 Hours**

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **K2** | 2 | 1 | - | - | 1 | 1 | - | - | 1 | 1 | - | 1 | - | 1 |
| **CO2** | **K2** | 2 | 1 | - | - | 1 | 1 | - | - | 1 | 1 | - | 1 | - | 1 |
| **CO3** | **K2** | 2 | 1 | - | - | 1 | 1 | - | - | 1 | 1 | - | 1 | - | 1 |
| **CO4** | **K2** | 2 | 1 | - | - | 1 | 1 | - | - | 1 | 1 | - | 1 | - | 1 |
| **CO5** | **K2** | 2 | 1 | - | - | 1 | 1 | - | - | 1 | 1 | - | 1 | - | 1 |
| **Average** | | **2** | **1** | **-** | **-** | **1** | **1** | **-** | **-** | **1** | **1** | **-** | **1** | **-** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **B.E Biomedical Engineering** | | **2024-2025** |
|---|---|---|
| **24BEBME391** | **INTERNSHIP / FIELD PROJECT - I** | **SEMESTER – III**<br>**2H-1C** |
| **Instruction Hours/week:** L:0 T:0 P:2 | | **Marks:** Internal**:100** External**:00** Total**:100**<br>**End Semester Exam:**3 Hours |

**SEMESTER – IV**

| **B.E Biomedical Engineering** | | **2024-2025** |
|---|---|---|
| **24BEBME401** | **BIOMATERIALS AND ARTIFICIAL ORGANS** | **SEMESTER – IV 3H-3C** |

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Infer characteristics and classification of Biomaterials
- Interpret the interaction of biomaterials in living system
- Outline the characteristics of metals, ceramics and polymers used for implant design

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the properties of Biomaterials (K2)
- Compare the metallic and ceramic materials used in implants (K2)
- Interpret the functions of polymeric implants used in biomedical applications (K2)
- Illustrate the operations of Artificial Organs (K2)
- Summarize material selection for implant design (K2)

**UNIT I INTRODUCTION TO BIO-MATERIALS 09**

Definition and classification of bio-materials, mechanical properties, visco elasticity, biomaterial performance, body response to implants, wound healing, blood compatibility, Nano scale phenomena

**UNIT II METALLIC AND CERAMIC MATERIALS 09**

Metallic implants – Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics

**UNIT III POLYMERIC IMPLANT MATERIALS 09**

Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin. Medical Textiles, Materials for ophthalmology: contact lens, intraocular lens. Membranes for plasma separation and Blood oxygenation, electro spinning: a new approach

**UNIT IV ARTIFICIAL ORGANS 09**

Use of patient's lung for gas exchange, the ideal heart lung device. Comparisons of natural and artificial lungs, Basic types of oxygenators, temperature maintenance, and gas flow rate requirements for artificial lungs. Basic methods of artificial waste removal, Hemodialysis, modeling of the patient, artificial kidney system, Drug delivery carriers

**UNIT V IMPLANT DESIGN PARAMETERS AND ITS SOLUTION 09**

Principles of implant design, Clinical problems requiring implants for solution, Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Implants for Bone, Devices for nerve regeneration, Carbons and its medical applications

**Total: 45 Hours**

**TEXT BOOKS:**


1. Sujata V. Bhatt, "Biomaterials", Narosa Publishing House , 2005
2. Sreeram Ramakrishna, Murugan Ramalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, "Biomaterials: A Nano Approach", CRC Press , 2010
3. Kopff W.J, "Artificial Organs", John Wiley and sons, New York, 1st edition , 1976


**REFERENCE BOOKS:**


1. Myer Kutz, "Standard Handbook of Biomedical Engineering& Design", McGraw Hill, 2003
2. B. D. Ratner, AS Hoffmann, FJ Schoen,JE Lemmon, "An Introduction to Materials in Medicine", Academic Press 2012
3. J. D. Bronzin, "Biomedical Engineering handbook Volume II", CRC Press / IEEE Press 2000
4. R.S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill 2003


**WEBSITES:**

1. https://www.nature.com/subjects/biomaterials
2. https://www.sciencedirect.com/journal/biomaterials
3. https://nptel.ac.in/courses/113108071
4. https://ocw.mit.edu/courses/2-782j-design-of-medical-devices-and-implants-spring

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO5 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **Average** | | **2** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **2** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME402** | **BIOMEDICAL SIGNAL PROCESSING** | **SEMESTER – IV**<br>**4H-4C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: SIGNALS AND SYSTEMS**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Summarize the process of physiological signal acquisition
- Make use of mathematical models to eliminate the noise and artifacts in the biomedical signal
- Develop a mathematical model to perform signal classification and recognition

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the process of biomedical signal acquisition (K2)
- Apply time and frequency domain filters to remove noise from biomedical signal (K3)
- Choose appropriate mathematical model for cardiovascular applications (K3)
- Compare the statistical approaches used for neurological applications (K2)
- Apply machine learning approaches for biomedical signal classification (K3)

**UNIT I INTRODUCTION TO BIOMEDICAL SIGNALS 12**

Sampling and aliasing , Signal reconstruction, Signal conversion systems, convolution - Correlation - FFT - decimation in time algorithm, Decimation in Frequency algorithm. Artificial intelligence in signal processing. Biosignal Characteristics of Electro Cardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Electrogastrogram (EGG), Electroneurogram (ENG), Event related potentials (ERPs), Phonocardiogram (PCG), Speech signal, Objectives of Biomedical signal analysis, Difficulties in Biomedical signal analysis, Computer-aided diagnosis.

**UNIT II FILTERING FOR REMOVAL OF ARTIFACTS 12**

Time-domain Filters - synchronized averaging, Moving Average Filters, Derivative-based operators to remove low-frequency artifacts. Frequency-domain filters - Removal of High Frequency noise, Removal of low frequency noise, Removal of periodic artifacts, optimal filter- Wiener filter, Adaptive filters for removal of interference.

**UNIT III CARDIOVASCULAR APPLICATIONS 12**

Noise &Artifacts, ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection, Adaptive noise cancelling in ECG, improved adaptive filtering in FECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets. Wavelet transforms - mother wavelet, Computation of diagnostic signal parameters of ECG like Heart rate and QRS detection using Multivariate analysis (PCA and ICA). Segmentation of PCG, intensity patterns, Spectral modelling and analysis of PCG signals.

**UNIT IV** **NEUROLOGICAL APPLICATIONS** **12**

EEG rhythms & waveforms, EEG applications- Epilepsy, sleep disorders, brain computer interface. Modelling EEG- linear, stochastic models - Nonlinear modelling of EEG - artifacts in EEG & their characteristics and processing – Nonparametric spectral analysis, Model based spectral analysis - EEG segmentation - Joint Time- Frequency analysis - correlation analysis of EEG channels - coherence analysis of EEG channels. Evoked potentials- noise characteristics, Noise reduction by linear filtering.

**UNIT V** **ANALYSIS ON WAVESHAPE, SIGNAL CLASSIFICATION AND RECOGNITION** **12**

Modelling intramuscular EMG-Intramuscular signal decomposition-Fractal analysis of EMG signals. Statistical analysis of VAG signals. Analysis on amplitude and latency of MEG signals. Analysis of ERP effect. Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Analysis of EEG using Empirical mode decomposition (EMD)

**Total: 60 Hours**

**TEXT BOOKS:**

1. John G. Proakis and Dimitris G.Manolakis, "Digital Signal Processing, Algorithms and Applications", PHI of India Ltd., New Delhi, 3rd Edition,2021
2. Rangaraj.M.Rangayyan, "Biomedical signal Analysis", Wiley-IEEE Press, 2015

**REFERENCE BOOKS:**

1. Sanjit K.Mitra, "Digital Signal Processing,A Computer Based Approach", Tata McGraw-Hill, New Delhi, 2001
2. D.C.Reddy, "Biomedical Signal Processing, Principles and Technique", TMH, New Delhi, 2005

**WEBSITES:**

1. tel.ac.in/courses/108105101
2. w.mit.edu/courses/res-6-008-digital-signal-processing-spring-2011/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 2 |
| CO2 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 2 |
| CO3 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 2 |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 2 |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 2 |
| **Average** | | **2.6** | **1.6** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME403** | **BIOMEDICAL INSTRUMENTATION** | **SEMESTER – IV**<br>**3H-3C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Outline the process of recording the biopotentials
- Illustrate the signal conditioning circuits for efficient measurement of biological signals
- Develop biosensors to acquire non-electrical and biochemical parameter

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the process of acquiring biopotentials (K2)
- Illustrate the working of biopotential measuring systems (K2)
- Infer the principles of signal conditioning circuits for noise filtering (K2)
- Interpret the techniques for measuring non-electrical parameters (K2)
- Identify biochemical components present in body using sensors (K3)

**UNIT I BIOPOTENTIAL ELECTRODES 09**

Cell and its structure – resting potentials – action potentials – bioelectric potentials – measurement of potentials and their recording – Electrode theory – bipolar and Unipolar electrode-surface electrode – electrode impedance –equivalent circuit for extra cellular electrodes- micro electrodes. basic principles of ECG, EEG, EMG.

**UNIT II BIOPOTENTIAL MEASUREMENTS 09**

Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven‘s triangle, standard 12 lead system, Principles of vector cardiograph. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. Recording of ERG, EOG and EGG

**UNIT III SIGNAL CONDITIONING CIRCUITS 09**

Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering

**UNIT IV MEASUREMENT OF NON-ELECTRICAL PARAMETERS 09**

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 measurement. Measurement of heart sounds – phonocardiography. Cardiac pacemakers – internal and external pacemakers, defibrillators. Plethysmography –photo electric and impedance plethysmographs

**UNIT V BIOCHEMICAL MEASUREMENT AND BIOSENSORS 09**

Biochemical sensors - pH, $pO_2$ and $pCO_2$, Ion selective Field effect Transistor(ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors, Blood gas analyzers - colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyser (simplified schematic description) – Bio Sensors – Principles – amperometric and voltometric techniques.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi 2014
2. John G. Webster Medical Instrumentation Application and Design John Wiley and sons 2020

**REFERENCE BOOKS:**

1. Leslie Cromwell, Biomedical Instrumentation and Prentice hall of India, New Delhi 2007
2. Myer Kutz,Standard Handbook of Biomedical Engineering & Design,McGraw-Hill, 2003

**WEBSITES:**

1. https://ocw.mit.edu/courses/20-309-biological-engineering-ii-instrumentation-and-measurement-fall- 2006/pages/syllabus/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | - | - | - | **1** | **1** | - | **1** | **2** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME404** | **EMBEDDED SYSTEMS** | **SEMESTER – IV**<br>**3H-3C** |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:**40 **External:**60 **Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the architecture and working of embedded system
- Illustrate the working of operating system and embedded programming
- Build the embedded devices for biomedical applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Illustrate the architecture and functions of 8051 microcontroller (K2)
- Explain the building blocks of embedded systems (K2)
- Interpret the components of embedded programming (K2)
- Outline the process and operating system used in embedded systems (K2)
- Develop embedded system for biomedical applications (K2)

**UNIT I** **8051 MICROCONTROLLERS** **09**

Microcontrollers for an Embedded System – 8051 – Architecture – Addressing Modes – Instruction Set – Program and Data Memory – Stacks – Interrupts – Timers/Counters – Serial Ports – Programming.

**UNIT II** **EMBEDDED SYSTEMS** **09**

Embedded System Design Process – Model Train Controller – ARM Processor – Instruction Set Preliminaries – CPU – Programming Input and Output – Supervisor Mode – Exceptions and Trap – Models for programs – Assembly, Linking and Loading – Compilation Techniques – Program Level Performance Analysis.

**UNIT III** **EMBEDDED PROGRAMMING** **09**

Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.

**UNIT IV** **PROCESSES AND OPERATING SYSTEMS** **09**

Structure of a real time system – Task Assignment and Scheduling – Multiple Tasks and Multiple Processes – Multirate Systems – Pre emptive real – time Operating systems – Priority based scheduling – Interprocess Communication Mechanisms – Distributed Embedded Systems – MPSoCs and Shared Memory Multiprocessors – Design Example – Audio Player, Engine Control Unit and Video Accelerator

**09**

**UNIT V APPLICATION DEVELOPMENT**

Discussions on Basics of Linux supportive RTOS - uCOS - C Executive for development of RTOS Application - Case study

**Total: 45 Hours**

**TEXT BOOKS:**


1. Wolf, Marilyn. Computers as components: principles of embedded computing system design. Elsevier, 2012.
2. Liu, Jane WS. Real-time systems. Pearson Education India, 2006.


**REFERENCE BOOKS:**


1. Das, Lyla B. Embedded systems: An integrated approach. Pearson Education India, 2012.
2. Valvano, Jonathan W. Embedded microcomputer systems: real time interfacing. CL-Engineering, 2011.
3. Simon, David E. An embedded software primer. Vol. 1. Addison-Wesley Professional, 1999.
4. Bhur, Raymond JA, and Donald L. Bialey. "An Introduction to real time systems: Design to networking with C/C++." (1999).
5. Prasad, K. V. K. K. Embedded Real-time Systems. DreamTec, 2005.
6. Iyer, Sriram, and Pankaj Gupta. Embedded realtime systems programming. Tata McGraw-Hill Education, 2003.


**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | - | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | - | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| 24BEBME405 | QUALITY CONTROL FOR BIOMEDICAL DEVICES | SEMESTER – IV 3H-3C |

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:**40 **External:**60 **Total:100**

**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the principles and standards to improve the quality of medical devices
- Summarize the tools for efficient quality control and performance of medical devices
- Select the standards and procedure to improve the quality of devices

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Summarize the principles of quality management (K2)
- Outline the standards and requirements of medical devices (K2)
- Interpret the concept of statistical process control. (K2)
- Explain the tools of TQM (K2)
- Make use of standards to improve the performance of medical device (K3)

**UNIT-I INTRODUCTION TO QUALITY 09**

Quality: Terminologies – Dimensions of Quality – Quality Planning. Basic concepts of Total Quality Management – Principles of TQM, Leadership – Concepts: Role of Senior Management – Quality Council – Quality Council – Strategic Planning Barriers to TQM Implementation.

**UNIT II MEDICAL DEVICES STANDARDS AND REQUIREMENTS 09**

Customer satisfaction – Customer Perception of Quality, Customer Complaints – Service Quality – Customer Retention, Employee Involvement Motivation Empowerment Teams Team Work Recognition and Reward Recognition and Reward..

**UNIT III STATISTICAL PROCESS CONTROL 09**

The seven tools of quality, Cause-and-effect diagram – Check sheet – Control chart Histogram – Pareto chart – Scatter diagram – Stratification – Six sigma.

**UNIT IV TQM TOOLS 09**

Benchmarking – Reasons to Benchmark – Benchmarking Process – Quality Function Deployment (QFD) – House of Quality – QFD Process – Benefits Total Productive Maintenance (TPM) – Concept – Improvement Needs – FMEA Stages of FMEA.

**UNIT V STANDARDS FOR MEDICAL DEVICES 09**

Standards, Need for standards, Types – Medical device safety – Medical device quality management systems requirements ISO 9000:2000 Quality System – Clauses – FDA Functions – ASTM International – Description – CE – CE marking – IEC – Specifications.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Rose J.E, Total Quality Management, Kogan Page Ltd., 1993
2. Cesar A. Cacere, Albert Zana,The Practise of clinical Engineering, Academic Press,1997
3. Greg Bounds, Beyond Total Quality Management-Toward the emerging paradigm, McGraw Hill, 2013.

**REFERENCE BOOKS:**

1. Joseph J.Carr, Elements of Electronics Instrumentation and Measurement, 2nd ed., Pearson Education, 2003.
2. Jerrold T. Bushberg, John M. Boone, The essential physics of medical imaging, 3rd ed., Lippincott Williams & Wilkins, 2011.

**WEBSITES:**

1. https://nptel.ac.in/courses/102101068
2. https://nptel.ac.in/courses/102105090

**CO - PO - PSO MAPPING**

| COs / POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | K2 | 2 | 1 | - | - | - | 1 | - | 1 | 1 | 1 | - | 1 | 3 | - |
| **CO2** | K2 | 2 | 1 | - | - | - | 1 | - | 1 | 1 | 1 | - | 1 | 3 | - |
| **CO3** | K2 | 2 | 1 | - | - | - | 1 | - | 1 | 1 | 1 | - | 1 | 3 | - |
| **CO4** | K2 | 2 | 1 | - | - | - | 1 | - | 1 | 1 | 1 | - | 1 | 3 | - |
| **CO5** | K3 | 3 | 2 | 1 | - | - | 1 | - | 1 | 1 | 1 | - | 1 | 3 | - |
| **Average** | | **2.2** | **1.2** | **1** | - | - | **1** | - | **1** | **1** | **1** | - | **1** | **3** | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME441** | **JAVA PROGRAMMING** | **SEMESTER – IV**<br>**5H-4C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** NIL

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Learn the fundamental concepts of Java programming
- Acquire the knowledge of inheritance, abstraction, exception and package in Java
- Obtain the knowledge of Java Collection API, Multithreading, JDBC and Lambda expression in Java

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Infer the fundamental concepts, architecture, and features of Java Programming (K2)
- Solve programming challenges using object-oriented paradigms (K3)
- Build applications using multi-tasking mechanisms, and exception handling strategies (K3)
- Construct robust and efficient Java applications using JDBC, lambda expressions and interface (K3)
- Develop Java applications by amalgamating object-oriented design, collection usage and advanced data manipulation (K3)

**UNIT I INTRODUCTION TO JAVA 09**

History of Java – Features of Java – Java Architecture – Comments – Data Types – Variables – Operators – Type Conversion and Casting – Flow Control Statements – Reading Input from keyboard – Command Line Arguments – Using Scanner Class – Arrays – Classes and Objects – UML Class diagram – Methods – Constructors – static variables and Methods – this Keyword – Encapsulation – Concept of Access Control.

**UNIT II INHERITANCE 09**

Inheritance – Types of Inheritance – Super and Sub Classes – super keyword – final class and methods – Object class –Polymorphism – Types of polymorphism – Method Overloading – Constructor Overloading – Method Overriding – Dynamic Method Dispatching – garbage collection – String class –String Buffer class –String Builder class.

**UNIT III DATA ABSTRACTION 09**

Packages – Introduction to Packages – User Defined Packages – Accessing Packages – Abstract classes and Methods – Interface – Defining an interface – implementing interfaces – extending interfaces – Multiple Inheritance Using Interface – Exception Handling – Errors vs Exceptions – Exception hierarchy – usage of try – catch – throw – throws and finally – built in exceptions – user defined exceptions.

**UNIT IV COLLECTION API AND LAMBDA 09**

Introduction to wrapper classes – Predefined wrapper classes – Conversion of types – Concept of Auto boxing and unboxing – Java Collections API – Introduction to Collection – Generics – List implementations – Set implementations – Map implementations – Functional Interfaces – Lambda

Expressions – Accessing local variables – Accessing class variables – Predicates – Functions – Suppliers – Consumers – Stream API – Filter – Sorted – Map – Reduce – Count – Parallel Streams.

**UNIT V JDBC AND MULTITHREADING 09**

JDBC – Introduction to JDBC – Establishing connection – Executing query – Processing results – Prepared Statement – Callable Statement – Transactions – Meta Data objects – Multithreading: Introduction to Multithreading – Process Vs Thread –Thread life cycle – Thread class – Runnable Interface – Thread creation – Thread control and priorities – Thread synchronization.

**Total: 45 Hours**

**LIST OF EXPERIMENTS:**

1. Develop programs using flow control statements and arrays to manage execution flow and data organization effectively.
2. Implement programs using inheritance and polymorphism to promote code reusability and dynamic method binding.
3. Develop programs incorporating packages, abstract classes, and interfaces to structure code modularly and enforce abstraction.
4. Implement programs using exception handling mechanisms to ensure robust error detection and graceful recovery.
5. Create programs using the Collection API and lambda expressions to manage groups of objects with flexibility and high performance.
6. Implement programs using JDBC to establish and manage database connections for data persistence and retrieval.
7. Develop programs using multithreading to achieve concurrent execution and improve application performance.

**TEXT BOOKS:**

1. Herbert Scheldt, "Java: The Complete Reference", 12th edition, Tata McGraw-Hill, 2022
2. Cay S Horstmann and Gary Cornell, "Core Java: Volume I – Fundamentals", 12th edition, Prentice Hall, 2021

**REFERENCE BOOKS:**

1. David Flanagan and Benjamin Evans, "Java in Nutshell", 8th edition, O'Reilly Media, 2022.
2. Kathy Sierra, Bert Bates, Trisha Gee, "Head First Java", 3rd edition, O'Reilly Media, Inc, 2022.
3. Joshua Bloch, "Effective Java", 3rd Edition, Addison-Wesley Professional, 2018

**WEBSITES:**

1. www.https://docs.oracle.com/javase/tutorial/java/nutsandbolts
2. www. https://javabeginner.com/learn-java
3. www. https://dev.java/learn
4. https://www.w3schools.com/java/java_intro.asp

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | 1 | - | - | - | 2 | 2 | - | 2 | - | - |
| CO2 | K3 | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 2 | - | 2 | - | - |
| CO3 | K3 | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 2 | - | 2 | - | - |
| CO4 | K3 | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 2 | - | 2 | - | - |
| CO5 | K3 | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 2 | - | 2 | - | - |
| **Average** | | **2.8** | **1.8** | **1** | **-** | **1** | - | - | - | **2** | **2** | - | **2** | - | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME411** | **BIOMEDICAL SIGNAL PROCESSING LABORATORY** | **SEMESTER – IV 2H-1C** |
|---|---|---|

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** NIL

## COURSE OBJECTIVES

The goal of this course is for students to:

- Apply the fundamental operations on biomedical signals
- Inspect the sampling and filtering operations
- Make use of mathematical approach to extract statistical features of biosignals

## COURSE OUTCOMES

Upon completion of this course, the student will be able to:

- Construct elementary time signals (K3)
- Identify the convolution and correlation of signals (K3)
- Analyze the frequency response of biosignals (K4)
- Examine IIR and FIR filters (K4)
- Apply mathematical model to extract statistical features of biosignals (K3)

## LIST OF EXPERIMENTS

1. Construct elementary Discrete Time signals
2. Compare Linear and Circular convolution
3. Construct Auto Correlation and Cross Correlation
4. Analyze the frequency response using FFT
5. Utilize scaling parameter for up and down sampling
6. Design of FIR LPF and HPF Filters
7. Design of FIR BPF and BSF Filters
8. Design of IIR Butterworth filter (LPF and HPF)
9. Design of IIR Chebyshev filter (BPF and BSF)
10. Identify the first order statistical features of biosignal

**Total Periods : 30**

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K3 | 3 | 2 | 1 | - | 3 | - | - | - | 2 | 2 | - | 1 | 2 | 1 |
| CO2 | K3 | 3 | 2 | 1 | - | 3 | 1 | - | 1 | 2 | 2 | - | 1 | 2 | 1 |
| CO3 | K4 | 3 | 3 | 2 | 1 | 3 | 1 | - | 1 | 2 | 2 | - | 1 | 2 | 1 |
| CO4 | K3 | 3 | 2 | 1 | - | 3 | 1 | - | 1 | 2 | 2 | - | 1 | 2 | 1 |
| CO5 | K4 | 3 | 3 | 2 | 1 | 3 | 1 | - | 1 | 2 | 2 | - | 1 | 2 | 1 |
| **Average** | | **3** | **2.4** | **1.4** | **1** | **3** | 1 | - | 1 | **2** | **2** | - | **1** | **2** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME412** | **BIOMEDICAL INSTRUMENTATION LABORATORY** | **SEMESTER – IV 2H-1C** |
|---|---|---|

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** NIL

## COURSE OBJECTIVES

The goal of this course is for students to:

- Design amplifier circuits to capture maximal information while acquiring biopotentials
- Measure electrical and non-electrical parameters effectively
- Construct a PCB layout for the required electronic circuit

## COURSE OUTCOMES

Upon completion of this course, the student will be able to:

- Develop amplifier circuits for biomedical signal acquisition (K3)
- Identify pH and conductivity (K3)
- Make use of biosensors to calculate pulse rate and blood pressure (K3)
- Experiment with ECG and EEG recordings (K3)
- Plan a PCB layout for the required electronic circuits for recording biosignal (K3)

## LABORATORY EXPERIMENTS

1. Simulate ECG Amplifier
2. Simulate EMG Amplifier
3. Simulate EEG Amplifier
4. Measurement of pulse-rate using Photo transducer.
5. Measurement of pH and conductivity.
6. Measurement of blood pressure using a sphygmomanometer.
7. Monitoring of Electrocardiogram (ECG) for bipolar limb leads L1, L2 and L3
8. Monitoring of Electrocardiogram (ECG) for augmented leads aVL, aVF and aVR
9. Monitoring of Electroencephalogram (EEG) signal for different lobes
10. Design a PCB layout for any bio amplifier using software tool

**Total Periods : 30**

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K3 | 3 | 2 | 1 | - | - | - | - | - | 2 | 2 | - | 1 | 2 | 1 |
| CO2 | K3 | 3 | 2 | 1 | - | - | - | - | - | 2 | 2 | - | 1 | 2 | 1 |
| CO3 | K3 | 3 | 2 | 1 | - | - | - | - | 2 | 2 | 2 | - | 1 | 2 | 1 |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | 2 | 2 | 2 | - | 1 | 2 | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 2 | 2 | - | 1 | 2 | 1 |
| **Average** | | **3** | **2** | **1** | **-** | **-** | **-** | **-** | 2 | **2** | **2** | **-** | **1** | **2** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**B.E Biomedical Engineering** **2024-2025**

| 24BEBME413 | SKILL DEVELOPMENT -II<br>MEDICAL DEVICE CALIBRATION | SEMESTER – IV<br>2H-1C |
|---|---|---|

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Understand calibration principles
- Interpret the international standards and safety norms
- Make use of the calibration techniques to provide quality care to the patients.

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Illustrate the electrical safety and grounding aspects in hospital.
- Explain the performance of vital devices
- Utilize the calibration instruments at par with standard protocol.
- Identify the need for maintenance and troubleshooting of ICU equipment
- Experiment with electronic calibration unit to formulate solution for equipment failure.

**LIST OF EXPERIMENTS**

1. Electrical Safety Analyzer Calibration
2. Gas Flow Analyzers
3. SpO2 functional tester
4. Ventilator Tester
5. Infusion Pump Calibration
6. RF / High Frequency Calibration
7. Defibrillator calibration equipment
8. Pressure Calibration
9. Vital signs simulator
10. Electronic Calibration

**Total Periods: 30**

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **K2** | 2 | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **CO2** | **K2** | 2 | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **CO3** | **K2** | 2 | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **CO4** | **K2** | 2 | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **CO5** | **K2** | 2 | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **Average** | | **2** | **1** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **1** | **-** | **1** | **2** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**SEMESTER – V**

**B.E Biomedical Engineering** **2024-2025**

| **24BEBME501** | **INTERNET OF MEDICAL THINGS (IoMT)** | **SEMESTER – V** **3H-3C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: EMBEDDED SYSTEMS**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Illustrate the IoT Architectures
- Interpret IoMT protocols
- Construct IoMT systems for biomedical applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Infer the fundamentals of IoT (K2)
- Interpret the IoT protocols (K2)
- Build IoT Systems using Arduino and Raspberry Pi (K3)
- Apply data analytics for IoMT (K3)
- Model IoMT for healthcare application (K3)

**UNIT I FUNDAMENTALS OF IOT 09**

Evolution of Internet of Things - Enabling Technologies – IoT Architectures: one M2M,IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack –– Fog, Edge and Cloud in IoT – Functional blocks of an IoT eco system–Sensors, Actuators, Smart Objects and Connecting Smart Objects.

**UNIT II IOT PROTOCOLS 09**

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE802.15.4,802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN–Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: WPAN, Routing over Low Power and Lossy Networks–Application Transport Methods: Supervisory Control and Data Acquisition–Application Layer Protocols: CoAP and MQTT.

**UNIT III DESIGN AND DEVELOPMENT 09**

Design Methodology - Embedded computing logic - Microcontroller, System on Chips -IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi –Interfaces and Raspberry Pi with Python Programming.

**UNIT IV DATA ANALYTICS AND SUPPORTING SERVICES 09**

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark –Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework–Django–AWS for IoT–System Management with NETCONF-YANG.

**UNIT V** **INTERNET OF MEDICAL THINGS** **09**

Case studies – Novel Symmetrical Uncertainty Measure (NSUM) Technique for Diabetes Patients, Healthcare Monitoring system through Cyber-physical system, An IoT Model for Neuro sensors, Ada Boost with feature selection using loT for somatic mutations evaluation in Cancer, A Fuzzy-Based expert System to diagnose Alzheimer's Disease, Secured architecture for IoT enabled Personalized Healthcare Systems, Healthcare Application Development in Mobile and Cloud Environments.

**Total: 45 Hours**

**REFERENCE BOOKS:**


1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, 2017.
2. Arsh deep Bahga, Vijay Madisetti "Internet of Things – A hands-on approach" Universities Press,2015.
3. Jan Ho¨ ller, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesan David Boyle. "From Machine-to-Machine to the Internetof Things –Introduction to a New Age of Intelligence,Elsevier, 2014.
4. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internetof Things - Key applications and Protocols", Wiley, 2012.
5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.


**WEBSITES:**

1. https://ocw.mit.edu/courses/20-309-biological-engineering-ii-instrumentation-and-measurement-fall- 2006/pages/syllabus/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO3 | K3 | 3 | 2 | 1 | - | 1 | 1 | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO4 | K3 | 3 | 2 | 1 | - | 1 | 1 | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO5 | K3 | 3 | 2 | 1 | - | 1 | 1 | - | - | 1 | 1 | - | 1 | 2 | 2 |
| **Average** | | **2.6** | **1.6** | **1** | **-** | **1** | **1** | **-** | **-** | **1** | **1** | **-** | **1** | **2** | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME502** | **BIOMEDICAL IMAGE PROCESSING** | **SEMESTER – V**<br>**3H-3C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: BIOMEDICAL SIGNAL PROCESSING**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Illustrate the concepts of images and its relation between pixels
- Apply image transforms and filtering techniques
- Develop the image compression, reconstruction and restoration techniques

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the fundamentals of image processing (K2)
- Illustrate image transformations and its properties (K2)
- Make use of statistical approach for enhancing medical images (K3)
- Utilize filtering and transform techniques for image restoration and reconstruction (K3)
- Apply image compression techniques on medical images (K3)

**UNIT I** **DIGITAL IMAGE FUNDAMENTAL** **09**

Elements of digital image processing systems, Elements of Visual perception, structure of human eye and image formation, Image sampling and quantization, Some Basic relationships between pixels, Matrix and Singular Value representation of discrete images.

**UNIT II** **IMAGE TRANSFORMS** **09**

2D DFT, Cosine, Sine Hadamard, Haar, Slant, KL transform, Fourier transform and their properties.

**UNIT III** **IMAGE ENHANCEMENT** **09**

Histogram – Modification and specification techniques, Enhancement by point processing Image smoothening, Image sharpening, generation of spatial masks from frequency domain specification, Homomorphic filtering, and color image processing, color model – RGB Colormodel and HIS color model.

**UNIT IV** **IMAGE RESTORATIONAND RECONSTRUCTION OF MEDICAL IMAGE** **09**

Image degradation models, Unconstrained and Constrained restoration, mean filters, inverse filtering, Band pass filter, Band reject filter, Least mean square filter, Image reconstruction from projections– Radon transforms, Filter back projection algorithm, Fourier slice theorem, Fourier reconstruction of MRI Images.

**UNIT V APPLICATIONS AND EXPERT SYSTEMS 09**

Run length, Huffman coding, arithmetic coding, Golomb coding, Symbol based coding, Pixel coding, transform coding, JPEG Standard, predictive techniques, Wavelet coding. Application of image processing techniques in thermography, SPECT, PET images.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Rafael C, Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson Education, Asia, 2017.
2. Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, 2015.

**REFERENCE BOOKS:**

1. William K. Pratt, "Digital Image Processing", John Wiley, 2010.
2. S.Sridhar, "Digital Image processing", Oxford University press, 2016.

**WEBSITES:**

1. https://nptel.ac.in/courses/102105090
2. https://nptel.ac.in/courses/108105091
3. https://ocw.mit.edu/courses/hst-582j-biomedical-signal-and-image-processing-spring-20

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO3 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| **Average** | | **2.6** | **1.6** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **2** | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME503** | **BIO CONTROL SYSTEM** | **SEMESTER – V**<br>**3H-3C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: BIOMEDICAL INSTRUMENTATION**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Interpret the blocks of biocontrol systems
- Model thermal regulation and physiological system of human body
- Develop mathematical models to control autonomous and musculoskeletal functions

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Illustrate the blocks of bio control systems (K2)
- Compare engineering and physiological control system (K2)
- Construct thermal regulation process of human body (K3)
- Model a biocontrol system for autonomous function (K3)
- Develop a biocontrol system for musculoskeletal system (K3)

**UNIT I INTRODUCTION TO BIO CONTROL SYSTEM 09**

Introduction: Technological control system, transfer function, mathematical approaches, system stability, introduction to biological control system, Modelling and block diagram, closed loop dynamics of first order and second order control system, similarities between biological and engineering control system, biological receptors and receptor characteristics.

**UNIT II PROCESS REGULATION 09**

Difference between engineering and physiological control systems, generalized system properties, models with combination of system elements. Physiological system modelling, Linear model of respiratory mechanics, model of chemical regulation of ventilation, linear model of muscle mechanics, model of regulation of cardiac output, model of Neuromuscular reflex motion

**UNIT III MODELING OF HUMAN THERMAL REGULATORY SYSTEM 09**

Parameters involved, control system model etc. Biochemistry of digestion, types of heat loss from body, models of heat transfer between subsystems of human body like skin - core etc. and systems like within body, body environment.

**UNIT IV BIOLOGICAL CONTROL I 09**

Cardiac rate, blood pressure, respiratory rate, mass balancing of lungs, oxygen uptake by RBC and pulmonary capillaries, oxygen and carbon dioxide transport in blood and tissues.

**UNIT V** **BIOLOGICAL CONTROL II** **09**

Urine formation and control, Pupil control systems, skeletal muscle servomechanism and semicircular canal. Free swinging limbs, Endocrine control system.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Concise Medical Physiology by Sujit K.Chaudhuri, New Central Book agency, 2006
2. Modern control engineering by Ogata Katsuhika, 2nd edition, Prentice Hall, 2001

**REFERENCE BOOKS:**

1. Learning and Physiological Regulation by Barry R.Dworkin, University Of Chicago Press, 1994
2. Modelling and Control in Biomedical Systems 2000 by E.Carson, E. Salzsieder, Pergamon Publishing, 2001

**WEBSITES:**

2. www.mit.edu
3. www.nptel.ac.in

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO3 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **Average** | | **2.6** | **1.6** | **1** | **-** | **-** | - | - | - | **1** | **1** | - | **1** | 2 | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME541** | **BUSINESS DATA PROCESSING** | **SEMESTER – V**<br>**5H-4C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** NIL

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Understand the fundamentals of business data processing and its significance in modern organizations
- Learn data analysis and visualization techniques
- Summarize the applications of robotic process automation

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Apply business data processing in modern organizations to recognize the different types of data (K3)
- Build a relational database table using SQL query for normalization technique (K3)
- Utilize data analysis and data visualization techniques to support business decision-making ( K3)
- Identify Robotic Process Automation (RPA) in business data processing (K3)
- Analyze secure data transmission and storage practices to protect user data (K4)

**UNIT I INTRODUCTION TO BUSINESS DATA PROCESSING 09**

Introduction - Overview of business data processing - significance in modern organizations - structured - unstructured - and semi-structured data - Data processing lifecycle - data collection - data entry - data storage - data processing - data output - information systems - Ethical and legal considerations.

**UNIT II DATABASE MANAGEMENT SYSTEMS 09**

Introduction to database management systems - Database design principles - Relational database concepts - tables - relationships - keys - normalization - SQL fundamentals - DDL - DML - Data integrity - Data Security – Privacy

**UNIT III DATA ANALYSIS AND VISUALIZATION 09**

Introduction - importance in business decision-making - techniques - descriptive - diagnostic - predictive - prescriptive analysis - data visualization tools - techniques - Exploratory data analysis - visualization for business reporting and performance tracking.

**UNIT IV BUSINESS PROCESS AUTOMATION 09**

Introduction to business process automation - Workflow management systems - process modelling - Business process reengineering - process optimization - Robotic Process Automation (RPA) - its applications in business data processing

.

**UNIT V DATA SECURITY AND PRIVACY IN BUSINESS 09**

Overview of data security and privacy concerns - Data protection regulations - compliance - Secure data transmission and storage practices - Access control - user authentication - Data backup - disaster recovery.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Ramesh Sharda, DursunDelen, Efraim Turban, "Business Intelligence and Analytics: Systems for Decision Support", 11th Edition, Pearson, 2021
2. Carlos Coronel, Steven Morris, Peter Rob, "Database Systems: Design, Implementation, and Management", 13th Edition, Cengage Learning, 2019

**REFERENCE BOOKS:**

1. Thomas H. Davenport, "Big Data at Work: Dispelling the Myths, Uncovering the Opportunities", Harvard Business Review Press, 2014
2. Alberto Cairo, "The Truthful Art: Data, Charts, and Maps for Communication", New Riders, 2016
3. Randy Krum, "Cool Infographics: Effective Communication with Data Visualization and Design", Wiley, 2013

**WEBSITES:**

1. https://www.coursera.org/specializations/business-data-management-communication
2. https://indiafreenotes.com/business-data-processing/www.mit.edu

**LIST OF EXPERIMENTS**

1. Exploring Data Types and Significance in Business
2. Designing a Relational Database Schema
3. SQL Querying and Data Manipulation
4. Visualizing Data for Business Insights
5. Process Modeling for Business Automation
6. Normalizing Tables for Data Integrity
7. Analyzing Descriptive Statistics in Business Data
8. Predictive Analytics for Forecasting Trends
9. Implementing Robotic Process Automation (RPA)
10. Securing Data and Ensuring Compliance

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K3 | 3 | 2 | 1 | - | 2 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO2 | K3 | 3 | 2 | 1 | - | 2 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO3 | K3 | 3 | 2 | 1 | - | 2 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO4 | K3 | 3 | 2 | 1 | - | 2 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO5 | K4 | 3 | 3 | 2 | 1 | 2 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| **Average** | | **3** | **2.2** | **1.2** | **1** | **2** | - | - | - | **2** | **2** | - | **1** | - | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**B.E Biomedical Engineering** **2024-2025**

| **24BEBME511** | **BIOMEDICAL IMAGE PROCESSING LABORATORY** | **SEMESTER – V 2H-1C** |
|---|---|---|

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: BIOMEDICAL SIGNAL PROCESSING**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Apply mathematical operations for biomedical image analysis
- Make use of filtering techniques to remove noise and enhance images
- Experiment with transform techniques for restoration and reconstruction of medical images

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Experiment with scaling operators on medical images (K3)
- Apply filtering and transformation techniques for image enhancement (K3)
- Utilize boundary detection algorithms for edge detection (K3)
- Make use of mathematical models for image restoration and reconstruction (K3)
- Develop a workflow for biomedical image analysis (K3)

**LIST OF EXPERIMENTS**

1. Digital image fundamentals.
2. Brain tumor image enhancement using filtering operation
3. Transformation of medical images using mathematical approach
4. Identify the edge and boundary of brain tumor image using boundary tracing techniques
5. Removal of noise in medical images.
6. Segmentation of user defined regions in retina images
7. Restoration and reconstruction of medical images
8. Image compressions
9. Feature extraction from medical images
10. Determine the SNR of medical images

**Total Periods: 30**

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K3 | 3 | 2 | 1 | - | 3 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO2 | K3 | 3 | 2 | 1 | - | 3 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO3 | K3 | 3 | 2 | 1 | - | 3 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO4 | K3 | 3 | 2 | 1 | - | 3 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO5 | K3 | 3 | 2 | 1 | - | 3 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| **Average** | | **3** | **2** | **1** | **-** | **3** | **-** | **-** | **-** | **2** | **2** | **-** | **1** | **-** | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| 24BEBME512 | INTERNET ON MEDICAL THINGS LABORATORY | SEMESTER – V<br>2H-1C |

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: EMBEDDED SYSTEMS**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the principles of embedded programming
- Make use of development board for medical application
- Develop prototypes for IoMT applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the arithmetic programs using embedded C (K2)
- Build timer based applications (K3)
- Develop biomedical applications using embedded systems (K3)
- Plan simple control systems using embedded systems (K3)
- Construct interfacing system for medical application (K3)

**LIST OF EXPERIMENTS**

1. Write Basic and arithmetic Programs Using Embedded C.
2. Write Embedded C program to test interrupt and timers.
3. Develop Real time applications–clock generation, waveform generation, counter using embedded C.
4. Interface LED/Buzzer with platform/Arduino/Raspberry Pi. And write an embedded C program to turn on/off LED/Buzzer with specified delay.
5. Interface DC/stepper motor using relay with open platform /Arduino/Raspberry Pi and write an embedded C program to turn on the motor if push button is pressed.
6. Develop simple applications–testing infrared sensors–IoT Applications–using open platform/Raspberry Pi.
7. Develop a simple application to interface DHT11 sensor with and write a program to display temperature humidity readings in LCD.
8. Develop IoMT Application using open platform /Arduino/Raspberry Pi and sensors such as temperature, ECG, Pulse etc

**Total Periods: 30**

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | 3 | - | - | - | 2 | 2 | - | 1 | 3 | 2 |
| CO2 | K3 | 3 | 2 | 1 | - | 3 | - | - | - | 2 | 2 | - | 1 | 3 | 2 |
| CO3 | K3 | 3 | 2 | 1 | - | 3 | - | - | - | 2 | 2 | - | 1 | 3 | 2 |
| CO4 | K3 | 3 | 2 | 1 | - | 3 | - | - | - | 2 | 2 | - | 1 | 3 | 2 |
| CO5 | K3 | 3 | 2 | 1 | - | 3 | - | - | - | 2 | 2 | - | 1 | 3 | 2 |
| **Average** | | **2.8** | **2** | **1** | **-** | **3** | - | - | - | **2** | **2** | - | **1** | **3** | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| **24BEBME513** | **COMMUNITY ENGAGEMENT AND SOCIAL RESPONSIBILITY** | **SEMESTER – V**<br>**4H-2C** |

**Instruction Hours/week:** L:0 T:0 P:4 **Marks:** Internal**:100** External**:00** Total**:100**

**End Semester Exam:**3 Hours

**Unit-I**

Concept, Ethics and Spectrum of Community engagement-Local community, Rural culture and Practice of community engagement

**Unit-II**

Stages, Components and Principles of community development, Utility of public resources – Contributions of self-help groups

**Unit-III**

Rural Development Programs and Rural institutions- Local Administration and Community Involvement

**Unit-IV**

Social contribution of community networking, various government schemes– Programmes of community engagement and their evaluation.

**Unit-V**

Community Engaged Research and Ethics in Community Engaged Research- Rural Distress, Rural Poverty, Impact of COVID-19 on Migrant Laborers, Mitigation of Disaster

**Reference:**


1. Principles of Community Engagement, 2nd Edition, NIH Publication No. 11-7782, Printed June 2011.
2. Lando, Lily Ann & Aktar, Shamima & JM, Apgar & Attwood, Simon & J, Brown & Chisonga, Nixon & Chea, Siek & A, Choudhery & Cole, Steven & Clayton, Terry & Crissman, Charles & Douthwaite, Boru & B, Downing & F, Golam & S, Hak & Gareth, Johnstone & Kabir, Kazi Ahmed & K, Kamp & Karim, Manjurul & Waters-Bayer, Ann. (2015). Research in development: Learning from the CGIAR Research Program on Aquatic Agricultural Systems.
3. https://youtu.be/-SQK9RGBt7o
4. https://www.uvm.edu/sites/default/files/community_engagement_handout.pdf (Community Engagement)
5. https://www.atsdr.cdc.gov/communityengagement/pce_concepts.html (Perspectives of Community)
6. https://egyankosh.ac.in/bitstream/123456789/59002/1/Unit1.pdf (community concepts)
7. https://sustainingcommunity.wordpress.com/2013/07/09/ethics-and-community-engagement/(Ethics of community engagement)

| **B.E Biomedical Engineering** | | **2024-2025** |
|---|---|---|
| **24BEBME5E- -** | **PROFESSIONAL ELECTIVE-I** | **SEMESTER – V**<br>**3H-3C** |
| **Instruction Hours/week:** L:3 T:0 P:0 | | **Marks:** Internal**:60** External**:40** Total**:100**<br>**End Semester Exam:**3 Hours |

| **B.E Biomedical Engineering** | | **2024-2025** |
|---|---|---|
| **24BEBME5E- -** | **PROFESSIONAL ELECTIVE-II** | **SEMESTER – V**<br>**3H-3C** |
| **Instruction Hours/week:** L:3 T:0 P:0 | | **Marks:** Internal**:60** External**:40** Total**:100**<br>**End Semester Exam:**3 Hours |

| **B.E Biomedical Engineering** | | **2024-2025** |
|---|---|---|
| **24BEBME591** | **INTERNSHIP / FIELD PROJECT - II** | **SEMESTER – V**<br>**2H-1C** |
| **Instruction Hours/week:** L:0 T:0 P:2 | | **Marks:** Internal**:100** External**:00** Total**:100**<br>**End Semester Exam:**3 Hours |

**SEMESTER – VI**

| **B.E Biomedical Engineering** | | **2024-2025** |
|---|---|---|
| **24BECC601** | **UNIVERSAL HUMAN VALUES** | **SEMESTER – VI**<br>**2H-2C** |

**Instruction Hours/week:** L:2 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** NIL

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Understand the holistic perspective towards life and profession
- Develop self confidence, commitment and courage to act
- Infer the harmony in the human being (self & body), family, society and nature/existence

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the human aspiration, goal, activities and purpose of life (K2)
- Outline the self management to improve the human values social skills (K2)
- Relate the concepts of harmony of self and body (K2)
- Identify the role of harmony in family and individual (K3)
- Extend the role of harmony in society (K2)

**UNIT I** **COURSE INTRODUCTION - NEED, BASIC GUIDELINES, CONTENT AND PROCESS FOR VALUE EDUCATION** **05**

Understanding the need, basic guidelines, content and process for Value Education, Self Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

**UNIT II** **UNDERSTANDING HARMONY IN THE HUMAN BEING HARMONY IN MYSELF** **05**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

**UNIT III** **UNDERSTANDING HARMONY IN THE FAMILY AND SOCIETY HARMONY IN HUMAN-HUMAN RELATIONSHIP** **05**

Understanding harmony in the Family- the basic unit of human interaction , Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay- tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship, Understanding the meaning of Vishwas; Difference between intention and competence, Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals, Visualizing a universal harmonious order in society Undivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)- from family to world family

**Total: 15 Hours**

**TEXT BOOKS:**


1. R.R Gaur, R Asthana, G.P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi 2019
2. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
3. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
4. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
5. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
6. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
7. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.


**REFERENCE BOOKS:**


1. A.N. Tripathi, "Human Values New Age", Intl. Publishers, New Delhi 2004


**WEBSITES:**

1. http://uhv.ac.in
2. http://www.uptu.ac.in
3. http://www.storyofstuff.com

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | 2 | 1 | 1 | - | 1 | - | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | 2 | 1 | 1 | - | 1 | - | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | 2 | 1 | 1 | - | 1 | - | - |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | 2 | 1 | 1 | - | 1 | - | - |
| CO5 | K2 | 2 | 1 | - | - | - | - | - | 2 | 1 | 1 | - | 1 | - | - |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | **-** | **-** | **2** | **1** | **1** | **-** | **1** | **-** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME602** | **BIOMECHANICS** | **SEMESTER – VI**<br>**4H-4C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:1 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: BIO CONTROL SYSTEM**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Illustrate the fundamental concepts of kinetics and kinematics of human motion
- Make use of mechanical properties of musculoskeletal, cardiovascular, respiratory and joint mechanics
- Infer the ergonomics factors

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Outline the principles of kinetics and kinematics operations of biomechanics (K2)
- Infer the mechanical properties of bone, muscle and tissues (K2)
- Utilize the netwonian fluids to measure the viscosity and interaction mechanism
- between blood and lung (K3)
- Classify the biomechanics of multiple joints and its functional movement (K2)
- Identify the factors affecting the ergonomics (K3)

**UNIT I INTRODUCTION TO MECHANICS 12**

Introduction – Scalars and vectors, Statics – Force types, Resolution and composition of forces, Moments of force and couple, Resultant force determination, parallel forces in space, equilibrium coplanar forces, Dynamics, Basic principles – Linear motion, Newton‘s laws of motion, Impulse and Momentum, Work and Energy Kinetics – Velocity and acceleration, Kinematics – Link segment models, Force transducers, Force plates, Introduction to Constitutive equations –Constitutive equations of Non viscous fluid, Newtonian Viscous fluid and Hookean Elastic solid

**UNIT II MUSCULOSKELETAL MECHANICS 12**

Bone structure and composition, Mechanical properties of bone: Electrical properties of bone, fracture mechanism and crack propagation in bones, fracture fixators, repairing of bones. Muscle structure, Muscle Actions - Mechanical Methods of Muscle Action Analysis, Tissue loads, Response of tissue to forces, Biomechanics of passive Muscle - Tendon units, ligament, Mechanical characteristics of muscles - Stretch shortening cycles, Force -Time Principle, Gait Analysis.

**UNIT III CARDIOVASCULAR AND RESPIRATORY MECHANICS 12**

Hook's law, Newtonian Fluid, Non-Newtonian fluid-. Blood flow: Laminar and Turbulent - Haematology and Blood Rheology - Relationship between diameter, velocity and pressure of blood flow - Resistance against flow. Mechanical properties of blood vessels - Arteries, arterioles, capillaries, veins, vascular graft-Prosthetic heart valves- TAH - heart valve dynamics. Interaction of blood and lung-Alveoli mechanics, P-V curve of lung - Airway resistance - Physics of lung diseases

**UNIT IV BIOMECHANICS OF JOINTS 12**

Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, Freebody diagrams, Structure of joints, Types of joints, Biomechanical analysis of elbow, shoulder, spinal

column, hip, knee and ankle, Lubrication of synovial joints, Gait analysis, Motion analysis using video.

**UNIT V MODELING AND ERGONOMICS 12**

Introduction to Finite Element Analysis, finite element analysis of lumbar spine; Ergonomics – Musculoskeletal disorders, Ergonomic principles contributing to good workplace design , Process of seeing – visual capabilities-factors affecting visual acuity and contrast sensitivity – human factor aspects of hard copy text and computer screen text Whole body vibrations, Hand transmitted vibrations.

**Total: 60 Hours**

**TEXT BOOKS:**


1. Y.C. Fung, "Bio-Mechanics- Mechanical Properties of Tissues" Springer-Verlag, 1998.
8. Duane Knudson, "Fundamentals of Biomechanics", Second Edition, Springer, 2007.


**REFERENCE BOOKS:**


1. Sheraz S. Malik and Shahbaz S. Malik, "Orthopaedic Biomechanics Made Easy", Cambridge University Press, 2015.
2. Jay D. Humphrey, Sherry De Lange, "An Introduction to Biomechanics: Solids and Fluids", Analysis and Design, Springer Science Business Media, 2004.
3. Shrawan Kumar, "Biomechanics in Ergonomics, Second Edition", CRC Press, 2007.
4. Neil J. Mansfeild, "Human Response to Vibration", CRC Press, 2005


**WEBSITES:**

1. https://nptel.ac.in/courses/112105305
2. https://nptel.ac.in/courses/112106248
3. https://ocw.mit.edu/courses/hst-021-musculoskeletal-pathophysiology-january-iap-2006/pages/lecture-notes

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | 1 | 1 | 1 | 1 | 1 | - | 1 | 2 | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | 1 | 1 | 1 | 1 | 1 | - | 1 | 2 | 1 |
| CO3 | K3 | 3 | 2 | 1 | - | - | 1 | 1 | 1 | 1 | 1 | - | 1 | 2 | 1 |
| CO4 | K2 | 2 | 1 | - | - | - | 1 | 1 | 1 | 1 | 1 | - | 1 | 2 | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | - | 1 | 1 | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **1** | **1** | **1** | **1** | **1** | **-** | **1** | **2** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| | | |
|---|---|---|
| **24BEBME603** | **MEDICAL DIAGNOSTIC AND THERAPEUTIC EQUIPMENT** | **SEMESTER – VI**<br>**3H-3C** |

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: BIO CONTROL SYSTEM**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Outline the diagnostic medical device for cardiac and respiratory mechanism
- Apply the electrical stimulator techniques for nerve and muscles
- Illustrate radio therapy equipment and its application in medicine

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the working mechanism of cardiac equipment (K2)
- Illustrate the principles of respiratory devices (K2)
- Choose the stimulation methods for pain relief system (K3)
- Make use of electro therapeutic equipment in special cases (K3)
- Infer the principles of laser and radiation therapeutic equipment and its types (K2)

**UNIT I CARDIAC EQUIPMENT 09**

External and Implantable pacemakers, Programmable pacemakers, Power sources, Design of encapsulation and leads, Pacing system analyzers. Cardiac Defibrillators, Basic principles and comparison of different Defibrillators, Energy requirements, Synchronous operation, Implantable Defibrillators, Defibrillator analyzers.

**UNIT II RESPIRATORY EQUIPMENT 09**

Principles of constant pressure and constant volume ventilators, Basic principles of electromechanical, Pneumatic and electronic ventilators, Nebulizer, Ventilator testing.

**UNIT III ELECTROTHERAPY EQUIPMENT-I 09**

Electro diagnosis, Electrotherapy, Electrodes, Stimulators for Nerve and Muscle, Stimulator for pain relief, Interferential current therapy, Spinal cord stimulator, Functional Electrical Stimulation.

**UNIT IV ELECTROTHERAPY EQUIPMENT-II 09**

High frequency heat therapy, Principle, Shortwave diathermy, Microwave diathermy, Ultrasonic therapy, Lithotripsy, Therapeutic IR radiation, Therapeutic UV lamps.

**UNIT V THERAPEUTIC LASERS 09**

Basic principles of Biomedical LASERS: Applications of lasers in medicine, CO2 laser, He- Ne laser, Nd-YAG and Ruby laser.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Khandpur R.S, "Hand book of Biomedical Instrumentation", Third Edition, McGraw Hill Education (India) Private Limited, 2014.
2. John G. Webster, Amit J. Nimunkar, "Medical Instrumentation, Application and Design", Fifth Edition. Wiley &sons, Inc., New York, 2020.
3. Joseph J. Carr, John M. Brown, "Introduction to Biomedical Equipment Technology", Sixth edition. Pearson Education Inc., New Delhi, 2011.

**REFERENCE BOOKS:**

1. Leslie Cromwell, Fred J.Weibell & Erich, A.Pfeiffer, " Biomedical Instrumentation and Measurements", Second Edition. Pearson India, 2015.
2. Val Robertson, Alex Ward, John Low & Ann Reed, "Electrotherapy Explained, Principles and Practice", Fourth Edition. Butterworth Heinemann Ltd, Elsevier, 2008.

**WEBSITES:**

1. https://www.mayoclinic.org/tests-procedures/implantable-cardioverter-defibrillators/about/pac-20384692
2. https://www.spine-health.com/treatment/pain-management/all-about-electrotherapy-and-pain-relief

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | 3 | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | 3 | 1 |
| CO3 | K3 | 3 | 2 | 1 | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | 3 | 1 |
| CO4 | K3 | 3 | 2 | 1 | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | 3 | 1 |
| CO5 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | 3 | 1 |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **1** | **1** | **2** | **1** | **1** | **-** | **2** | **3** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME604** | **ASSISTIVE TECHNOLOGY & REHABILITATION** | **SEMESTER – VI 3H-3C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: BIOMEDICAL INSTRUMENTATION**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Make use of assistive technology for visually and auditory impaired problems
- Outline the concept of alternative and augmentative communication
- Identify different types of therapeutic exercise techniques

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Compare the functioning of assistive devices (K2)
- Interpret the functions of alternative and augmented communications (K2)
- Explain the concepts of rehabilitation engineering (K2)
- Model orthopaedic prosthetics (K3)
- Select the therapeutic exercise for gait analysis (K3)

**UNIT I ENGINEERING CONCEPTS IN ASSISTIVE TECHNOLOGY 09**

Sensory augmentation and substitution. Assistive Technology for visually Impaired – General Purpose, Task Specific (Mobility, Reading, Writing, Computer Access, Communication). Assistive Technology for Hearing Impaired – Hearing Assistance Solutions –Medical and Surgical Approach to restore function – Hearing aids, Cochlear Implantation, Assistive Listening Solutions and Visual and Tactual Substitution.

**UNIT II ALTERNATIVE AND AUGMENTATIVE COMMUNICATION (AAC) 09**

User interface, Language Representation, Technology and Devices Feature. Human Factors, Performance Measurement, Wheelchairs- Manual, Electric Power, Power Assisted, Multi-Functional, Standards, Wheelchairs Transportation System, Securement Systems.

**UNIT III INTRODUCTION TO REHABILITATION ENGINEERING 09**

Principles involved in rehabilitation engineering. Steps in patient management, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability and Functional Diagnosis, Medical Rehabilitation.

**UNIT IV ORTHOPEDIC PROSTHETICS AND ORTHOTICS IN REHABILITATION 09**

Engineering Principles. Prosthesis Amputation Types Prescribed Prostheses, Components of Upper Limb Prosthesis – Sockets and Liners, Suspension, Control Systems (Myoelectric), Shoulder, Elbow and Wrist components, Terminal Devices. Components of lower limb prosthesis – Sockets and Liners, Suspension, Hip, Pelvic, Knee and Ankle Components. Orthotics- Biomechanical Principles, Spinal, Upper Extremity and Lower Extremity. FES systems-Restoration of hand function, restoration of standing and walking.

**UNIT V THERAPEUTIC EXERCISE TECHNIQUE 09**

Co-ordination exercises, Frenkels exercises, Gait analyses -Pathological Gaits, Gait Training, Relaxation exercises -Methods for training Relaxation, Strengthening exercises -Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises.

**Total: 45 Hours**

**TEXT BOOKS:**


1. Dr. Rory A. Cooper, Hisaichi Ohnabe, Douglas A. Hosbon, "An Introduction to Rehabilitation Engineering", CRC Press Book, Taylor and Francis Group, 2007.
2. Horia- Nocholai Teodorecu, L. C. Jain, "Intelligent systems and technologies in rehabilitation engineering", CRC, December 2000.
3. Sunder Textbook of "Rehabilitation", Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint, 2007
3. Joseph D.Bronzino, "The Biomedical Engineering Handbook", Third edition-3 volume set, Taylor and Francis, 2006


**REFERENCE BOOKS:**


1. Charles J. Robinson, "Rehabilitation Engineering", CRC Press, 1995.
2. Joseph D. Bronzino, "The Biomedical Engineering Handbook", Volume-II, CRC Press 2006
4. G. Salvendy, "Handbook of Human Factors and Ergonomics", Wiley, 2006.
5. Horia- Nocholai Teodorecu, L.C.Jain, "Intelligent systems and technologies in rehabilitation Engineering", CRC; December 2000.
6. Keswick. J, "What is Rehabilitation Engineering, Annual Reviews of Rehabilitation", SpringerVerlag, New York, 1982.
7. Warren E. Finn, Peter G. LoPresti, "Handbook of Neuroprosthetic Methods CRC", edition 2002.
8. Rory A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), "An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering", CRC Press, 2006.


**WEBSITES:**

1. https://idrr.ontariotechu.ca/our-research/epidemiology-of-disability-and-rehabilitation/index.php
2. https://www.orthomedctr.com/gait-analysis.php

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | 2 | - | 2 | 1 | 1 | - | 2 | 3 | 2 |
| CO2 | K2 | 2 | 1 | - | - | - | 2 | - | 2 | 1 | 1 | - | 2 | 3 | 2 |
| CO3 | K2 | 2 | 1 | - | - | - | 2 | - | 2 | 1 | 1 | - | 2 | 3 | 2 |
| CO4 | K3 | 3 | 2 | 1 | - | - | 2 | - | 2 | 1 | 1 | - | 2 | 3 | 2 |
| CO5 | K3 | 3 | 2 | 1 | - | - | 2 | - | 2 | 1 | 1 | - | 2 | 3 | 2 |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **2** | **-** | **2** | **1** | **1** | **-** | **2** | **3** | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| | | |
|---|---|---|
| **24BEBME611** | **DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY** | **SEMESTER – VI**<br>**2H-1C** |

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: BIOMEDICAL INSTRUMENTATION**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Demonstrate the recording of different biopotentials
- Utilize the function of therapeutic equipment
- Make use of electrical safety measurements to save the life of equipment

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Analysis the QRS waveform and heart rate using ECG (K4)
- Experiment with diathermy and medical stimulator (K3)
- Inspect Audiogram and Spirometer (K4)
- Make use of ESU and biotelemetry (K3)
- Test for electrical safety parameters (K4)

**LIST OF EXPERIMENTS**

1. Simulation of ECG – detection of QRS complex and heart rate
2. Measurement of physiological parameters using patient monitor
3. Demonstrate shortwave diathermy unit
4. Demonstrate and ultrasonic diathermy unit
5. Exhibit the application of biotelemetry
6. Measurement of respiratory parameters using spirometry.
7. Exhibit the muscle stimulator.
8. Demonstrate the ESU – cutting and coagulation modes
9. Recording of Audiogram
10. Electrical safety measurements

**Total Periods : 30**

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K4 | 3 | 3 | 2 | 1 | 1 | 1 | - | 1 | 1 | 1 | - | 2 | 3 | 2 |
| CO2 | K3 | 3 | 2 | 1 | - | 1 | 1 | - | 1 | 1 | 1 | - | 2 | 3 | 2 |
| CO3 | K4 | 3 | 3 | 2 | 1 | 1 | 1 | - | 1 | 1 | 1 | - | 2 | 3 | 2 |
| CO4 | K3 | 3 | 2 | 1 | - | 1 | 1 | - | 1 | 1 | 1 | - | 2 | 3 | 2 |
| CO5 | K4 | 3 | 3 | 2 | 1 | 1 | 1 | - | 1 | 1 | 1 | - | 2 | 3 | 2 |
| **Average** | | **3** | **2.4** | **1.4** | **1** | **1** | **1** | **-** | **1** | **1** | **1** | **-** | **2** | **3** | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME612** | **MEDICAL EQUIPMENT TROUBLESHOOTING LABORATORY (Industry Curriculum)** | **SEMESTER – VI 2H-1C** |
|---|---|---|

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: BIOMEDICAL INSTRUMENTATION**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Outline the trouble shooting methods and fault finding aids
- Identify the fault in the electronic circuits
- Analyze the medical equipment for quality control

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Utilize the troubleshooting methods and its techniques (K3)
- Inspect the grounding systems in equipment (K4)
- Test for the faults in electronic circuits (K4)
- Examine the parameters for digital troubleshooting (K4)
- Inference the troubleshooting technique for medical devices (K4)

**LIST OF EXPERIMENTS**

1. Fault Diagnosis in Circuit board and Fault finding Aids
2. Grounding Systems in Electronic Equipment
3. Fault Diagnosis in bioamplifiers circuits
4. Digital IC Troubleshooters
5. Troubleshooting of ECG Machine
6. Troubleshooting of EEG Machine
7. Troubleshooting of Defibrillator
8. Troubleshooting of Electrosurgical unit
9. Trouble shooting of Anaesthesia machine
10. Trouble shooting of Patient monitoring system

**Total Periods : 30**

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K3 | 3 | 2 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | - | 2 | 3 | - |
| CO2 | K4 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | 2 | 3 | - |
| CO3 | K4 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | 2 | 3 | - |
| CO4 | K4 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | 2 | 3 | - |
| CO5 | K4 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | 2 | 3 | - |
| **Average** | | **3** | **2.8** | **1.8** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **-** | **2** | **3** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| **24BEBME6E- -** | **PROFESSIONAL ELECTIVE-III** | **SEMESTER – VI**<br>**3H-3C** |
| **Instruction Hours/week:** L:3 T:0 P:0 | | **Marks:** Internal**:60** External**:40** Total**:100**<br>**End Semester Exam:**3 Hours |

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| **24BEBME6E- -** | **PROFESSIONAL ELECTIVE-IV** | **SEMESTER – VI**<br>**3H-3C** |
| **Instruction Hours/week:** L:3 T:0 P:0 | | **Marks:** Internal**:60** External**:40** Total**:100**<br>**End Semester Exam:**3 Hours |

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| **24BEBME6E- -** | **OPEN ELECTIVE -I** | **SEMESTER – VI**<br>**3H-3C** |
| **Instruction Hours/week:** L:3 T:0 P:0 | | **Marks:** Internal**:60** External**:40** Total**:100**<br>**End Semester Exam:**3 Hours |

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| **24BEBME691** | **MINI PROJECT** | **SEMESTER – VI**<br>**2H-1C** |
| **Instruction Hours/week:** L:0 T:0 P:2 | | **Marks:** Internal**:60** External**:40** Total**:100**<br>**End Semester Exam:**3 Hours |

**SEMESTER – VII**

| **B.E Biomedical Engineering** | | **2024-2025** |
|---|---|---|
| **24BEBME701** | **ARTIFICIAL INTELLIGENCE IN HEALTHCARE** | **SEMESTER – VII 3H-3C** |

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** NIL

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Outline the concept of AI and basic production system
- Make use of knowledge based representation for expert system
- Develop an expert system for biomedical applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Illustrate the characteristics of AI and production systems in healthcare (K2)
- Interpret the methods for knowledge representation (K2)
- Infer the production based system using knowledge inference algorithm (K2)
- Explain the concept of plan generation system and machine learning approaches (K2)
- Model a expert systems for biomedical applications (K3)

**UNIT I INTRODUCTION TO AL AND PRODUCTION SYSTEMS 09**

Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Specialized production system- Problem solving methods – Problem graphs, Matching, Indexing and Heuristic functions - Hill Climbing-Depth first and Breath first, Constraints satisfaction – Related algorithms, Measure of performance and analysis of search algorithms.

**UNIT II REPRESENTATION OF KNOWLEDGE 09**

Game playing – Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge. Control Systems - Artificial Intelligence based optimal control - Reinforcement learning

**UNIT III KNOWLEDGE INFERENCE 09**

Knowledge representation -Production based system, Frame based system. Inference – Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning – Certainty factors, Bayesian Theory-Bayesian Network-Dempster – Shafer theory.

**UNIT IV PLANNING AND MACHINE LEARNING 09**

Basic plan generation systems – Strips -Advanced plan generation systems – K strips -Strategic explanations - Why, Why not and how explanations. Learning- Machine learning, adaptive Learning

**UNIT V APPLICATIONS AND EXPERT SYSTEMS 09**

Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert system shells. Blood pressure control, Speech Recognition – Robot control for surgical applications - Hardware - Perception - Planning – Moving image guidance

**Total: 45 Hours**

**TEXT BOOKS:**

1. Deepak Khemani "Artificial Intelligence", Tata McGraw Hill Education, 2013.

**REFERENCE BOOKS:**

1. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007.
2. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education, 2007

**WEBSITES:**

1. https://www.javatpoint.com/knowledge-representation-in-ai
2. https://aimaterials.blogspot.com/p/unit-iv.html

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | - | 2 |
| CO2 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | - | 2 |
| CO3 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | - | 2 |
| CO4 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | - | 2 |
| CO5 | K3 | 3 | 2 | 1 | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | - | 2 |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | **1** | **1** | **2** | **1** | **1** | **-** | **2** | **-** | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME702** | **MEDICAL REGULATORY AFFAIRS** | **SEMESTER – VII** **3H-3C** |
|---|---|---|

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** NIL

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Outline the regulatory testing factors for food and drug administration
- Summarize the Indian medical device rules and regulations
- Select the regulatory standards and safety procedures for biomedical device development

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the medical device testing factors (K2)
- Infer the regulatory standards for Food and Drug administration (K2)
- Summarize the Indian medical device rules and regulation (K2)
- Show the importance of product safety and compliance (K2)
- Identify the regulatory standards for biomedical applications (K3)

**UNIT I DEFINITION OF TESTING 09**

Parsing test requirements, test protocol, test methodology, purpose of the test, failure definition, determining sample size and test length, types of testing. Analysis of test data- failure rate, mean time between failure, reliability, confidence level, confidence limits, minimum life, graphical analysis. Reliability and liability- negligence, strict liability, breach of warranty, defects, plaintiff's conduct, defendant's conduct, defendant related issues, manufacturers and physicians responsibilities, accident reconstruction and forensics.

**UNIT II FOOD AND DRUG ADMINISTRATION 09**

History of device regulation, device classification, registration and listing, 510(k) process, declaration of conformance to a recognized standard, PMA application, investigational device exemptions, good laboratory practices, good manufacturing practices, human factors, design control, FDA and software classification, FDA inspection, advice on dealing with the FDA regulations and standards- definition of medical device, MDD, United States Domestic Standards, rest of the world standards.

**UNIT III INDIAN MEDICAL DEVICE RULES AND REGULATIONS 09**

Indian medical device rules and regulations-2017, licensing patents, copyrights and trade secrets, trademarks. Manufacturing and quality control- GMP regulations, design for manufacturability, design for assembly, manufacturing process

**UNIT IV PRODUCT SAFETY AND LEGAL ISSUES 09**

Learning from failure, design for failure, design for convenience, universal design, design for assembly, prevention through design, design for the environment, pokayoke, product life issues, product testing issues. Product safety and legal issues, accident reconstruction and forensics, biomechanics and traffic-accident investigations. professional issues, BME – related professional

societies, standards setting groups, professional engineering licensure, rules of professional conduct, codes of ethics, forensics and consulting, continuing education.

**UNIT V** **CASE STUDIES** **09**

Multi-detector brain scanning system development, testing of anesthetists, apnea detection system, cancer clinic charting, EKG analysis techniques & module.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Seeram Ramakrishna, "Medical Devices Regulations, Standards and Practices", Wood Head Publishing series in Biomaterials, UK, 2015

**REFERENCE BOOKS:**

1. Val Theisz, "Medical Device Regulatory Practices", An International Perspective, CRC Press 2016

**WEBSITES:**

1. https://nptel.ac.in/courses/127106136
2. https://nptel.ac.in/courses/127106010

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | 1 | - | 2 | 1 | 1 | - | 2 | 2 | - |
| CO2 | K2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | 2 | - |
| CO3 | K2 | 2 | 1 | - | - | - | 1 | - | 2 | 1 | 1 | - | 2 | 2 | - |
| CO4 | K2 | 2 | 1 | - | - | - | 1 | - | 2 | 1 | 1 | - | 2 | 2 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | 1 | 1 | 2 | 1 | 1 | - | 2 | 2 | - |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | **1** | **1** | **2** | **1** | **1** | **-** | **2** | **2** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| | | |
|---|---|---|
| **24BEBME703** | **BIOMEDICAL WASTE AND HOSPITAL MANAGEMENT** | **SEMESTER – VII**<br>**3H-3C** |

**Instruction Hours/week:** L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** NIL

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Categories the biomedical waste management
- Outline the function of hospital administration and human resource management in hospital
- Plan the quality standards in hospital management

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Classify the biomedical waste and its management practices (K2)
- Infer the impact of Hazardous material and safety precautions in hospital (K2)
- Show the challenges and planning in hospital Administration (K2)
- Interpret functions of human resource management (K2)
- Organize the quality standards in hospital management (K3)

**UNIT I BIOMEDICAL WASTE MANAGEMENT 09**

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 labeling, waste handling, collection,storage and transportation,treatment and disposal.

**UNIT II HAZARDOUS MATERIALS 09**

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.Hazardand Safety in a hospital Setup.

**UNIT III OVER VIEW OF HOSPITAL ADMINISTRATION 09**

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.

**UNIT IV HUMAN RESOURCE MANAGEMENT IN HOSPITAL 09**

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, Communication – nature, scope, barriers, styles and modes of communication.

**UNIT V** **HOSPITAL INFORMATION SYSTEMS & QUALITY ASPECTS IN HOSPITAL** **09**

Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information Systems –Medical Transcription,Medical Records Department–Central Sterilization. International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – ISO 13485-Environment Management Systems.NABH,JCI,NABL,NABA.Security–Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care –Medical Audit.

**Total: 45 Hours**

**TEXT BOOKS:**

1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI, 2006.
2. G.D.Kunders, "Hospitals – Facilities Planning and Management", TMH, 2007.
3. Anant preet Singh, Sukhjit Kaur , "Biomedical Waste Disposal ", Jaypee Brothers, 2012.

**REFERENCE BOOKS:**

1. Tweedy, James T, "Healthcare hazard control and safety management", CRC Press Taylor and Francis, 2014.

**WEBSITES:**

1. https://www.csm.tech/in/healthcare/offering/hospital-administration-management-system/
2. https://byjus.com/current-affairs/biomedical-waste/
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7152398/#:~:text=Health%20Risks,health%20 facilities

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **2** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**B.E Biomedical Engineering** **2024-2025**

| **24BEBME711** | **ARTIFICIAL INTELLIGENCE LABORATORY** | **SEMESTER – VII 2H-1C** |
|---|---|---|

**Instruction Hours/week:** L:0 T:0 P:2 **Marks:** Internal**:40** External**:60** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES:** NIL

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Build turbo PROLOG program for medical diagnosis
- Analyze the factorial and fibonacci of given number using AI based algorithms
- Outline the Hill climbing algorithm

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Interpret the functions of PROLOG programming language (K2)
- Develop the programe for a given problem (K3)
- Identify the turbo PROLOG program for medical diagnosis (K3)
- Solve the 4-queen and salesman problems using PROLOG (K3)
- Analyze LISP and Hill climbing algorithms (K4)

**LIST OF EXPERIMENTS**

1. Study of PROLOG programming language and its functions
2. Write simple fact for the statements using PROLOG
3. Write predicates one converts centigrade temperature to Fahrenheit, the other checks if a temperature is below freezing
4. Write a program to solve the monkey banana problem using PROLOG
5. WAP in turbo prolog for medical diagnosis and show the advantages and disadvantages of green and red cuts.
6. WAP to implement factorial, Fibonacci of given number using prolog
7. Write a program to solve 4-queen problem using prolog
8. Write a program to implement travelling salesman problem using prolog
9. Write a program to solve water jug problem using LISP
10. Write a program to implement Hill climbing algorithm

**Total Periods : 30**

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | 2 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO2 | K3 | 3 | 2 | 1 | - | 2 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO3 | K3 | 3 | 2 | 1 | - | 2 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO4 | K3 | 3 | 2 | 1 | - | 2 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| CO5 | K4 | 3 | 3 | 2 | 1 | 2 | - | - | - | 2 | 2 | - | 1 | - | 2 |
| **Average** | | **2.8** | **2** | **1.3** | **1** | **2** | - | - | - | **2** | **2** | - | **1** | - | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| 24BEBME7E- - | PROFESSIONAL ELECTIVE-V | SEMESTER – VII<br>3H-3C |
| Instruction Hours/week: L:3 T:0 P:0 | Marks: Internal:60 External:40 Total:100<br>End Semester Exam:3 Hours | |

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| 24BEBME7E- - | PROFESSIONAL ELECTIVE-VI | SEMESTER – VII<br>3H-3C |
| Instruction Hours/week: L:3 T:0 P:0 | Marks: Internal:60 External:40 Total:100<br>End Semester Exam:3 Hours | |

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| 24BEBMEOE- - | OPEN ELECTIVE-II | SEMESTER – VII<br>3H-3C |
| Instruction Hours/week: L:3 T:0 P:0 | Marks: Internal:60 External:40 Total:100<br>End Semester Exam:3 Hours | |

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| 24BEBME791 | PROJECT WORK PHASE-I / INTERNSHIP / FIELD PROJECT - III | SEMESTER – VII<br>8H-4C |
| Instruction Hours/week: L:0 T:0 P:8 | Marks: Internal:80 External:120 Total:200<br>End Semester Exam:3 Hours | |

**SEMESTER – VIII**

| | | |
|---|---|---|
| **B.E Biomedical Engineering** | | **2024-2025** |
| **24BEBME891** | **PROJECT WORK PHASE-1I** | **SEMESTER – VIII**<br>**16H-8C** |
| **Instruction Hours/week: L:0 T:0 P:16** | **Marks: Internal:120 External:180 Total:200**<br>**End Semester Exam:3 Hours** | |

**PROFESSIONAL ELECTIVES**
**BIO ENGINEERING**

**B.E Biomedical Engineering** **2024-2025**

**24BEBME5E01 MODELING OF PHYSIOLOGICAL SYSTEMS** **Elective 3H-3C**

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES:** Biocontrol System

**COURSE OBJECTIVES**
The goal of this course is for students to:
- Explain about physiological control systems
- Interpret the working of circulatory and thermoregulatory system
- Model the filtration system and transport mechanisms in human body

**COURSE OUTCOMES**
Upon completion of this course, the student will be able to:
- Infer the mathematical approaches in the physiological systems
- Illustrate the working of circulatory system of human body
- Outline the principle of digestion and heat transfer in human body
- Construct the ultrafiltration system in biological system
- Model a lung to understand the transportation of oxygen

**UNIT I** **BASICS OF PHYSIOLOGICAL SYSTEMS** **09**
System Analysis, examples of physiological control systems, differences between engineering and physiological control systems. Generalized system properties, mathematical approach, electrical analogs, linear models, Lung mechanics, Muscle mechanics, distributed parameter versus lumped parameter models, static analysis, regulation of cardiac output, blood glucose regulation, chemical regulation of ventilation, electrical model of neural control mechanism.

**UNIT II** **CIRCULATORY SYSTEM** **09**
Physical, chemical and rheological properties of blood, problems associated with extracorporeal blood flow, dynamics of circulatory system.

**UNIT III** **THERMAL REGULATORY SYSTEM** **09**
Parameters involved, Control system model etc. Biochemistry of digestion, types of heat loss from body, models of heat transfer between subsystems of human body like skin core, etc and systems like within body, body- environment, etc.

**UNIT IV** **ULTRA FILTRATION SYSTEM** **09**
Transport through cells and tubules, diffusion, facilitated diffusion and active transport, methods of waste removal, counter current model of urine formation in nephron, Modeling Henle‟s loop.

**UNIT V** **RESPIRATORY SYSTEM** **09**
Modelling oxygen uptake by RBC and pulmonary capillaries, Mass balancing by lungs, Gas transport mechanisms of lungs, oxygen and carbon dioxide transport in blood and tissues.

**Total: 45 Hours**

**TEXT BOOKS:**

1. David O.Cooney, "Biomedical Engineering Principles", Marcel Decker Pub. Co,2017

**REFERENCE BOOKS:**

1. Michael C. K. Kho, Physiological Control Systems, Prentice Hall of India, 2018.
2. John Enderly, Susan Blanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Academic Press Series in Biomedical Engineering, 2005.

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **B.E Biomedical Engineering** | | **2024-2025** |
|---|---|---|
| **2BEBME5E02** | **CELL BIOLOGY** | **Elective 3H-3C** |
| **Instruction Hours/week: L:3 T:0 P:0** | | **Marks: Internal:40 External:60 Total:100 End Semester Exam:3 Hours** |

**PREREQUISITES:** Human anatomy and physiology

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Summarize the structure and functions of cells
- Illustrate the working of transportation mechanism in human body
- Apply signal transduction methods to study the nature cells

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the cell at structural and functional level
- Infer the cell division, cell cultures and their applications.
- Compare the process of Ion transportation between cell membranes
- Make use of secondary messengers and signal transduction mechanism
- Utilize the state of art methods to detect the type of cell

**UNIT I CELL STRUCTURE AND FUNCTION OF THE ORGANELLES 09**

Prokaryotic, Eukaryotic cells, Sub-cellular organelles and functions. Principles of membrane organization membrane proteins, cytoskeletal proteins. Extra cellular matrix, cell-cell junctions.

**UNIT II CELL DIVISION, CANCER, APOPTOSIS AND IMMORTALIZATION OF CELLS 09**

Cell cycle – Mitosis, Meiosis, Molecules controlling cell cycle, cancer, role of Ras and Raf in oncogenesis and apoptosis. Stem cells, Cell culture and immortalization of cells and its applications.

**UNIT III TRANSPORT ACROSS CELL MEMBRANE 09**

Passive and Active Transport, Permeases, Ion channels, ATP pumps. Na+ / K+ /Ca+2Tpumps, uniport, symport antiporter system. Ligand gated / voltage gated channels, Agonists and Antagonists.

**UNIT IV SIGNAL TRANSDUCTION 09**

Receptors – extracellular signaling, Cell surface / cytosolic receptors and examples, Different classes of receptors antocrine / paracrine / endocrine models, Secondary messengers molecules.

**UNIT V TECHNIQUES USED TO STUDY CELLS 09**

Cell fractionation and flow cytometry, Morphology and identification of cells using microscopic studies like SEM, TEM and Confocal Microscopy. Localization of proteins in cells – Immunostaining.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Lodish, Harvey etal., Molecular Cell Biology, 7th Edition, W.H.Freeman, 2013
2. Cooper, G.M. and R.E. Hansman, The Cell: A Molecular Approach, 8th Edition, Oxford University Press, 2018
3. Alberts, Bruce etal. Molecular Biology of the Cell, W.W. Norton, 2014

**REFERENCE BOOKS:**

1. Becker, W.M. etal., The World of the Cell, 9th Edition, Pearson Education, 2003.
2. Campbell, N.A., J.B. Recee and E.J. Simon, Essential Biology, VIIth Edition, Pearson International 2007

**WEBSITES:**

1. https://nptel.ac.in/
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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| **24BEBME5E05** | **BIOMEMS** | **Elective 3H-3C** |
| **Instruction Hours/week: L:3 T:0 P:0** | | **Marks: Internal:40 External:60 Total:100 End Semester Exam:3 Hours** |

**PREREQUISITES:** Biomaterials

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the principles of MEMS sensors
- Illustrate the properties of sensors suitable for medical application
- Construct MEMS device for biological applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Classify MEMS fabrication techniques
- Illustrate the principles of mechanical and thermal sensors
- Summarize the properties of electrostatic and piezoelectric sensors
- Outline the working of microfludic systems
- Model MEMS devices for medical applications

**UNIT I** **MEMS MATERIALS AND FABRICATION** **09**

Typical MEMs and Microsystems, materials for MEMS - active substrate materials- Silicon and it compounds, Silicon piezo resistors, Gallium Arsenide, quartz, polymers. Micromachining photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA

**UNIT II** **MECHANICAL AND THERMAL SENSORS AND ACTUATORS** **09**

Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermomechanics, fracture and thin film mechanics. 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, flow sensor.

**UNIT III** **ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATORS** **09**

Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator –inchworm motor, inertia sensor, flow sensor.

**UNIT IV** **MICROFLUIDIC SYSTEMS** **09**

Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in micro conduits, in submicrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, dielectrophoresis, microfluid dispenser, microneedle, micropumps-continuous flow system, micromixers

**UNIT V** **APPLICATIONS OF BIOMEMS** **09**

CAD for MEMs, Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR), DNA sensor, MEMS based drug delivery

**Total: 45 Hours**

**TEXT BOOKS:**

1. Tai-Ran Hsu, MEMS & Microsystems- Design, Manufacture and Nanoscale Engineering, 2nd Edition, John Wiley & Sons, 2008.
2. Wanjun Wang & Steven A.Soper, BioMEMS- Technologies and applications, CRC Press, 1st Edition, 2007.

**REFERENCE BOOKS:**

1. Nitaigour Premchand Mahalik, MEMS, Tata McGraw Hill, 2nd Reprint, 2008.
2. Chang Liu, Foundations of MEMS, Pearson Education International, New Jersey, USA, 2006

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO4 | K2 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO5 | K2 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **2** | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**B.E Biomedical Engineering** **2024-2025**

| **24BEBME5E06** | **BIOMEDICAL INFORMATICS** | **Elective 3H-3C** |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Interpret the standards involved in bioinformatics
- Illustrate the process of storage and automation of biomedical data
- Utilize the state of art methods for biomedical data analytics

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain health informatics and hospital information system
- Compare the medical standards for medical data storage and analysis
- Outline the process of medical data storage and automation
- Summarize the bioinformatics procedures
- Model the process of bioinformatics for medical applications

**UNIT I MEDICAL INFORMATICS 09**

Introduction, Medical Informatics, Bioinformatics, Health Informatics, Structure of Medical Informatics Functional capabilities of Hospital Information System, On-line services and off, line services, History taking by computer, Dialogue with the computer

**UNIT II MEDICAL STANDARDS 09**

Evolution of Medical Standards, IEEE 11073, HL7, DICOM, IRMA, LOINC, HIPPA, Electronics Patient Records, Healthcare Standard Organizations, JCAHO (Join Commission on Accreditation of Healthcare Organization), JCIA (Joint Commission International Accreditation), Evidence Based Medicine, Bioethics.

**UNIT III MEDICAL DATA STORAGE AND AUTOMATION 09**

Plug in Data Acquisition and Control Boards, Data Acquisition using Serial Interface, Medical Data formats, Signal, Image and Video Formats, Medical Databases, Automation in clinical laboratories, Intelligent Laboratory Information System, PACS, Datamining

**UNIT IV HEALTH INFORMATICS 09**

Bioinformatics Databases, Bio-information technologies, Semantic web and Bioinformatics, Genome projects, Clinical informatics, Nursing informatics, Public health informatics, Education and Training.

**UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 09**

Medical Expert Systems, Virtual reality applications in medicine, Virtual Environment, Surgical simulation, Radiation therapy and planning, Telemedicine, virtual Hospitals, Smart Medical Homes, Personalized e-health services, Biometrics, GRID and Cloud Computing in Medicine.

**Total: 45 Hours**

**TEXT BOOKS:**


1. R.D.Lele, Computers in medicine progress in medical informatics, Tata McGraw Hill Publishing computers Ltd, New Delhi, 2005.
2. Mohan Bansal, Medical informatics, Tata McGraw Hill Publishing Computers Ltd, NewDelhi, 2003.
3. N.Mathivanan, PC-Based Instrumentation, Prentice Hall of India Pvt Ltd, New Delhi, 2007


**REFERENCE BOOKS:**


1. Orpita Bosu and Simminder Kaur Thukral, Bioinformatics Databases, Tools and Algorithms, Oxford University press, New Delhi, 2007.
2. Yi, Ping Phoebe Chen, Bioinformatics Technologies, Springer International Edition, NewDelhi, 2007.


**WEBSITES:**

1. https://nptel.ac.in/
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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | | | | | | | 1 | 1 | | 1 | 1 | 2 |
| CO2 | K2 | 2 | 1 | | | | | | | 1 | 1 | | 1 | 1 | 2 |
| CO3 | K2 | 2 | 1 | | | | | | | 1 | 1 | | 1 | 1 | 2 |
| CO4 | K2 | 3 | 2 | 1 | | | | | | 1 | 1 | | 1 | 1 | 2 |
| CO5 | K3 | 3 | 2 | 1 | | | | | | 1 | 1 | | 1 | 1 | 2 |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **2** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| | | |
|---|---|---|
| **B.E Biomedical Engineering** | | **2024-2025** |
| **24BEBME6E01** | **MICRO FLUIDICS** | **Elective 3H-3C** |
| **Instruction Hours/week: L:3 T:0 P:0** | | **Marks: Internal:40 External:60 Total:100 End Semester Exam:3 Hours** |

**PREREQUISITES:** Biomechanics

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Infer the concepts of microfluidics, materials and fabrication processes
- Illustrate the working of detection and control of microfluidic systems
- Model a microfluidic device for biomedical applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the fundamentals of microfluidics
- Compare the materials and fabrication processes for microfluidics
- Summarize the methods for detection and control of fluidic systems
- Outline the principles of microdevice technologies
- Construct a fluidic system for medical applications

**UNIT I BASIC MICROFLUDIC CONCEPTS 09**

Introduction to Microfluidics- Introduction to Microfluidics- The microfluidic advantage- Fluidics and Transport Fundamentals: The continuum approximation- Laminar flow- Diffusion in microfluidic systems - Surface forces and droplets- 1 Pumps and valves- Electrokinetics- Electro-osmosis- Electrophoresis

**UNIT II MATERIALS AND FABRICATION PROCESSES FOR MICROFLUIDIC 09**

Materials for Microfluidic Devices- Silicon Based Materials- Glass Based Materials- Polymers Based Material- Fabrication of Microfluidics devices- Photolithography & its techniques- Additive Techniques- Subtractive Techniques- Silicon microfabrication- Injection molding and Hot embossing- Casting & Lithography- Fabrication of microfluidic channels in SU-8- Microfluidic networks created in biodegradable materials.

**UNIT III FLUIDIC CONTROL METHODS AND DETECTION METHODS 09**

Fluid Control :Basic theory- Pressure –Driven Flow- Shear driven Flow- Shear driven flow examples- Electrokinetically –driven flow- Electrokinetically –driven flow problem and examples- Single Molecule Detection Methods- Optical detection methods- Electrochemical method examples- Measurement of Fluidic Properties: Non Intrusive flow measurement techniques- Current monitoring in electroosmotic flowcimetry- Laser-induced fluorescence photobleaching anemometer with stimulated emission depletion

**UNIT IV MICRODEVICE TECHNOLOGIES 09**

Actuators for micropumps- Actuators for Microvalves- Flow sensors- Microarrays- Microreactors- Pipettes and Dispensers- Microanalytical Chips- Electrochemical microfluidics devices- Paper Microfluidics devices- 3D Printed Microfluidic Devices

**UNIT V** **ADVANCEMENTS IN BIOENGINEERING** **09**

Electrophoresis:DNA separation- Case study :DNA separation- Shear-driven flow: Biomolecular separation- Case study : Biomolecular separation- Ion Transport with case study- Concentration with case study- Bioanalysis:Immunoassay- DNA analysis- On-chip separations and combinations- Sample injection and separation- Micro-gas chromatography: Micro gas sensors for micro GC- Case study for a micro GC- Micro-scale impedance measurements- Biosensor- Nano- Biosensors

**Total: 45 Hours**

**TEXT BOOKS:**

1. Patric Tabeling, Introduction to Microfluidics, Oxford U. Press, New York,2005.
2. Yujun Song, Daojian Cheng& Liang Zhao, Microfluidics: Fundamentals, Devices, and Applications, Wiley VCH, First edition, 2018.
3. Xiujun (James) Li and Yu Zhou, Microfluidic devices for biomedical applications, Woodhead Publishing Limited, 16th edition, 2013.

**REFERENCE BOOKS:**

1. Wei-Cheng Tian, Erin Finehout, Microfluidics for Biological Applications, Springer, 2008.
2. Nam-Trung Nguyen, Steven T. Wereley, Fundamentals And Applications of Microfluidics, Artech Print on Demand, Second Edition, 2006.

**WEBSITES:**

1. https://nptel.ac.in/
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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.4** | **1.4** | **1** | - | - | - | - | - | **1** | **1** | - | **1** | **1** | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME6E02** | **BIOMIMETICS** | **Elective 3H-3C** |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES:** Biosensors and measurements

**COURSE OBJECTIVES**

The goal of this course is for students to:

1. Interpret the concept and mechanisms of biomimetic technologies for cognition and open ended design automation
2. Summarize the importance of bio-inspired devices for biomimetic applications
3. Develop a bio-inspired biomimetic system for diagnostic and therapeutic applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

1. Explain the concepts of biomimetics
2. Illustrate the mechanism of cognition and open-ended design automation.
3. Summarize the importance of bio-inspired sensors and biomimetic actuators.
4. Outline the concepts in the biomimetic of motion.
5. Construct the biomimetic device for real time applications

**UNIT I** **INTRODUCTION TO BIOMIMETICS** **09**

Introduction: Biologically Inspired Mechanisms, Biologically Inspired Structures and Parts, Defense and Attack Mechanisms in Biology, Materials and Processes in Biology, Bio-Sensors. Robotics Emulating Biology- Robotics Emulating Biology, Muscle function, Muscle design, Muscle adaptation, Biomimetics of muscle design, Bio-inspired fiber composites.

**UNIT II** **MECHANISM OF COGNITION AND OPEN-ENDED DESIGN AUTOMATION** **09**

Mechanized Cognition, Training and Education, Language Cognition, Sound Cognition, Visual Cognition, Machine Bodies and Brains: Evolving Controllers and Some Aspects of the Morphology, Evolving Bodies and Brains, Morphology Representations: Tree representations Developmental representations, Regulatory network representations, Evolving Machines in Physical Reality, Economy of Design Automation, Principles of Design, Research Methodology.

**UNIT III** **BIO-INSPIRED SENSORS AND BIOMIMETIC ACTUATORS** **09**

Biomimetic tactile sensing:Human sense of touch, Biomimetic artificial touch, Examples of bio-inspired tactile sensing, Bio-Inspired hair based interial sensors: Hair structures for inertial sensing, Cricket-inspired accelerometer, Fly-inspired gyroscope, Olfactory sensor system for the e-nose, Olfactory classification-data processing, Polymer network actuators, Biomimetic vision systems, Novel biomimetic materials :Introduction, Design of self-oscillating polymer gel, Control of self-Oscillating chemomechanical behaviors, Design of biomimetic soft actuators, Design of autonomous mass transport systems, Self-oscillating fluids.

**UNIT IV** **BIOMIMETICS OF MOTION** **09**

Biomechanics of motion: Control center, Passive & Active external and internal actuation, Agonist Mechanism: Hygroscopic mechanism, Agonist Mechanism: Hygroscopic mechanism, Muscular Antagonism, Power amplification: Elastic amplification, Deformation of a constant volume, Mechanics of hydrostatic systems: Single compartment systems, Multiple compartment systems, Rhythmics of motion: Gait, Passive Locomotion, Limbless locomotion, Multiple limb locomotion.

**UNIT V** **APPLICATION OF BIOMIMETIC TECHNOLOGIES** **09**

Artificial intelligence through symbolic connectionism, Localist symbolic connectionism, Distributed symbolic connectionism, Symbolic connectionism in biological models, Neurofuzzy systems, Bio-Inspired adhesion technologies, Bio-Inspired adhesion technologies, Size and current technology, Quadruped robot system: Mechanical components, Electrical components of quadruped robot, Biologically inspired antenna array design Biologically inspired antenna array design.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Yoseph Bar-Cohen, "BIOMIMETICS Biologically Inspired Technologies", CRC Press, 1 st Edition, 2006.
2. 2. Trung Dung Ngo, "Biomimetic Technologies: Principles and Applications", Wood head Publishing Ltd, 1 st Edition, 2015.

**REFERENCE BOOKS:**

1. Sandra Persiani, "Biomimetics of Motion: Nature-Inspired Parameters and Schemes for Kinetic Design", Springer, 1 st Edition, 2019.
2. P Gruber, D Bruckner, C Hellmich, · H B. Schmiedmayer, H. Stachelberger, I C. Gebeshuber, "Biomimetics – Materials,Structuresand ProcessesExamples, Ideas and Case Studies", Springer, 1 st Edition, 2011

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| 24BEBME6E05 | BIOFLUID MECHANICS | Elective<br>3H-3C |

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES:** Biomechanics

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Outline the fundamentals of soft tissue mechanics
- Compare the macrocirculation and microcirculation systems
- Make use of biofluid mechanics of organ systems

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the fundamentals of soft tissue mechanics
- Show the various transports in biological systems
- Interpret the role of biofluid mechanics in various organ systems
- Illustrate the concepts of cardiac systems and its biofluid mechanics
- Utilize the concept of biofluid mechanics for medical applications

**UNIT I FUNDAMENTAL OF SOFT TISSUE MECHANICS 09**

Introduction: Structural organization of skeletal muscle- Muscle fiber- Motor unit- Fiber types- Fiber architecture- Muscle function- Maximum Muscle Stress- Maximum Muscle Contraction Velocity- Types of Muscle Models- Huxley biochemical models- Hill phenomenological models- Constitutive models- Tendon-morphology- Tendon-properties- Ligament –morphology- Ligament –properties- Articular cartilage – morphology and properties

**UNIT II BASIC CONCEPT OF BIOFLUIDS 09**

Introduction –Body fluids, Dimension and unit-Basic Concepts and Definitions of Fluid Mechanics-Fluid Kinematics and Viscosity-Newtonian Fluids-Non-Newtonian Fluids-Dimensionless Numbers of Biofluid Mechanics-Steady versus Unsteady Flow and Laminar Versus Turbulent Flow-Boundary Conditions and No Slip Boundary Condition -Navier Stokes Equations-Bernoulli Equation-Hagen Poiseuille Equation-Steady Flow Along Tube, Hematology and blood rheology

**UNIT III MACROCIRCULATION AND MICROCIRCULATION SYSTEM 09**

Introduction of macrocirculation and microcirculation-Pulsatile flow properties-Arteries-Veins-Vascular bifurcations and branches-Blood flow through curved vessels-Mechanical and elasticity properties of vessels-Atherosclerosis characteristics-Blood flow through stenosis-Arterioles and blood flow aspects-Capillaries and venules-Fahraeus and Fahraeus lindqvist effects-Mass transport in tissue-Porosity, tortuosity and permeability-Governing equations in porous media-Fluid transport in poroelastic media

**UNIT IV CARDIAC MECHANICS 09**

Introduction-Cardiac Geometry and Structure- Ventricular Geometry-Myofiber Architecture-Extracellular Matrix Organization-Cardiac Pump Function: Ventricular Hemodynamics-Ventricular Pressure--Volume Relations and Energetics-Myocardial Material Properties: Muscle Contractile Properties-Muscle Contractile Properties-Resting Myocardial Properties-Regional Ventricular Mechanics: Stress and Strain

**UNIT V BIOFLUID MECHANICS OF ORGANS SYSTEM 09**

Kidney :Structure and function-Fluid flow in an artificial kidney model- Liver: structure and function-Hepatic acinus model-Fluid flow in hepatic acinus model- Lung : Structure and function-Elasticity of the lung blood vessels and alveoli-Pressure-volume relationship for air flow in the lungs-Oxygen/carbon dioxide diffusion and transport in the blood-Compressible fluid flow-Lubrication of joints: function-Formation of synovial fluid-Synovial fluid flow-Mechanical forces within joint.

**Total: 45 Hours**

**TEXT BOOKS:**

1. David A. Rubenstein, Wei Yin & Mary D. Frame, Biofluid mechanics: An introduction to fluid mechanics, macrocirculation and microcirculation (Biomedical Engineering), Elsevier,2nd edition,2012.
2. Clement Kleinstreuer, Biofluid Dynamics: Principles and Selected Applications, CRC Press; 1 edition,2016.

**REFERENCE BOOKS:**

1. Susan Hall, Basic Biomechanics, McGraw-Hill Education,6th edition,2011.
2. Ali Ostadfar, Biofluid Mechanics -Principles and Applications, Elsevier,1st edition,2016.

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.4** | **1.2** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**24BEBME6E06** **ROBOTICS AND AUTOMATION IN MEDICINE** **Elective 3H-3C**

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Infer the principles and basic mechanism of robotic subsystems.
- Illustrate the design, analysis and working principle of manipulators and actuators.
- Build a robotic architecture to assist in the medical field.

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Outline the concepts of robotics.
- Explain the working principles of actuators and grippers.
- Classify manipulators and its types.
- Make use of the power source of sensors in robotics.
- Model prototypes of robotic system in medical application.

**UNIT I** **INTRODUCTION OF ROBOTICS** **09**

Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation, Mechanisms and movements, Dynamic stabilization- Applications of robotics in medicine.

**UNIT II** **ACTUATORS AND GRIPPERS** **09**

Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, Design consideration in vacuum and other methods of gripping, PD and PID feedback actuator model.

**UNIT III** **MANIPULATORS & BASIC KINEMATICS** **09**

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems.

**UNIT IV** **POWER SOURCES AND SENSORS** **09**

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors,force sensors, laser range finder, variable speed arrangements, Path determination - Machinery vision, Ranging, Laser- Acoustic, Magnetic fiber optic and Tactile sensor.

**UNIT V** **ROBOTICS IN MEDICINE** **09**

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric-, and General- Surgery, Gynecologic Surgery, General Surgery and Nano robotics.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, 2018.
2. Reza N.Jazar, Theory of Applied Robotics Kinematics, Dynamics and Control, Springer, First Indian Reprint 2016.
3. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons,First edition, 2015.

**REFERENCE BOOKS:**

1. Jacob Rosen, Blake Hannaford & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011.
2. Constantinos Mavroidis, Antoine Ferreira, "Nanorobotics: Current approaches and Techniques", Springer 2011.

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **Average** | | **2.4** | **1.4** | **1** | - | - | - | - | - | **1** | **1** | - | **1** | **1** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| 24BEBME7E01 | INTELLECTUAL PROPERTY RIGHTS | Elective 3H-3C |

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Infer the fundamentals and the codes of medical ethics
- Explain about intellectual property rights, patents and copyrights
- Utilize the overall idea about trademarks and geographical indicators

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Outline the importance of medical ethics
- Apply the knowledge of Intellectual Property Rights.
- Interpret the protocols and principles of patents
- Outline the key aspects on copyrights
- Make use of the concepts of trademarks and geographical indicators

**UNIT I CLINICAL TRIALS 09**

Definition and historic evolution of bioethics - Definition and historic evolution of bioethics - Medical ethics:some basic issues - Teaching and learning medical ethics - Codes of conduct - Rights of patients - Rights of patients - Malpractice - Negligence - Care of the terminally ill - Distributive Justice in Health Care – Human experimentation and Clinical trials.

**UNIT II INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS 09**

Introduction to Intellectual Property Rights - History of IPR - Importance and need for protection of intellectual property - Importance and need for protection of intellectual property - Patentable subject matter - Emerging trends and issues in IPR - Emerging trends and issues in IPR - Emerging trends and issues in IPR - Public Vs. Private - Public Vs. Private - World Intellectual Property Organization(WIPO) - World Trade Organisation (WTO) - General Agreement on Tariffs and Trade(GATT ) agreement - Major Conventions on IP - Berne Convention - Paris Convention - TRIPS agreement - Basic forms of intellectual property rights.

**UNIT III PATENTS 09**

Definition of patents - Purpose of a patent - What sort of things can be patented, Patentable and non-patentable inventions – What sort of things can be patented, Patentable and non-patentable inventions - Invention vs Innovation - Process Patent - Product Patent – Types of patent applications - Precautions while patenting - Patent specification, Patent claims - Disclosures and non-disclosures, Patent rights and infringement, Rights of a patent owner – Patent cooperation treaty - Paris convention for the protection of industrial property - Paris convention for the protection of industrial property

**UNIT IV** **COPYRIGHTS** **09**

What is copyright - Why copyright - Literature and artistic works - Literature and artistic works - Protection of copyright - Protection of copyright - Right of public performance- broadcasting, translation, Adaptation- Transfer of copyright - Transfer of copyright - Transfer of copyright - International conventions and treaties- International conventions and treaties- Works that are protected by copyright.

**UNIT V** **TRADEMARKS AND GEOGRAPHICAL INDICATORS** **09**

Trademark and purpose of a trademark - Characteristics of trademark - Functions of trademarks – Guidelines for the registration of a trademark - Nontraditional trademarks - Major types of trademarks - Protection of a trademark, Purpose of a trademark – Madrid system for the International registration of trademarks - Industrial design-Purpose of industrial design - Protection of industrial design The Hague agreement Geographical indication - Appellation of origin - Protection of geographical indication(GI) – Protection of geographical indication(GI).

**Total: 45 Hours**

**TEXT BOOKS:**

1. Ramakrishna B and Anil Kumar H S, 'Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers', Notion Press, 2017.
2. C M Francis, Medical Ethics, Second Edition, Jaypee Brothers, 2004.

**REFERENCE BOOKS:**

1. Chawla H S, Introduction To Intellectual Property Rights, Oxford and IBH Publishing, 2020.

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.4** | **1.2** | **1** | - | - | - | - | - | **1** | **1** | - | **1** | **1** | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME7E02** | **BIOERGONOMICS** | **Elective 3H-3C** |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Infer the ergonomic principles and mechanics of muscle physiology concepts.
- Outline the process of hearing and factors in anthropometric design of work space surfaces
- Make use of the mathematical models, analysis and design of biomedical devices using case studies.

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the principles of ergonomics.
- Analyse the factors in design of work space surfaces
- Illustrate the mathematical models, analysis and design of biomedical devices using case studies.
- Apply the principles of good ergonomic design in anthropometry
- Model prototypes by applying ergonomics in medical fields

**UNIT I VISUAL AND AUDITORY ERGONOMICS 09**

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.

**UNIT II MUSCLE PHYSIOLOGY 09**

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.

**UNIT III CONTROLS AND DISPLAYS 09**

Spatial compatibility physical arrangement of displays and controls- movement capability- rotary controls and rotar displays movement of displays orientation of the operator and movement relationships control orders and control responses- human limitations in tracking task.

**UNIT IV ANTHROPOMETRY 09**

Anthropometry- anthropometric design principles –work space envelope- factors in design of work space surfaces- principles of seat design –principles of control panel. Organization classification of human errors theories of accident causation-reducing accidents by altering behavior.

**UNIT V CASE STUDIES 09**

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: 45 Hours**

**TEXT BOOKS:**

1. Pascale Carayon, Handbook of Human Factors and Engineering, Second Edition, CRC Press,2016.
2. Robert.N. Bailey, Human Performance Engineering, Third Edition, Prentice Hall,1996

**REFERENCE BOOKS:**

1. Martin Helander, Guide to Human Factors and Ergonomics, Second Edition, CRC Press,2005.

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| **Average** | | **2.4** | **1.4** | **1** | - | - | - | - | - | **1** | **1** | - | **1** | **2** | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**24BEBME7E05** **GENETIC ENGINEERING** **Elective**
**3H-3C**

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES:** Human anatomy and physiology

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Relate the concepts of DNA technology and libraries
- Summarize the concepts of genome sequencing and mapping
- Develop a genome sequencing system

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the concepts of DNA technology
- Interpret the concepts of DNA libraries
- Outline the concepts of gene and genome sequencing techniques
- Classify the structure of Genome mapping
- Build a genome sequencing system

**UNIT I BASICS OF RECOMBINANT DNA TECHNOLOGY 09**

Manipulation of DNA – Restriction and Modification enzymes, Design of linkers and adaptors. Characteristics of cloning and expression vectors based on plasmid and bacteriophage, Vectors for insect, yeast and mammalian system, Prokaryotic and eukaryotic host systems, Introduction of recombinant DNA in to host cells and selection methods.

**UNIT II DNA LIBRARIES 09**

Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Chromosomal walking, Screening of DNA libraries using nucleic acid probes and antisera.

**UNIT III SEQUENCING AND AMPLIFICATION OF DNA 09**

Maxam Gilbert's and Sanger's methods of DNA sequencing. Inverse PCR, Nested PCR, AFLP- PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, inverse PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis.

**UNIT IV ORGANIZATION AND STRUCTURE OF GENOMES 09**

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, Restriction Enzyme Finger Printing, Hybridization mapping, Radiation Hybrid Maps, Optical mapping. ORF finding and functional annotation.

**UNIT V CURRENT STATUS OF GENOME SEQUENCING PROJECTS 09**

Current status of genome sequencing projects, Introduction to Functional genomics, Microarrays, Serial Analysis of Gene expression (SAGE), Subtractive hybridization, DIGE, TOGA, Yeast Two hybrid System, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics.

**Total: 45 Hours**

**TEXT BOOKS:**

1. ld RW, Primrose SB, Principles of Gene Manipulation, An Introduction to Genetic Engineering, Blackwell Science Publications,1993.
2. S.B.Primrose and R.M.Twyman, Principles of Genome Analysis and Genomics 3rd Ed. Blackwell Publishing.

**REFERENCE BOOKS:**

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.
3. Arun K. Shukla, Proteomics in Biology, Academic Press, 2017.

**WEBSITES:**

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**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | - | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | - | 1 |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | - | 1 |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | - | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | - | 1 |
| **Average** | | **2.4** | **1.2** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **-** | 1 |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**B.E Biomedical Engineering** **2024-2025**

**24BEBME7E06** **CLINICAL ENGINEERING** **Elective 3H-3C**

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES:** Professional Ethics

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Summarize roles and activity of the clinical engineering
- Explain the challenges of healthcare technology management and patient safety
- Develop the advancement in patient safety system

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Summarize roles of the clinical engineering
- Explain the blocks of medical technology management
- Interpret the challenges in patient safety package system
- Outline the parameters of clinical engineering program management
- Build an advanced patient safety system

**UNIT I** **INTRODUCTION** **09**

Clinical engineering: Definition, Evolution, Role, Responsibilities, Functional status, History of clinical engineering and Technology in Health Care System, Enhancing patient safety.

**UNIT II** **MEDICAL TECHNOLOGY MANAGEMENT PRACTICES** **09**

Strategic Medical Technology Planning, Scope , Clinical necessity operational support, strategic planning process – Technology assessment: Technology audit, Budget strategies, Prerequisite for medical technology assessment – Management Practice for Medical Equipment - Device evaluation, Risk reduction, Asset management, ESHTA.

**UNIT III** **ESSENTIAL HEALTH CARE TECHNOLOGY PACKAGE (EHTP)** **09**

Introduction – – Package development: Methodology, Logical framework, Implementation, Information promotion and dissemination – EHTP Justification – EHTP matrix – EHTP advantages – Impact Analysis.

**UNIT IV** **CLINICAL ENGINEERING PROGRAM INDICATOR** **09**

Clinical engineering: program services, Program database – Clinical Engineering Program management, Program indicator, Managing clinical engineering performance using program indicators – Indicator management process.

**UNIT V** **ADVANCED TECHNOLOGY FOR PATIENT SAFETY** **09**

Factors Contributing to Medical Errors: Healthcare 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: 45 Hours**

**TEXT BOOKS:**

1. Ernesto Iadanza, Joseph Dyro, Clinical Engineering Handbook, Elsevier,Academic Press,2014.

**REFERENCE BOOKS:**

1. Robert Miniati Clinical Engineering from Devices to Systems Academic Press 23-Dec2015

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.4** | **1.2** | **1** | - | - | - | - | - | **1** | **1** | - | **1** | **1** | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**PROFESSIONAL ELECTIVES**
**BIOWEARABLE SYSTEMS**

| **B.E Biomedical Engineering** | | **2024-2025** |
|---|---|---|
| **24BEBME5E03** | **ANALOG AND DIGITAL COMMUNICATION** | **ELECTIVE 3H-3C** |

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the principles and techniques in analog and digital communications
- Compare the data and pulse communication techniques
- Make use of source and error control coding in multi-user radio communication

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Interpret the concepts of analog and digital communication techniques
- Compare the data and pulse communication techniques
- Illustrate the source and error control coding
- Develop modulation and demodulation techniques in pulse communication system
- Apply the channel assignment in multi-user radio communication

**UNIT I ANALOG COMMUNICATION 09**

Noise: Source of Noise – External Noise- Internal Noise – Noise Calculation. Introduction to Communication Systems: Modulation – Types – Need for Modulation. Theory of Amplitude Modulation- Evolution and Description of SSB Techniques – Theory of Frequency and Phase Modulation –Comparison of various Analog Communication System (AM – FM – PM).

**UNIT II DIGITAL COMMUNICATION 09**

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) –Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK – Quadrature Amplitude Modulation (QAM) – 8QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK– FSK – PSK – QAM).

**UNIT III DATA AND PULSE COMMUNICATION 09**

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) –Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK – Quadrature Amplitude Modulation (QAM) – 8QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK– FSK – PSK – QAM).

**UNIT IV SOURCE AND ERROR CONTROL CODING 09**

Entropy Source encoding theorem, Shannon Fano coding, Huffman coding, mutual information, channel capacity, channel coding theorem, Error Control Coding, linear block codes, cyclic codes, convolution codes, Viterbi decoding algorithm.

**UNIT V MULTI-USER RADIO COMMUNICATION 09**

Advanced Mobile Phone System (AMPS) – Global System for Mobile Communications (GSM) – Code Division Multiple Access (CDMA) – Cellular Concept and Frequency Reuse – Channel Assignment and Hand off – Overview of Multiple Access Schemes – Satellite Communication – Bluetooth

**Total: 45 Hours**

**TEXT BOOKS:**

1. Kennedy G, Kennedy's Electronic Communication Systems, McGraw Hill, 2014
2. Wayne Tomasi, Electronic Communication Systems: Fundamentals through Advanced Pearson Education, 2014

**REFERENCE BOOKS:**

1. Rappaport T.S, Wireless Communications: Principles and Practice, Pearson Education, 2010
2. B. P.Lathi, Modern Analog and Digital Communication Systems, Oxford University Press, 2011

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - |  | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME5E04** | **WEARABLE DEVICES** | **ELECTIVE 3H-3C** |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**

**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Outline the need of developing wearble diagnostic and therapeutic systems
- Relate the energy requirements of sensors used in wireless health monitoring systems
- Interpret the need of signal processing techniques in wireless devices.

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the recent trends and need for wearable systems.
- Interpret sensors and signal processing techniques
- Illustrate energy harvesting techniques for wearable systems.
- Outline the need for wireless health care systems
- Apply the principles of diagnostic wearable devices

**UNIT I SENSORS 09**

Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS, Based Biosensors, E-Textiles, Bio compatibility.

**UNIT II SIGNAL PROCESSING 09**

Wear ability issues-physical shape and placement of sensor, Technical challenges-sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information, Data mining.

**UNIT III ENERGY HARVESTING FOR WEARABLE DEVICES 09**

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) –Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK – Quadrature Amplitude Modulation (QAM) – 8QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK– FSK – PSK – QAM).

**UNIT IV WIRELESS HEALTH SYSTEMS 09**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture, Introduction, Wireless communication techniques.

**UNIT V APPLICATIONS OF WEARABLE SYSTEMS 09**

Medical Diagnostics, Medical Monitoring- Patients with chronic disease, Hospital patients, Elderly patients, Multi parameter monitoring, Neural recording, Gait analysis, Sports Medicine, Smart Fabrics.

**Total: 45 Hours**

**TEXT BOOKS:**

1. 1.Kennedy G, Kennedy's Electronic Communication Systems, McGraw Hill, 2014
2. Wayne Tomasi, Electronic Communication Systems: Fundamentals through Advanced Pearson Education, 2014

**REFERENCE BOOKS:**


1. Rappaport T.S, Wireless Communications: Principles and Practice, Pearson Education, 2010
2. B. P.Lathi, Modern Analog and Digital Communication Systems, Oxford University Press, 2011


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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 2 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 2 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 2 | - |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 2 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | 1 | 1 | 1 | - | 1 | 2 | - |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | **-** | **-** | **1** | **1** | **1** | **-** | **1** | **2** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME5E07** | **BODY AREA NETWORKS** | **ELECTIVE 3H-3C** |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**

**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the architectures of BAN
- Illustrate the communication and safety protocols to be followed in BAN
- Make use of BAN device for biomedical applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Outline the concepts of body area networks
- Illustrate the hardware architecture for BAN.
- Interpret the wireless communication and network protocols.
- Explain the challenges and security protocol in BAN
- Apply the principles of BAN devices for biomedical applications

**UNIT I** **INTRODUCTION** **09**

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BSN Architecture.

**UNIT II** **HARDWARE FOR BAN** **09**

Processor-Low Power MCUs, Mobile Computing MCUs, Integrated processor with radio transceiver, Memory, Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

**UNIT III** **WIRELESS COMMUNICATION AND NETWORK** **09**

RF communication in Body, Antenna design and testing, Propagation, Base Station Network Topology-Stand, Alone BAN, Wireless personal Area Network Technologies IEEE 802.15.1, IEEE P802.15.13, IEEE 802.15.14, Zigbee.

**UNIT IV** **COEXISTENCE ISSUES WITH BAN** **09**

Interferences, Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues -Medical Device regulation in USA and Asia, Security and Self-protection Bacterial attacks, Virus infection, Secured protocols, Selfprotection.

**UNIT V** **APPLICATIONS OF BAN** **09**

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2014.
2. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkatasubramanian, “Body Area Networks Safety, Security, and Sustainability,” Cambridge University Press, 2013.

**REFERENCE BOOKS:**


1. Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems", Springer, 2013.
2. Guang -Zhong Yang (Ed.), "Body Sensor Networks", Springer, 2006.
3. Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks Technology, Implementation, and applications", Pan Stanford Publishing Pte. Ltd, Singapore, 2012.


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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 2 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 2 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 2 | - |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 2 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | 1 | 1 | 1 | - | 1 | 2 | - |
| **Average** | | **2.2** | **1.2** | **1** | **-** | **-** | **-** | **-** | **1** | **1** | **1** | **-** | **1** | **2** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME5E08** | **VIRTUAL REALITY AND AUGMENTED REALITY IN HEALTHCARE** | **ELECTIVE 3H-3C** |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the concepts AR/VR
- Utilize the principles of modeling in AR/VR systems
- Develop AR/VR system for diagnostic and therapeutic applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Interpret the concepts of virtual and augmented reality
- Explain the geometric modelling and Virtual environment
- Illustrate Virtual Environment and Augmented Reality systems
- Explain the Hardware and Software tools for AR/VR
- Model the VR environment for biomedical applications

**UNIT I** **INTRODUCTION TO AUGMENTED REALITY AND VIRTUAL REALITY** **09**

Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics,Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark. Augmented Reality Concepts: History of Augmented Reality, Multimodal displays: Haptic, Tactile and Tangible Displays, Visual Perception

**UNIT II** **GEOMETRIC MODELLING** **09**

Geometric Modelling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation. Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection

**UNIT III** **VIRTUAL ENVIRONMENT AND AUGMENTED REALITY SYSTEMS** **09**

Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system. Augmented Reality Systems – Types, Taxonomy of Augmented Reality, Helmet, Headup display, Smart Glasses, Projection

**UNIT IV** **VR HARDWARE AND SOFTWARE** **09**

Human Factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML, Khronos Group – AR Toolkit – Augmented Reality Operating System – Role of Augmented Reality interfaces – Players and Platforms

**UNIT V** **AV/VR FOR BIOMEDICAL APPLICATIONS** **09**

Introduction, Engineering, Entertainment, Science, Training. The Future: Virtual environment, modes of interaction. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, Augmenting Dental Care, Virtual Reality for Rehabilitation , Medical Model Generation.

**Total: 45 Hours**

**TEXT BOOKS:**

1. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
2. 2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles and Practice", AddisonWesley Professional, 2016.

**REFERENCE BOOKS:**

1. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.
2. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
3. Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2nd Edition, 2006.
4. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008.
5. Jon Peddie, "Augmented Reality – Where We Will All Live", Springer International Publishing AG, 2017.
6.

**WEBSITES:**

1. https://nptel.ac.in/
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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | 1 | - | - | - | - | - | - | 1 | 1 | 1 |
| CO2 | K2 | 2 | 1 | - | - | 1 | - | - | - | - | - | - | 1 | 1 | 1 |
| CO3 | K2 | 2 | 1 | - | - | 1 | - | - | - | - | - | - | 1 | 1 | 1 |
| CO4 | K2 | 2 | 1 | - | - | 1 | - | - | - | - | - | - | 1 | 1 | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | 1 | - | - | - | - | - | - | 1 | 1 | 1 |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| 24BEBME6E03 | TELEMEDICINE | ELECTIVE 3H-3C |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**

**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Infer the key principles and ethical aspects of telemedicine
- Outline information and communication infrastructure for telemedicine
- Apply telemedicine concepts in the streams of healthcare

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the basic concepts and benefits of telemedicine
- Summarize the types of information and communication infrastructure for telemedicine
- Outline the ethical and legal aspects of telemedicine
- Build the picture archiving and communication systems of telemedicine
- Apply the concepts of telemedicine and e-health in real world scenarios

**UNIT I FUNDAMENTALS OF TELEMEDICINE 09**

History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.

**UNIT II TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR TELEMEDICINE 09**

Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.

**UNIT III ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE 09**

Confidentiality, patient rights and consent: confidentiality and the law, the patient doctor relationship, access to medical records, consent treatment - data protection & security, jurisdictional issues, intellectual property rights.

**UNIT IV PICTURE ARCHIVING AND COMMUNICATION SYSTEM 09**

Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture.

**UNIT V APPLICATIONS OF TELEMEDICINE 09**

Teleradiology, Telepathology, Telecardiology, Teleoncology, Teledermatology, Telesurgery, e Health and Cyber Medicine.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Khandpur R S, TELEMEDICINE– Technology and Applications, PHI Learning Pvt Ltd, 2017
2. Norris A C Essentials of Telemedicine and Telecare, John Wiley, New York, 2002

**REFERENCE BOOKS:**


1. H K Huang PACS and Imaging Informatics: Basic Principles and Applications Wiley, New Jersey 2010
2. Richard Wootton, John Craig, Victor Patterson Introduction to Telemedicine Taylor & Francis 2017


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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K3 | 3 | 2 | 1 | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **1** | **-** | **-** | **1** | **1** | **-** | 1 | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME6E04** | **MEDICAL SENSORS - MEMS & NEMS** | **ELECTIVE 3H-3C** |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Summarize the working principle of medical sensors.
- compare the fabrication and characterization techniques of MEMS
- Utilize the software tools for MEMS development in medical application

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the principle of sensors
- Illustrate the principles of MEMS and NEMS
- Outline the material synthesis, fabrication and characterization of the micro sensors
- Choose the biosensor for medical application
- Make use of software tools for MEMS development.

**UNIT I** **CLASSIFICATION OF MEDICAL SENSORS** **09**

Sensors for Pressure Measurement- Sensors for Motion and Force Measurement- Sensors for Flow Measurement -Temperature Measurement- Sensors for speed, torque, vibration- smart sensors, design of interface system. Artificial intelligence in sensor technology.

**UNIT II** **MICROSYSTEM DESIGN** **09**

Technological Breakthrough, Dielectrics for Use in MEMS Applications, Piezoelectric Thin Films for MEMS Applications, Modeling of Piezoelectric MEMS, Interface Circuits for Capacitive MEMS Gyroscope, Advanced MEMS Technologies for Tactile Sensing and Actuation, MEMS-Based Micro Hot-Plate Devices, Inertial Sensor. Design of microsystem for sensing and control. Case study. Machine Learning tools in system design and analysis.

**UNIT III** **MATERIAL FOR MEMS AND NEMS WITH FABRICATION METHODS** **09**

Working principle of Microsystems, materials for MEMS and Microsystems, micromachining, System modeling, Properties of materials, Synthesis, selection and characteristics of materials. Artificial intelligence in material characteristics. Clean room, microfabrication methods, Lithography, epitaxy, sputtering, deposition, surface and bulk micromachining.

**UNIT IV** **MEDICAL SENSORS** **09**

Mechanical sensors and actuators – beam and cantilever, piezoelectric materials, thermal sensors and actuators- micromachined thermocouple probe, Peltier effect, heat pumps, thermal flow sensors, micro gripper microlens, microneedle, micropumps-Testing of the performance using software tools. Deep learning in actuator design and analysis.Applications of Optimization tools.

**UNIT V** **SOFTWARE TOOLS** **09**

Modeling and design, using MatLab, Design of sensors, pressure sensor, vibration sensor, actuators Analysis using solvers, MatLab, Comsol, mechanical solver, electrical solver. Machine learning tools in design and analysis Total periods : 45

**Total: 45 Hours**

**TEXT BOOKS:**

1. VikasChoudhary, Krzysztof Iniewski, "MEMS: Fundamental Technology and Applications", CRC Press, UK, 2017.
2. 2. Tatsuo Togawa; Toshiyo Tamura; P. Ake Oberg, "Biomedical Sensors and Instruments", CRC Press, UK 2011.

**REFERENCE BOOKS:**

1. Octavian Adrian Postolache and Subhas Chandra Mukhopadhyay, "Sensors for Everyday Life: Healthcare Settings (Smart Sensors, Measurement and Instrumentation), CRC Press, 2017.
2. 2. Gabor Harsanyi, "Sensors In Biomedical Applications: Fundamentals, Technology & Applications", CRC Press, USA, 2000.
3. 3. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002.
4. 4. Marc J. Madou 'Fundamentals of Microfabrication: The Science of Miniaturization', CRC Press, 2002.
5. 5. Mohammad Ilyas, Imad Mahgoub, "Handbook of Sensor Networks Compact Wireless and Wired Sensing Systems" CRC Press, USA. 2005

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K3 | 3 | 2 | **1** | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.4** | **1.4** | **1** | - | - | - | - | - | **1** | **1** | - | **1** | **1** | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME6E07** | **LASER IN MEDICINE** | **ELECTIVE 3H-3C** |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**

**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Explain the functions of a laser system
- Compare LASER types
- Summarize the therapeutic and surgical applications of laser

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the working principle of laser
- Classify the LASER and its types
- Interpret the applications of laser in Urology, Gynaecology and dentistry
- Outline the therapeutic applications of laser
- Make use of LASER in surgical application

**UNIT I** **LASER SYSTEM** **09**

Laser – Definition-Properties of laser-Characteristics of Laser, Construction and working principle of laser system-Mono-chromaticity, Coherence-Directionality, Brightness-Laser Characteristics as applied to medicine and biology-Laser tissue Interaction

**UNIT II** **TYPES OF LASER** **09**

Construction- Working principle- Molecular Laser Construction- Working principle, Dye Laser ConClassification of Laser, Solid state Laser Construction- Working principle, Atomic lasestruction

**UNIT III** **NON-THERMAL DIAGNOSTIC APPLICATIONS** **09**

Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM, Holographic and speckle application of lasers in biology and medicine.

**UNIT IV** **THERAPEUTIC APPLICATIONS** **09**

Phototherapy, Photodynamic therapy (PDT) - Principle and mechanism - Oncological and non-oncological applications of PDT - Bio stimulation effect, applications-Laser Safety Procedures, Laser hazards

**UNIT V** **SURGICAL APPLICATIONS OF LASERS** **09**

Lasers in ophthalmology- Dermatology, Dentistry-Urology-Otolaryngology- Tissue welding, Applications of Lasers in Orthopedics, Applications of laser in neurology

**Total: 45 Hours**

**TEXT BOOKS:**

1.Markolf H. Niemz, "Laser-Tissue Interaction Fundamentals and Applications", Springer, 2019.

**REFERENCE BOOKS:**

1. Paras N. Prasad, "Introduction to Bio photonics", A. John Wiley and sons, Inc. Publications, 2003

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO2 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **-** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME6E08** | **BIOMETRIC SYSTEMS** | **ELECTIVE 3H-3C** |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Understand the concepts of biometric systems.
- Compare the face, hand geometry and Iris recognition system
- Develop a multimodal biometrics for biomedical applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the characteristics of biometric systems
- Infer the techniques used in finger print technology
- Compare the face recognition and hand geometry
- Interpret the functions of iris recognition system
- Build multimodal biometrics for biomedical applications

**UNIT I INTRODUCTION TO BIOMETRICS 09**

Introduction and back ground, biometric technologies, passive biometrics, active biometrics, Biometric characteristics, Biometric applications, Biometric Authentication systems- Taxonomy of Application Environment, Accuracy in Biometric Systems- False match rate- False non-match rate- Failure to enroll rate- Derived Metrics-Biometrics and Privacy.

**UNIT II FINGERPRINT TECHNOLOGY 09**

History of finger print pattern recognition-General description of finger prints-finger print sensors, finger print enhancement, Feature Extraction- Ridge orientation, ridge frequency, finger print matching techniques- correlation based, Minutiae based, Ridge feature based, finger print classification, Applications of finger prints, Finger scanstrengths and weaknesses, Evaluation of fingerprint verification algorithms.

**UNIT III FACE RECOGNITION AND HAND GEOMETRY 09**

Introduction to face recognition, face recognition using PCA, LDA, face recognition using shape and texture, face detection in color images, 3D model-based face recognition in video images, Neural networks for face recognition, Hand geometry, scanning, Feature Extraction, classification.

**UNIT IV IRIS RECOGNITION 09**

Introduction, Anatomical and Physiological underpinnings, Iris sensor, Iris representation and localization- Daugman and Wildes approach, Iris matching, Iris scan strengths and Weaknesses, System performance, future directions.

**UNIT V VOICE SCAN AND MULTIMODAL BIOMETRICS 09**

Voice scan, speaker features, short term spectral feature extraction, Mel frequency cepstral coefficients, speaker matching, Gaussian mixture model, NIST speaker Recognition Evaluation Program, Introduction to multimodal biometric system, Integration strategies, Architecture, level of

fusion, combination strategy, examples of multimodal biometric systems, Securing and trusting a biometric transaction, matching location, local host - authentication server, match on card (MOC)

**Total: 45 Hours**

**TEXT BOOKS:**

1. JamesWayman, AnilJain, DavideMaltoni Biometric Systems, Technology Design and Performance Evaluation Springer 2005
2. S.Y.Kung, S.H.Lin,M. W.Mak Biometric Authentication: A Machine Learning Approach Prentice Hall 2005

**REFERENCE BOOKS:**

1. "Biometrics: Advanced Identity Verification: The Complete Guide" by Julian Ashbourn

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO4 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **Average** | | **2.4** | **1.4** | **1** | - | - | - | - | - | 1 | **1** | - | 1 | **1** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| 24BEBME7E03 | SPEECH PROCESSING | ELECTIVE 3H-3C |

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**

**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Understand the fundamentals of speech processing
- Compare the features of speech signal
- Build a speech recoginition and synthesis system

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the concept of speech mechanism
- Compare the features of speech signal
- Build feature extraction algorithms for the speech signal
- Classify speech recoginition system
- Model a speech synthesis system.

**UNIT I BASIC CONCEPTS 09**

Speech Fundamentals: Articulatory Phonetics, Production and Classification of Speech Sounds; Acoustic Phonetics, Acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

**UNIT II SPEECH ANALYSIS 09**

Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures, mathematical and perceptual, Log, Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization, Dynamic Time Warping, Multiple Time, Alignment Paths.

**UNIT III SPEECH MODELING 09**

Hidden Markov Models: Markov Processes, HMMs, Evaluation, Optimal State Sequence, Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

**UNIT IV SPEECH RECOGNITION 09**

Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system, acoustics and language models, n-grams, context dependent sub-word units; Applications and present status.

**UNIT V SPEECH SYNTHESIS 09**

Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness, role of prosody, Applications and present status.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing, An Introduction to Natural Language Processing", Computational Linguistics, and Speech Recognition‖, Pearson Education, 2019.
2. Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, 2008

**REFERENCE BOOKS:**

1. Ben Gold and Nelson Morgan, Speech and audio signal processing, Processing and Perception of Speech and Music", Wiley- India Edition, 2006 Edition.
2. Thomas F Quatieri, "Discrete-Time Speech Signal Processing, Principles and Practice", Pearson Education, 2004
3. Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO3 | K3 | 3 | 2 | 1 | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO4 | K3 | 3 | 2 | 1 | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **Average** | | **2.6** | **1.6** | **1** | **-** | **-** | **1** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| 24BEBME7E04 | BRAIN COMPUTER INTERFACE | ELECTIVE 3H-3C |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Understand the concept of BCI and its types
- Illustrate the feature extraction methods involved in developing BCI
- Build a machine learning model for BCI for biomedical applications

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the concepts and types of BCI system
- Illustrate the types of brain activation function
- Interpret the methods used for data filtering in BCI systems
- Infer machine learning models used in BCI system
- Develop the BCI system for biomedical applications

**UNIT I INTRODUCTION TO BRAIN COMPUTER INTERFACES 09**

Concept of BCI, Invasive and Non-invasive Types, EEG Standards, Signal Features, Spectral Components, EEG Data Acquisition, Pre-processing, Hardware and Software, Artifacts, Methods to Remove, Near Infrared BCI. Machine learning for brain computer interface

**UNIT II BCI APPROACHES 09**

Movement Related EEG Potentials, Mental States, Visual Evoked Potential. P300 virtual platform. Design and construction, Interaction between human and computerized technical systems.

**UNIT III EEG FEATURE EXTRACTION METHODS 09**

Time/Space Methods, Fourier Transform, Wavelets, AR models, Band pass filtering, PCA, Laplacian Filters, Linear and Non-linear Features. Deep learning and artificial intelligence in feature extraction methods

**UNIT IV EEG FEATURE TRANSLATION METHODS 09**

LDA, Regression, Memory Based Vector Quantization, Gaussian Mixture Modeling, Hidden Markov Modeling

**UNIT V APPLICATIONS OF BCI 09**

Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Non-invasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection, Ethics of Brain Computer Interfacing

**Total: 45 Hours**

**TEXT BOOKS:**

1. Rajesh.P.N.Rao, Brain-Computer Interfacing: AnIntroduction Cambridge University Press, First edition 2013
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, Brain Computer Interfaces: Principles and practice, Oxford University Press, USA, Edition 1, 2012

**REFERENCE BOOKS:**

1. Ella Hassianien, A& Azar.A.T Brain-Computer Interfaces Current Trends and Applications Springer 2015
2. Andrew Webb Statistical Pattern Recognition Wiley International 2002.

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **Average** | | **2.4** | **1.4** | **1** | **-** | - | - | - | - | 1 | 1 | **-** | **1** | **1** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

| **24BEBME7E07** | **COGNITIVE ENGINEERING** | **ELECTIVE 3H-3C** |
|---|---|---|

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

- Understand the concepts of neural networks and its types.
- Interpret the concept fuzzy logic and genetic algorithm
- Develop a hybrid soft computing system

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Explain the concepts of neural network
- Classify neural networks
- Interpret the concept fuzzy logic
- Summarize the concepts of genetic algorithm
- Build a hybrid soft computing system

**UNIT I INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS 09**

Characteristics- learning methods – taxonomy – Evolution of neural networks- McCulloch-Pitts neuron - linear separability - Hebb network - supervised learning network: perceptron networks - adaptive linear neuron, multiple adaptive linear neuron. Artificial intelligence in medical applications

**UNIT II TYPES OF NEURAL NETWORKS 09**

BPN, RBF, TDNN- associative memory network: auto-associative memory network, hetero-associative memory network, BAM, hopfield networks, iterative autoassociative memory network & iterative associative memory network – unsupervised learning networks: Kohonenself organizing feature maps, LVQ – CP networks, ART network. Case studies on biomedical applications

**UNIT III FUZZY LOGIC 09**

Membership functions: features, fuzzification, methods of membership value assignments-Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic - extension principle – fuzzy measures - formation of rules-decomposition of rules, fuzzy inference systems-overview of fuzzy expert system-fuzzy decision making. Case studies on biomedical applications.

**UNIT IV GENETIC ALGORITHM 09**

Genetic algorithm and search space - general genetic algorithm, operators - Generational cycle, stopping condition, constraints. Classification, genetic programming, multilevel optimization, real life problem, Advances in GA. Case studies on biomedical applications using deep learning.

**UNIT V HYBRID SOFT COMPUTING TECHNIQUES AND APPLICATIONS 09**

Neuro-fuzzy hybrid systems - genetic neuro hybrid systems - genetic fuzzy hybrid and fuzzy genetic hybrid systems - simplified fuzzy ARTMAP. Case studies on biomedical applications. A fusion

approach of multispectral images with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing-based hybrid fuzzy controllers. Case studies on biomedical applications.

**Total: 45 Hours**

**TEXT BOOKS:**

1. Laurene V. Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms and Applications" Pearson Education, 2010.
2. S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt Ltd, 2011.

**REFERENCE BOOKS:**

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **Average** | | **2.4** | **1.4** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **1** |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

**24BEBME7E08** **COGNITIVE PSYCHOLOGY** **3H-3C**

**Instruction Hours/week: L:3 T:0 P:0** **Marks: Internal:40 External:60 Total:100**
**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

- Explain the cognitive psychology and its blocks
- Summarize the cognitive and memory learning system
- Identify the process of cognitive thinking

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Compare cognitive psychology and its types
- Explain the blocks of cognitive learning system
- Classify the memory learning system
- Interpret communication and perceptual process
- Organize the process of cognitive thinking

**UNIT I** **INTRODUCTION** **09**

Pre-scientific era, structuralism, functionalism, associationism, behaviorism, gestalt psychology, psychoanalysis, humanistic & existential psychology, cognitive psychology, fields, emerging fields; Physiological foundations of cognition: peripheral & central nervous systems, impulse transmission, brain imaging & basic neural processes

**UNIT II** **COGNITIVE DEVELOPMENT** **09**

During infancy, early childhood, later childhood, adolescence, adulthood & old age, cognitive dissonance and cognitive framework in self-attribution; learning & cognition: basic learning processes- habituation, conditioning: classical & operant, cognitive learning, avoidance learning, punishment, generalization & discrimination, concept learning, verbal, motor learning and transfer of learning;

**UNIT III** **MEMORY** **09**

Basic neural operations, systems: sensory, STM, organization in STM, working memory, phonological Loop, visuo-spatial sketch pad, LTM, levels of processing, implicit vs. Explicit memory, autobiographical memory, constructive memory, measurement of retention, forgetting, theories, improving memories and loss of memory;

**UNIT IV** **LANGUAGE & COGNITION** **09**

Language elements, meaning & concepts, pragmatics, verbal & nonverbal communication and psycholinguistics; perceptual processes: vision, audition & other senses;

**UNIT V** **THINKING** **09**

Level of processing approach, role of symbols, images & language, concept attainment, problem solving: strategies & stages, reasoning, stages of creative thinking, artificial intelligence.

**Total: 45 Hours**

**TEXT BOOKS:**

1. M. Eysenck and M. T. Keane, Cognitive Psychology: A Student's Handbook, 4 th Ed, Psychology Press, 2000.
2. M. W. Eysenck, Principles of Cognitive Psychology, 2 nd Ed, Psychology Press, 2001.

**REFERENCE BOOKS:**

1. Parker, E. L. Wilding and T. J. Bussey, The Cognitive Neuroscience of Memory, Psychology Press, 2002.
2. Rapp, The Handbook of Cognitive Neuropsychology, Psychology Press, 2000

**WEBSITES:**

1. https://nptel.ac.in/
2. https://ocw.mit.edu/

**CO - PO - PSO MAPPING**

| COs /POs | KL | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 1 | - |
| CO2 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 1 | - |
| CO3 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 1 | - |
| CO4 | K2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 1 | - |
| CO5 | K3 | 3 | 2 | 1 | - | - | - | - | 1 | 1 | 1 | - | 1 | 1 | - |
| **Average** | | **2.2** | **1.2** | **1** | - | - | - | - | **1** | **1** | **1** | - | 1 | **1** | - |

**1 - Low, 2 - Medium, 3 - High, '-' - No Correlation**

# MANDATORY COURSES

| **24BEMC151** | **WOMEN SAFETY AND SECURITY** | **SEMESTER – I**<br>**1H-0C** |
|---|---|---|

**Instruction Hours/week: L:1 T:0 P:0** **Marks: Internal:100 External:0 Total:100**

**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

The goal of this course is for the students to

- Highlight the social construction of gender in Indian society and the role of social institutions in the socialization process.
- Make aware about the practical issues concerning gender and politics.
- Classify the students in engendering national policies and programmes.
- Observe the liability of women and women's work in the context of globalization.
- Acquaint knowledge about the political participation of women and the gendered structures of governance and polity.

**COURSE OUTCOMES**

Upon completion of this course the students will be able to

- Infer into the basic concepts related to sex, gender, femininity etc.
- Demonstrate the rationale for women's studies
- Compare Gender Equality Issues and Movements in Women's Studies
- Summarize the Social construction of Gender, Gender Roles and Gender stereotyping.
- Illustrate Social Structures, Changing Status of Women in India.

**UNIT I FUNDAMENTAL CONCEPTS OF WOMEN'S STUDIES**

Definition- Objectives of Women's Studies; Importance of Women's Studies; Women's Studies as an Academic Discipline; Role of UGC Centre for Women's Studies

**UNIT II SOCIAL EMPOWERMENT**

Women in Higher Education; Gender issues in Health, Environment, Family welfare Measures, Indecent representation of Women in media; Women in Difficult circumstances; Constitutional.

**UNIT III POLITICAL EMPOWERMENT**

Women leaders in politics- Women in Local Governance- Barriers- Reservation policies- Women's Political Rights, Property Rights - Violence against Women - Women's work

**TEXT BOOKS:**

1. Amy S. Wharton. (2005). "The Sociology of Gender: An Introduction to Theory and Research". (Key Themes in Sociology) Blackwell Publishing, UK, Indian Reprint, Kilaso Books, New Delhi.
2. Devaki Jain and Pam Rajput (Ed). (2003). "Narratives from the Women"s Studies Family: Recreating Knowledge, Sage, and New Delhi.
3. Jasbir Jain (Ed). (2005). "Women in Patriarchy: Cross Cultural". Rawat Publication Jaipur.

| **24BEMC152** | **தமிழர் மரபும் பண்பாடும்** | **பருவம் -I** **1H-0C** |
|---|---|---|

கற்பித்தல் நேரம்/வாரம்**: L:1 T:0 P:0** **மதிப்பெண்: இடைத்தேர்வு: 100 மொத்தம்:100**

**PREREQUISITES: NIL**

## பாடத்திட்ட பயன் விளைவு:

- வரலாற்றிற்கு முற்பட்ட தமிழகத்தை மாணவர்களுக்கு அறிமுகப்படுத்துதல்
- பழந்தமிழர் பண்பாடு சார்ந்த வாழ்க்கை முறையை மாணவர்கள் அறிய ஊக்குவித்தல்
- தமிழ் மொழியின் பழைமையும், திராவிட மொழிகளில் தமிழ்மொழியின் தனிச்சிறப்பையும் மாணவர்களுக்கு அறிமுகப்படுத்துதல்.
- தமிழர்களின் வாழ்வியல், தமிழர்கலைகள், ஆற்றங்கரைப்பண்பாடுகள் குறித்து மாணவர்கள் அறியச்செய்தல்.
- இந்தியக்குடியுரிமைப்பணி முதலான போட்டித்தேர்வுகளில் விருப்பப்பாடமாக இடம்பெறுகின்ற தமிழ்நாகரிகமும் பண்பாடும் குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்

## பாடத்திட்டப் பொதுநோக்கம்:

- இந்தியக்குடியுரிமைப்பணி முதலான போட்டித்தேர்வுகளில், விருப்பப்பாடமாக இடம்பெறுகின்ற, 'தமிழ்இலக்கியவரலாறு' குறித்த முழுமையான அறிமுகம் பெற்றிருத்தல்.
- கல்வெட்டியல், ஓலைச்சுவடியியல் மற்றும் தொல்லியல் சார்ந்த ஆவணத்தேடலுக்குரிய ஆய்வுமனப்பான்மையுடன், இலக்கியங்களை அணுகுதல்.
- தமிழின்வளர்ச்சித்துறையாகிய, 'அறிவியல்தமிழ்'; ' இணையதமிழ்' குறித்த பன்நோக்கு அணுகுமுறையிலான ஆய்வுச்சிந்தனை மேம்பாடு.
- வேலைவாய்ப்புக்குரிய சுயதிறன் மேம்பாட்டுடன், படைப்பாக்கத்திறன் மேம்பாடும் பெற்றிருத்தல்.
- சமுதாய மற்றும் வாழ்வியல் மதிப்புகளைப்பேணுவதற்குக்கருவியாக இலக்கியங்களை நாடுகின்ற மனப்பான்மைவளர்ச்சி. மொழிபெயர்ப்புத்துறை சார்ந்த வேலைவாய்புத்திறன் பெற்றிருத்தல்.

**அலகு I** **தமிழர் மரபு**

மரபு-விளக்கம்-சங்ககால தமிழர் மரபு – திணைப்பகுப்பும் தமிழர் மரபும்-உலகப்பொதுமை – அகத்திணை மரபு – புறத்திணை மரபு-

இடைக்காலத்தமிழர் மரபு – பிற்கால மரபும் மாற்றமும் – தற்கால தமிழர்மரபு - வளர்ச்சி.

**அலகு II தமிழர் பண்பாடு**

பண்பாடு – விளக்கம் – பழந்தமிழர் பண்பாடு – இயற்கை சார்ந்த வாழ்வியல் – தமிழர் சமயம் – அரசியல் நிலை–சமூகப் பழக்கவழக்கங்கள் – நம்பிக்கைகள் – வாழ்வியல் அறங்கள் – வணிகம் போன்றவை.

**அலகு III தமிழர் கலைகள்**

தமிழகத்தில் கலைகளின் வளர்ச்சி – சிற்பக்கலை வளர்ச்சி –கோயில் கலை – கற்கோவில்கள் - ஓவியக்கலை – அழகுக்கலைகள் - கூத்துக்கலை – மருத்துவக்கலை – நாடகக்கலை– இசைக்கலை போன்றவை.

**அலகு IV தமிழர் சமயம்**

பழந்தமிழரின் சமயம் – சங்ககால சமயம் – தொல்காப்பியத்தில் சமயம் – சைவ சமயம் – வைணவம் – தமிழ்ப் பண்பாட்டில் பௌத்தம் – தமிழ்ப் பண்பாட்டில் சமணத்தின் தாக்கம்–தமிழ்ப் பண்பாட்டில் இசுலாம் மற்றும் கிறித்துவ சமயத்தின் தாக்கம்- தமிழர் பண்பாட்டில் விழாக்கள்- கோயில்களும் விழாக்களும்- சமூக ஒருங்கிணைப்பில் விழாக்களின் பங்கு-சங்க இலக்கியத்தில் விழாக்கள் பற்றிய குறிப்புகள்-இடைக்கால இலக்கியங்களில் விழாக்கள் பற்றிய செய்திகள் – விழாக்களின் சமூகப்பங்களிப்பு – தற்காலத்தில் தமிழர் விழாக்கள் - விளையாட்டும் விழாக்களும்.

**அலகு V இலக்கியங்களில் தமிழர் பண்பாட்டுப் பதிவுகள்**

சங்க இலக்கியமும் வாழ்வியலும்-திருக்குறளில் வாழ்வியல் நெறிகள் – இரட்டைக் காப்பியங்களும் வாழ்வியலும் – சிற்றிலக்கியங்களில் வாழ்வியல் பதிவுகள்-இக்கால இலக்கியமும் வாழ்வியலும்.

**பார்வைநூல்கள்:**


1. தமிழ் இலக்கிய வரலாறு – தமிழண்ணல், மீனாட்சி புத்தக நிலையம்- மதுரை-இரண்டாம் பதிப்பு-ஜூலை – 2000.
2. தமிழர் நாகரிகமும் பண்பாடும், அ. தட்சிணாமூர்த்தி, ஐந்திணைப் பதிப்பகம், சென்னை, திருத்திய பதிப்பு – 2022.
3. தமிழர் வரலாறும் பண்பாடும், நா. வானமாமலை, நியூசெஞ்சுரி புக் ஹவுஸ், சென்னை, ஆறாம்பதிப்பு – 2007
4. தமிழக வரலாறு மக்களும் பண்பாடும், கே.கே. பிள்ளை, உலகத் தமிழராய்ச்சி நிறுவனம், சென்னை.

| B.E Biomedical Engineering | | 2024-2025 |
|---|---|---|
| 24BEMC251 | YOGA | SEMESTER – II<br>4H-2C |

**Instruction Hours/week: L:0 T:0 P:4** **Marks:** Internal**:100** External**:0** Total**:100**

**End Semester Exam:3 Hours**

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course, is for the students:

- To have knowledge of Physical fitness and exercise management to lead better quality life
- To enable to officiate, supervise various sports events and organize sports events
- To acquire the knowledge of Physical Education, Sports and Yoga and understand the purpose and its development
- To gain knowledge to plan, organize and execute sports events

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

- Practice physical activities and yoga for strength, flexibility and relaxation.
- Use techniques for increasing concentration and decreasing anxiety for stronger academic performance.
- Perform yoga exercises in various combination and forms.
- Improve personal fitness through participation in sports and yoga activities.
- Follow sound nutritional practices for maintaining good health and physical performance.

**UNIT I INTRODUCTION TO PHYSICAL FITNESS**

Explain importance of physical education - Describe importance of Physical Fitness & Wellness - Explain the components of physical fitness - Demonstrate healthy life style - Prevent health threats by changing life style

**UNIT II FUNDAMENTALS OF ANATOMY & PHYSIOLOGY IN SPORTS & YOGA**

Explain importance of anatomy and physiology - Describe effects of exercise in various body systems - Describe concept of correct posture - Explain corrective measures for posture deformities.

**UNIT III YOGA & PRANAYAMA**

Explain importance of yoga - Perform various pranayama for increasing concentration - Use meditation and other relaxation techniques for improving concentration.

**TEXT BOOKS:**


1. Ajmer Singh, Modern Trends and Physical Education class 11 & class 12, Kalyani Publication, New Delhi ISBN:9789327264319.
2. B. K. S. Iyengar, Light on Yoga, Thomson's Publication, New Delhi ISBN: 8172235011
3. V. K. Sharma, Health and Physical Education, NCERT Books; Class 11, 12 Saraswati House Publication, New Delhi
4. Acharya Yatendra, Yoga and Stress Management, Finger print Publishing ISBN:938905303X
5. Swami Vivekanand, Patanjali Yoga Sutras, Fingerprint Publishing ISBN:9389567351.
6. Ramdev, Pranayam Rahasya, Patanjali-Divya Prakashan, Haridwar ISBN:978-8189235017
7. Ramdev, Yoga its Philosophy & Practice, Divya Prakashan, Haridwar.

| **24BEMC351** | **APTITUDE AND REASONING** | **SEMESTER – III**<br>**1H-0C** |
|---|---|---|

**Instruction Hours/week: L:1 T:0 P:0** **Marks:** Internal**:100** External**:0** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for the students to

- Categorize, apply, and use thought processes to distinguish between concepts of
- Quantitative methods.
- Prepare and explain the fundamentals related to various possibilities and probabilities
- related to quantitative aptitude.
- Critically evaluate numerous possibilities related to puzzles.
- Understand and solve puzzle-related questions from specific and other competitive tests.
- Solve questions related to Time and distance and time and work etc.

**COURSE OUTCOMES**

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

- Understand the basic concepts of quantitative ability
- Understand the basic concepts of logical reasoning Skills
- Acquire satisfactory competency in the use of reasoning
- Solve campus placements aptitude papers covering Quantitative Ability, Logical
- Gaun Reasoning Ability Compete in various competitive exams like CAT, CMAT, GATE, GRE, GATE, UPSC, GPSC etc.

**UNIT I** **Quantitative Ability (Basic Mathematics)**

1.1. Number Systems
1.2. LCM and HCF
1.3. Decimal Fractions
1.4. Simplification
1.5. Square Roots and Cube Roots
1.6. Problems on Ages
1.7. Surds & Indices
1.8. Percentages

**UNIT II** **Quantitative Ability (Applied & Engineering Mathematics)**

2.1. Logarithm
2.2. Permutation and Combinations
2.3 Probability
2.4 Profit and Loss
2.5 Simple and Compound Interest
2.6. Time, Speed and Distance
2.7. Time & Work
2.8. Ratio and Proportion
2.9. Area
2.10 Mixtures and Allegation

**UNIT III** **Verbal - Aptitude**

3.1. Words
3.2. Idioms
3.3. Phrases in Context
3.4. Reading comprehension techniques
3.5. Narrative sequencing
3.6. Data interpretation

**TEXT BOOKS:**

1. A Modern Approach to Verbal & Non-Verbal Reasoning By R S Agarwal
2. Analytical and Logical Reasoning By Sijwali B S
3. Quantitative aptitude for Competitive examination By R S Agarwal
4. Analytical and Logical Reasoning for CAT and other management entrance tests By Sijwali B S
5. Quantitative Aptitude by Competitive Examinations by Abhijit Guha 4th edition

**WEBSITES:**

1. https://prepinsta.com/
2. https://www.indiabix.com/
3. https://www.javatpoint.com/

| **24BEMC451** | **FOUNDATION OF ENTREPRENEURSHIP** | **SEMESTER – IV**<br>**1H-0C** |
|---|---|---|

**Instruction Hours/week: L:1 T:0 P:0** **Marks:** Internal**:100** External**:0** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for the students to

- Equip and develop the learners entrepreneurial skills and qualities essential to undertake business.
- Impart the learners entrepreneurial competencies needed for managing business efficiently and effectively.
- Understand basic concepts in the area of entrepreneurship
- Develop personal creativity and entrepreneurial initiative
- Adopt the key steps in the elaboration of business idea

**COURSE OUTCOMES**

Upon completion of this course the students will be able to

- Gain entrepreneurial competence to run the business efficiently.
- Undertake businesses in the entrepreneurial environment
- Prepare business plans and undertake feasible projects.
- Be efficient in launching and develop their business ventures successfully
- Monitor the business effectively towards growth and development

**UNIT I ENTREPRENEURAL COMPETENCE**

Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful Entrepreneurs – Knowledge and Skills of an Entrepreneur.

**UNIT II ENTREPRENEURAL ENVIRONMENT**

Business Environment - Role of Family and Society - Entrepreneurship Development

**UNIT III BUSINESS PLAN PREPARATION**

Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership

**UNIT IV LAUNCHING OF SMALL BUSINESS**

Finance and Human Resource Mobilization - Operations Planning - Market and Channel Selection - Growth Strategies

**UNIT V MANAGEMENT OF SMALL BUSINESS**

Monitoring and Evaluation of Business - Effective Management of small Business - Case Studies.

**Total: 15 Hours**

**TEXT BOOKS:**

1. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2016.
2. R.D.Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2018.
3. Rajeev Roy ,Entrepreneurship, Oxford University Press, 2nd Edition, 2011.
4. Donald F Kuratko,T.V Rao. Entrepreneurship: A South Asian perspective. Cengage Learning, 2012

| **24BEMC452** | **ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE AND HERITAGE** | **SEMESTER – IV 1H-0C** |
|---|---|---|

**Instruction Hours/week: L:1 T:0 P:0** **Marks:** Internal**:100** External**:0** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for the students to

- Impart a holistic understanding about Indian Culture and Thoughts from a Historical perspective.
- Encourage critical appreciation of the Indian thoughts and cultural manifestations.
- Introduce the students to important concepts from the diverse intellectual traditions of India.
- Make use of Indian cultural heritage and various epistemological inquiries.
- Gain knowledge of Indian heritage.

**COURSE OUTCOMES**

Upon completion of this course the students will be able to

- Understand the cultural diversity
- Infer the need of cultural unity
- Know the Dravidian culture
- Realize the power of Indian educational system called gurukul
- Come to know the concepts of Vedic thought

**UNIT I INTRODUCTION TO INDIAN THOUGHT AND CULTURE**

Plurality of Indian culture - Cultural Diversity and Cultural Unity -Different manifestations of Indian Culture: Indus valley culture -Vedic culture and Dravidian culture - The Medieval Bhakti Culture

**UNIT II TRADITIONAL KNOWLEDGE SYSTEMS OF INDIA**

Introduction to the Traditional Indian Education system of Gurukul - Parampara - Understanding Indian Philosophy: Vedic thought and the nine schools of philosophy - Indigenous Knowledge and Women in India

**TEXT BOOKS:**

1. Chatterjee, Satishchandra and Dhirendramohan Datta. (2007) Introduction to Indian Philosophy. Rupa Publications, New Delhi.
2. Husain,S. Abid. (2003). The National Culture of India. National Book Trust, New Delhi.

| **24BEMC551** | **CYBER SECURITY** | **SEMESTER – V**<br>**1H-0C** |
|---|---|---|

**Instruction Hours/week: L:1 T:0 P:0** **Marks:** Internal**:100** External**:0** Total**:100**

**End Semester Exam:**3 Hours

**PREREQUISITES: NIL**

**COURSE OBJECTIVES**

The goal of this course is for students to:

1. To understand the field of digital security and concepts of access control mechanism.
2. To introduce keywords and jargons involved in securing browser
3. To understand network basic and familiarize on security of network protocols
4. To understand cyber-attacks and data privacy
5. To learn the tools and methods used in cyber security

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to:

1. Infer the importance of a network basics and brief introduction on security of network protocols
2. Apply a solid foundation in digital security and measures taken to protect device from threats.
3. Discuss about cyber-attacks and data privacy issues and preventive measures.
4. Make use of tools and methods used in cyber security.
5. Explain Cyber security organizational implications.

**UNIT I NETWORKING BASICS**

Networking basics (home network and large-scale business networks), Networking protocols, Security of protocols, sample application hosted on-premises.

**UNIT II BASICS OF DIGITAL SECURITY**

Basics of digital security, protecting personal computers and devices, protecting.World Wide Web (www), the Internet and the HTTP protocol, security of browser to web server interaction

**UNIT III INTRODUCTION TO CYBER-ATTACKS**

Introduction to cyber-attacks, application security (design, development and testing), operations security, monitoring, identifying threats and remediating them.

**UNIT IV TOOLS AND METHODS**

Tools and methods used in cyber security: Proxy servers and anonymizers – Phishing – Password cracking – Keyloggers, Attacks on wireless networks – Phishing and Identity theft.

**UNIT V CYBER SECURITY ORGANIZATIONAL IMPLICATIONS**

Cyber security organizational implications: Cost of cyber crimes and IPR – Web threads for organizations – Security and privacy implications – Social media marketing – Incident handling – Forensics best practices for organization.

**Total: 15 Hours**

**TEXT BOOKS:**

1. Sammons, John, and Michael Cross. The basics of cyber safety: computer and mobile device safety made easy. Elsevier, 2016.
2. Nina Godbole and Sunit Belapure, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley Publisher, First Edition, 2011

**REFERENCE BOOKS:**


1. Charles P. Pfleeger, Shari Lawrence, Pfleeger Jonathan Margulies; Security in Computing, Pearson Education Inc . 5th Edition, 2015
2. Brooks, Charles J., Christopher Grow, Philip Craig, and Donald Short. Cyber security essentials. John Wiley & Sons, 2018
3. Harish Chander, Cyber Laws and IT Protection, PHI Learning, First Edition, 2012
4. James Graham, Ryan Olson and Rick Howard, Cyber Security Essentials, CRC Press, First Edition, CRC Press, First Edition